Modal Development: Input-Divergent L1 Acquisition in the Direction of Diachronic Reanalysis

by

Ailís Cournane

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy

Department of Linguistics
School of Graduate Studies
University of Toronto

© Copyright by Ailís Cournane 2015
Ailís Cournane

Doctor of Philosophy

Department of Linguistics
University of Toronto

2015

Abstract

This thesis explores the proposed causal link between child language development and language change from the language acquisition perspective. While theorists have argued for a causal link between acquisition and change for over a century (Meillet, 1912; Paul, 1920; i.a.), but little research has investigated whether this proposal makes sense for child language (c.f. Baron, 1977; van Gelderen, 2011: 21-26; Cournane, 2014). I investigate whether child input-divergent patterns (i.e., analyses which diverge away rather than converge towards the adult target) are compatible with innovations we see in the historical record.

I present a series of naturalistic and experimental studies focusing on modal expressions (e.g., must, can, have to, be going to) in English development. Modal expressions develop diachronically in a unidirectional manner: (a) syntactically, from verbs to functional verbs to INFL-elements (Roberts, 1985; i.a.), and (b) semantically, from root meanings (e.g., ability, obligation), to epistemic meanings (e.g., inference) (Traugott, 1989; i.a.). The studies in this thesis first propose what would need to be true of child language in order for child input-
divergence to be the source of historical innovations, and second, test whether these input-divergent patterns indeed occur in child development.

The corpus studies on naturalistic modal development provide evidence for syntactic re-categorization biases (i.e., for treatment of expressions which belong to lower categories like ν in the input, as higher categories, like INF, in the child grammar). These studies also show that the delayed onset of epistemic modal uses relative to root modal uses is best explained by grammatical development, not conceptual development (Papafragou, 1998; i.a.). The experimental studies provide evidence that preschool age children increasingly attribute epistemic-type interpretations to polysemous modal constructions, regardless of the presence or absence of meaning-determining aspect cues which adult speakers rely on (Condoravdi, 2002; Hacquard, 2006). Children appear to show U-shaped development for modal meaning and the direction of non adult-like meaning attributions is compatible with the diachronic root > epistemic trajectory.

Taken together, the studies in this thesis show that children have persistent input-divergent developmental biases in both the syntactic and semantic development of their modal expressions. Both developmental patterns are consistent with the view that there are grammar internal biases in development towards treating modal expressions as increasingly abstract and functional (higher scope, higher in the tree), the same directionality observed in historical development (von Fintel, 1995; Roberts & Roussou, 2003; i.a.).
Acknowledgements

I dedicate this work to my late uncles Barry O’Donovan and Dr. Gerard O’Donovan, respectively an avid scholar of Irish and a beloved professor of microbiology. I made a secret promise to Uncle Barry’s memory at his funeral when I was 18: I’d study Irish. Turns out I got three degrees in Linguistics in addition to some Irish.

I think he’d be happy about that.

I must thank my Mom and Dad first because they are a constant source of unqualified love and support through thick and thin. I love you Ma and Da. And to my whole family – Patrick, Jamie, Fintan, Eamon, Annie and Tadhg – Go raibh mile maith agaibh!

My dissertation would’ve been impossible without my committee, “The Romance Squad”: Ana Teresa Pérez-Leroux (¡Gracias!), Michela Ippolito (Grazie!), Yves Roberge (Merci!), Mihaela Pirvulescu (Mulfumesc!), and Cristina Cuervo (¡Gracias!). Thanks for working on English with me. To my external, Laura Wagner (Appreciations! [English borrowing from Romance]), thank you for a thorough review, insightful questions, and pushing me in the question period. There is no doubt that I am a better scholar because of all of you. To Ana Teresa, especially, thank you for believing in me and helping me turn my big-picture ideas into workable hypotheses.

Several other members of the academic community have been helpful, insightful, and encouraging. At U of T, big thanks to Susana Béjar, Arsalan Kahнемuyipour, Keren Rice, Elan Dresher, Alana Johns, Bronwyn Bjorkman, Simona Herdan, Tyler Peterson, Craig Chambers, Alexei Kochetov, Sali Tagliamonte, Diane Massam, Elizabeth Cowper, Naomi Nagy, Daphna Heller, Jack Chambers, Elaine Gold, Youri Zabbal, Bill “Billiam” Forrest, Jill Given-King, and Mary Hsu. I extend my thanks also to Valentine Hacquard, Jeff Lidz, Jill de Villiers, Tom Roeper, Petra Schulz, John Grinstead, Charles Yang, Joel Wallenberg, Robert Truswell, David Lightfoot, David Heap, Elizabeth Traugott, Elly van Gelderen, Jozina Vander Klok, Chiara Gianollo, and Nina Hyams. Hartelijk bedankt to the Amsterdam Grammar & Cognition group. And, since I know I must be forgetting people, a general thank-you to everyone who has talked shop with me over the years!

This dissertation could not have happened without the participation of numerous adorable children and less adorable but still very helpful adults. So many wonderful parents, daycare directors, neighbours, students, and friends have helped out and I want to thank them all so much. I love working with the children more than anything. They are a constant source of amusement and a constant reminder of just how remarkable yet everyday the process of language acquisition is. In particular, thank you to my puppeteers Mira Kates-Rose, Erin Pettibone, TJ Dunn, and Olivia Marasco; to my guinea pigs Chris Spahr, Mahak Jain, Ross Godfrey, Derek Denis, Dan Milway, Maral Sanassian, and Giselle Frieda; to the particularly go-getter-awesome
daycare directors Maureen Bailey, Sean Heggie, and Colette Kane (George Brown Daycares); and helpful friends and colleagues Elaine Gold (& family), Dan Milway (& family), Kevin Barrett, and Julia Martyn. Thanks also to the late Dr. Roger Brown & colleagues and to “Sarah” & family; wherever they are, they still contribute to child language research on a regular basis.

Data can be tricky, finicky, business. A few people have been especially helpful with data collection, management, statistics and software. A huge thank you to Ana Teresa Pérez-Leroux, Daphna Heller, Beth MacLeod, and Derek Denis for giving me the tools and confidence to become an experimentalist, to Barend Beekhuizen for some search tricks and for holding my hand during the confusingest parts of corpus coding, to Michael Weiss for helping me program in MATLAB (ok, doing it and then explaining), and to Ewan Dunbar for several illuminating and seriously helpful sessions with R, Python, and the gods of mathematics.

Next I oughtta thank my former beaux who were current and very important for periods of my PhD life, and who continue to be important in my story. I’ve been lucky to have only kind, loving partners in my life and it’s not possible to measure how much I have learned and loved. Merci Mathieu Lavoie! Hvala Pavle Levkovic! Dank je Barend Beekhuizen! And to my current beau, Michael Weiss, you are a source of calm and comfort, you are marvellously clever and wise, you are Wise Weiss <3

I have the best friends and I can’t thank them enough! To my lovelies: Sandrine “Sandypantalons” Taillour (& menfolk Matt and bébé Lucas), the one and only Michelle “Smelly” St-Amour, Nicole Stratton from The Shire (& menfolk Jake, Perry, Archer, & Arik), the witty, wise, and wonderful Sarah Clarke, Becky “Becks/Bend-it-like-Becky/The Beckster/Rebecky/[I could go on...]” Tollan, the stylish, smart, and sassy Beth MacLeod, my ENFP partner-in-extroversion Eduardo Costa, the notorious duo of Isaac Gould & Nik Rolle, Derek “Dr. Viking” Denis, the badass dynamic dynamo Alex Motut, the considerate & clever Yu-Leng Lin, Anne “Math Goddess” MacKay, David Henbest for being the first person to inspire me to write a lot, and the enigmatic (slightly insane in the good way) Ewan “Yoon!” Dunbar. And and and, of course, Maral, Aurélie, Sam, Laura, Olivier, & Allen! Bisous à tous! And to family friends: Merci beaucoup à Serge et Monique! Veel dank aan Annette en Jeff! Thank you Marge Kennedy!

To my linguistics department pals, I just gotta say, you are a lovely bunch of coconuts. To all my linguists: Slainte! In particular, but in no particular order, thanks to Dan (but not his moustache), Kenji O’Da, Richard “Stabby” Compton (for teaching me the most about U of T graduate school when I first arrived), Tomo the Clean, Radu (Irish class buddies!), Will, Chris S (& Mahak!), Ross, Joanne, Marina, Nelleke, Marisa, Monica, Manami, Jada, Julianne, Joanna (& John!), Rick, Annick, Shayna, Mercedeh, Safi (cohort buddy!), Catherine (& Jonathan!), Jessamyn, Chiara, all the SpanPort ladies & my whole amazing MA crew! And to the many MA and PhD cohorts that followed! And to the brilliant visitors: Samantha J, Mike P, Claire, Signe, and Becky W! Slainte to my GALA(NA) and BUCLD pals and to the DiGS crew!

And I shan’t forget my roomies over the Toronto years: Stephanie, Sandrine, Alex, and (for a whopping 5+ years) Eddy Okun and Amos Craig. Thanks for sharing our living space and being super! And on the topic of living-mates, I’m gonna mention my kitty Darwin, who came into my
life as a cute all-black kitten in January 2014. He has been a constant source of amusement (with a dose of stress when he relieves himself inappropriately or up and breaks his jaw on a foray outside (true stories)). He is not human and that makes him very interesting to my primate brain – what is this weird little mammal doing in my house and why do I love him so? He cannot read this, but everyone who can should know how much I love my non-human baby (and evolutionary science).

It is probable that if I could measure all the time I spent writing my dissertation, we would find that the bulk of it occurred at cafés in Kensington Market/Little Italy. My favourite haunts throughout the years: Pamenar, Jimmy’s, Rick’s Café, Voodoo Child, & Manic (“the good place without internet”). Koffie in Oost was my café during my stint in Amsterdam, and I’m pictured on their website writing Chapter 3! A warm thank you to all the lovely baristas, other regulars, and to coffee itself.

Throughout the PhD years I went to several conferences and had to rely on the kindness of friends and hosts for accommodations. I extend thanks to: my Ottawa hosts Annie-Joelle Tailleur et famille, Andrew & Veronica, Beth & Conrad; my Montréal hosts Serge et Monique and Olivier Couture; my France hosts Sam et Aurélie; my Germany and Netherlands hosts Laura Lee et Jan Kirmse and Barend en Paul Beekhuizen; my Texas hosts Brian O’Donovan and Renata Ponte; my Washington/MD hosts Kate Harrigan (& hubby Jeff) and Valentine Hacquard (& hubby Tarek); my Boston hosts Annie & Eamon, Michelle and Naomi, and Julia & Mihir. And three cheers for AirBnb and Couchsurfing!

Finally, I extend the exact opposite of gratitude to the administrative offices of U of T for regularly opting to ‘solve’ higher education funding problems by downloading them on the most powerless members of the research and teaching community, while concurrently growing administrative salaries well beyond inflation. I believe the best of humanity is seen in the search for knowledge about our world and ourselves. The worst is seen in the search for personal gain beyond reasonable need and at the expense of others. Moving away from the worst and towards the best, the university community can and must respect the contributions of graduate student colleagues with a reliable base living stipend that takes into account both teaching and research work required, protects research time relative to teaching, and is commensurate with actual completion times. I’m glad to be free of this aspect of studenthood, but I won’t forget it.

To the modal future, where the very best things are possible!
Table of Contents

Abstract ........................................................................................................................................... ii

Acknowledgements .......................................................................................................................... iv

Table of Contents ............................................................................................................................. vii

List of Tables ..................................................................................................................................... ix

List of Figures .................................................................................................................................... x

Chapter 1: Introduction and Background ...................................................................................... 1

1.1. Introduction ................................................................................................................................. 1

1.1.1. Motivation ................................................................................................................................. 3

1.2. Background .................................................................................................................................. 11

1.2.1. Modality .................................................................................................................................... 11

1.2.2. Functional Modals in the Syntax ............................................................................................. 18

1.2.3. English modals categories (and how they came to be) ......................................................... 23

1.2.4. Explaining modal form-meaning mappings for functional modals ........................................ 28

1.3. Diachronic Directionality: steps on the Modal Cycle ................................................................. 32

1.3.1. Explaining the modal cycle .................................................................................................... 38

1.4. Assessing child evidence for the Child Reanalysis Proposal .................................................... 41

Chapter 2: Learning Modals ............................................................................................................ 44

2.1. Mapping a complex category ....................................................................................................... 44

2.2. The force contrast in children’s comprehension of modals ....................................................... 47

2.3. The development of modal flavour and the “Epistemic Gap” .................................................... 51

2.3.1. Early naturalistic evidence ....................................................................................................... 51

2.3.2. Experimental evidence ........................................................................................................... 55

2.3.3. The development of evidentiality ............................................................................................. 58

2.4. Explaining the epistemic gap ..................................................................................................... 62

2.4.1. Clarifying the grammatical approach to explaining the Epistemic Gap ............................... 65

2.5. Directly testing the Child Reanalysis Proposal .......................................................................... 74

2.6. Conclusion .................................................................................................................................... 77

Chapter 3: In search of naturalistic evidence for diachronic reanalysis: longitudinal corpus study .................................................................................................................................................. 80

3.1. Introduction .................................................................................................................................... 80

3.1.1. Assumptions: mapping words to modal meanings and modal meanings to words ............. 82

3.2. Study 1: In search of epistemic lexical modals .......................................................................... 87

3.2.1. Questions and Hypotheses ....................................................................................................... 87

3.2.2. Methods ..................................................................................................................................... 88

3.2.3. Results ....................................................................................................................................... 89

3.2.4. Discussion ................................................................................................................................. 92

3.3. Study 2: Addressing the Frequency Hypothesis .......................................................................... 95
**List of Tables**

**Table 1.1.** English modals under consideration in this dissertation
**Table 1.2.** Modals and pre-modals in English

**Table 2.1.** Syntactic category by group: root contexts (from Cournane, 2014)
**Table 2.2.** Syntactic category by group: non-root contexts (from Cournane, 2014)
**Table 2.3.** Error rates for condition across groups, preference task (from Cournane, 2014)

**Table 3.1.** Expected epistemic uses by developmental stage
**Table 3.2.** Root and Epistemic modal counts
**Table 3.3.** Epistemic modal uses by syntactic category
**Table 3.4.** Sureness by flavour
**Table 3.5.** INFL counts and percentages in child and mother
**Table 3.6.** Flavour breakdown for INFL modals for child and mother
**Table 3.7.** Pearson residuals squared
**Table 3.8.** Little-ν modal counts and percentages in child and mother
**Table 3.9.** Premodal lexical counts for child and mother
**Table 3.10.** Counts by syntactic category for child and mother
**Table 3.11.** Sarah’s grammatical and modal milestones

**Table 4.1.** Relationship between the two tasks of the study
**Table 4.2.** The three stories that elicited the most distinct ratings for target sentences
**Table 4.3.** Modal Flavour Task Design (2x2)
**Table 4.4.** (ADULTS) Mixed effects logistic regression
**Table 4.5.** (CHILDREN) Mixed effects logistic regression
**Table 4.6.** Modal Detection Task Design (2x2)
**Table 4.7.** (ADULTS) Confidence intervals from mixed-effects logistic regression with prior
**Table 4.8.** (CHILDREN) Confidence intervals from mixed-effects logistic regression with prior
List of Figures

Figure 3.1. Root and epistemic modal counts by group
Figure 3.2. Epistemic counts by syntactic category by group
Figure 3.3. Syntax-Semantics alignments
Figure 3.4. Sarah’s root and epistemic development
Figure 3.5. Flavours within INFL category
Figure 3.6. INFL and v future modals by month
Figure 3.7. Counts by syntactic category by group
Figure 3.8. Premodal complement-types by month
Figure 3.9. Little-v complement-types by month
Figure 3.10. BE-omissions for going and supposed by month

Figure 4.1. The four picture-types involved in each story
Figure 4.2. The Likert scale given to the participant to judge each sentence
Figure 4.3. Penguin and her book
Figure 4.4. First training item
Figure 4.5. Sequence of pictures for a story
Figure 4.6. Target pictures for each test-sentence
Figure 4.7. Epistemic picture choices by condition by group
Figure 4.8. Epistemic picture choices by condition by group, Perfect Condition
Figure 4.9. Epistemic picture choices by condition by group, Progressive Condition
Figure 4.10. The Diversity Condition
Figure 4.11. Test item and puppets
Figure 4.12. Must-sentence choices by condition by group
Chapter 1: Introduction and Background

1.1. Introduction

This dissertation investigates whether child learners drive the reanalyses we see in the historical record, focusing on modal verbs. Modal verbs evolve in a unidirectional manner: (a) syntactically, from verbs to functional verbs to INFL-elements, and (b) semantically, from root meanings to epistemic meanings, along the Modal Cycle (Jespersen, 1961; Lightfoot, 1979; Traugott, 1989; Bybee, Perkins, & Pagliuca, 1994; Gergel, 2009; i.a.). Many theorists have proposed a causal link between first language (L1) acquisition and change, arguing that innovations in a language’s history result from learners’ divergent analyses of the input language; the core of this idea traces back to the beginnings of formal historical linguistics (Paul, 1920 [1880]; (Meillet, 1912 [1958]; Halle, 1964; Andersen, 1973; Lightfoot, 1979; Kiparsky, 1982; i.a.) and continues to be a central tenet of current theoretical discussion (Kroch, 1989, 1994; Faarlund, 1990; Hale, 1998; Roberts & Roussou, 2003; Roberts & Roussou, 1999; van Gelderen, 2004, 2009, 2011; Meisel et al. 2013; i.a.).

Despite the appealing nature of this proposal (henceforth the Child Reanalysis Proposal (CRP)), and its utility in historical linguistic analysis (e.g. van Gelderen, 2009), the CRP suffers from lack of evidence from child language. The significance and viability of this proposal for the learner’s developmental pathway have been explored only rarely with child data (c.f., Baron, 1977; van Gelderen, 2011:21-26; Cournane, 2014), and to limited ends. In this dissertation, I use longitudinal and experimental child data to test the child language predictions of the CRP. It is my hope that this approach to the CRP provides meaningful insights and methods for linking the dynamic fields of diachronic linguistics and language acquisition, both of which deal with development and change at their core.

The CRP prompts the following broad questions for child language researchers: (i) do child learners diverge from their input during development in such a way that, if sustained, the divergent analyses are compatible with the directional innovations of diachrony? And, (ii), if the answer to question (i) is affirmative, then what aspect of the language faculty or the acquisition process is responsible for the input-divergent biases seen in child language? The term bias is
used for any learning metrics that come from within the language faculty and thus contribute to learning in a manner that is independent from usage facts.

For the Modal Cycle, I explore whether child learners can be responsible for both the syntactic and semantic changes that are associated with modal expressions in diachrony: respectively, $V \rightarrow v \rightarrow \text{INFL}$ reanalysis, and $\text{Content} \rightarrow \text{Root}$ (e.g., ability, obligation) $\rightarrow \text{Epistemic}$ (knowledge or evidence-based inference) reanalysis. I test the following semi-independent (see §1.2.3) hypotheses that arise from the Modal Cycle:

I. For the syntactic cycle, child learners are expected to treat items that are lower (e.g., $v$) in the input as higher (e.g., INFL); for example, to treat main verbs as functional verbs or functional verbs as auxiliaries. These upwards mis-categorizations would drive the syntactic modal cycle if they were sustained.

II. For the semantic cycle, child learners are expected to overextend the meanings of content verbs to root meanings, and root modals to epistemic meanings; for example, to use premodal $\text{want}$ to denote the future, or root modal $\text{can}$ to denote epistemic possibility. These overextensions, if sustained, would drive the semantic modal cycle.

These hypotheses are tested from two angles, (a) in a longitudinal naturalistic corpus study, and (b) in a series of experimental picture-preference and sentence-preference tasks. The corpus study investigates the modal and premodal (those verbs which are known to be recruited into the modal cycle, Lightfoot, 1979) development of a single child (“Sarah”, Brown, 1973) and a sample of her input language. A further longitudinal naturalistic study of 4 other children is conducted to corroborate and expand upon findings from Sarah’s corpus. This study targets the developmental differences between all of Sarah’s verbal modals: premodals ($\text{want, know, try}$), functional verb modals ($\text{have to, gonna}$), INFL-modals ($\text{must, can}$) and adverbs ($\text{maybe}$). I explore patterns of syntactic (mis)categorization and meaning overextensions to test both hypotheses I and II.

The picture-preference and sentence-preference tasks target the semantic development of modal meanings with respect to interactions with progressive and perfect aspect marking. Aspect marking keys functional modals (like $\text{must}$, which can express either root or epistemic meanings) to epistemic readings (Hacquard, 2006; c.f., Ramchand, 2012). This study tests the child’s comprehension of modal-aspect interactions, measuring the age at which children exhibit sensitivity to modal-aspect interactions that key modal interpretations. It is the first battery of experiments explicitly and systematically addressing modal and aspect marking in development.
(see also Heizmann, 2006). Three groups are assessed to test for developmental patterns of form-to-meaning overextension in line with the diachronic semantic cycle: three, four and five-year-olds, as well as to adult controls. The CRP predicts that children should treat must as epistemic more often and in more contexts than adults, contributing to the diachronic drift towards increased usage of newer forms (see Kroch, 1994; Tagliamonte & D’Arcy, 2007, i.a.).

In order to provide support for a causal link between child learner input-divergence and diachronic cycles, typically developing children are expected to show learning biases in modal development that are compatible with diachronic biases. Further, if biases in L1 modal acquisition are linked to grammatical changes in the developing child, then we can begin to describe which aspect(s) of development in L1 acquisition may drive change.

### 1.1.1. Motivation

In historical linguistics, pathways of grammaticalization are repeated within and across languages. As one lexical item grammaticalizes to more functional roles, others are recruited to fill the expressive grammatical space that has been left behind; this is referred to as the Linguistic Cycle, where there is an emphasis on the renewing nature of the cycle (van Gelderen, 2004, 2009, 2011; see e.g., Condillac, 1746; Tooke, 1786-1805; Jespersen, 1917; Tauli, 1958; Hodge, 1970; Givón, 1978; Katz, 1996; , cited in van Gelderen, 2011) or as grammaticalization when there is an emphasis on the pathways that morphemes travel (coined by Meillet, 1912; Lehmann, [1982] 1995; Traugott & Heine, 1991; Simpson & Wu, 2002; Roberts & Roussou, 2003; Fuβ, 2005). These unidirectional\(^1\) cycles are well-attested, with few relatively inconsequential counterexamples (see Shepherd, 1981; Traugott, 2001; Traugott & Dasher, 2002:87). Examples are provided for Jespersen’s Cycle on negation (1a; Jespersen, 1917; Dahl, 1979; Horn, 1989; van der Auwera, 2009; i.a.), the Agreement Cycle (1b; Poletto, 1995; Egerland, 2005; Fuβ, 2005; Couranne, 2010; i.a), the Copula Cycle (1c; Lohndal, 2009; Tailleur & Couranne, 2014; i.a), the Adpostion Cycle (1d; Heine, Claudi, & Hünnehmeyer, 1991; Waters, 2009; i.a.), and the Definiteness Cycle (1e; Lyons, 1999; van Gelderen, 2007; i.a).

\(^1\) Newmeyer, 1998:263-275) and Lightfoot, 2006:38) argue against unidirectionality. Lightfoot (2006; p.c.) argues
negative argument > negative adverb > negative particle > zero
negative verb > auxiliary > negative > zero

b. Agreement Cycle
demonstrative > strong pronoun > weak pronoun > clitic > agreement > zero
c. Copula Cycle
demonstrative > copula > zero
verb/adposition > copula > zero
d. Place/time Cycle
noun > adposition > complementizer
e. Definiteness Cycle
demonstrative > definite article > ‘Case’ > zero

The classic example of a three-stage version of Jespersen’s Cycle from French is provided in (2); ne weakens from negative particle > zero (2a-b) while the negative adverb pas provides renewal in this case study (2b-c). More nuanced stages exist (see van der Auwera, 2009).

(2) Jespersen’s Cycle in French (based on van der Auwera, 2009: 39)
   a. Il ne peut venir ce soir. (Preverbal negation ne alone)
   b. Il ne peut pas venir ce soir. (Weakening of ne, addition of reinforcer pas)
   c. Il peut pas venir ce soir. (Loss of ne; pas becomes sole negative marker)
      ‘He can’t come tonight.’

I focus on the Modal Cycle; the semantic trajectory of the modal cycle is shown in (3).

Examples from German show that müssen first appears historically with ability interpretations (3a), and only later with root deontic meanings (3b). Modern German müssen is also epistemic (3c). This trajectory is cross-linguistically robust (Traugott, 1989; Bybee et al. 1994).

   O.H.G. müssenability → M.H.G. müssendeontic → Mod.G. müssenepistemic
   a. Sie ni musan gan so fram zi themo heidinen man.
      They not were-able go so far to the heathen man.
      ‘[For religious reasons] They were not able to proceed further to [the palace of] the heathen man (Pilate)’.
      (9thC Otfrid IV.20.4) (pg 386)
   b. Tie minnera habeton die muosan gan.
      Those no.money had they had.to walk
      ‘Those who had no money were obliged to walk’.
      (c. 1000 Notker I.152.1) (pg 386)
   c. Du must wohl müde sein.
      you must MOD.PART tired be
      ‘You must be tired.’
      (Stefana Gargova, p.c.)
The same pathway that occurred in German for müssen, is repeated in other languages; for example, in the Romance languages Lat. debere charts the same general path as German müssen, albeit starting with a different premodal verb (meaning ‘to owe money’). The path for debere is shown here with French devoir (4). Nearly identical to debere, with the same premodal meaning as a starting point, Proto-Germanic *skel- became future shall in Early Modern English (5). French, unlike English, maintains the original to owe money meaning to this day. Comparison of (4) and (5) illustrates that deontic meanings may develop into either future or epistemic meanings (see Bybee, Perkins, & Pagliuca, 1994: 197-199, 258-263).

(4) French (C.N.R.T.L.)
LAT. debere to owe money → E.O.F. (c.842) deveir obligation → L.O.F. (c.1100) devoir epistemic

(5) English (O.E.D.)
GER. *skel-to owe money → O.E. (c. 800) sceal obligation → E.M.E. (c.1500) shall future

The syntactic modal pathway is shown in (6). Examples from the history of English show that the current set of canonical modal auxiliaries began as main verbs which took direct objects (Old English present preterite verbs and willan; 6a). These were reanalysed as functional verbs, and began to appear without objects, but below aspect (6b), possibly in v (as assumed here; see also Tollan, 2013). Finally, these modals appear in INFL, above aspect (6c), as today (Roberts, 1985; Pollock, 1989; i.a.).

(6) The Syntactic Modal Cycle (English INFL Modals; Roberts, 1985)
O.E (400-1100CE) → M.E. (1100-1500CE) → Mod.E. (1500CE-)
V → v → INFL

a. he cwæð pæt he sceolde him hundteontig mittan hwætes
he said that he shall him hundred bushels of-wheat
‘He said that he owed him a hundred bushels of wheat’
(Æhom 17:26; Fischer, 2003:25)
b. we wolden han gon toward tho trees full gladly, if wee had might
c. He might’ve won the race.

In generative approaches, target-divergent learners are seen as the source of grammatical change in the language continuum (e.g. Lightfoot’s 1979 Transparency Principle; Clark & Roberts' 1993 computational model for learning and change). The child learner is charged with the task of building a productive, creative, mental grammar from exposure to (and interacting
with) the input (or Primary Linguistic Data (PLD)); the child only has indirect evidence, however ample, to the grammars of others, making L1A a logical place to locate innovation.\(^2\)

Reanalysis exhibits unidirectionality and as such the CRP predicts that learner-divergence is directionally biased. The directional bias of the learner cannot be teleological but must rather be epiphenomenal, arising from the nature of the learning process. For example, van Gelderen (2004, 2011) proposes a theory based on economy principles provided by UG that are at work in the L1A process. Whenever the learner fails to converge on the target, the effects of these principles are reflected in cyclic changes. The child is expected to treat the input non-uniformly in such a way that divergence leads to known changes: root modals become epistemic modals but not v.v., determiners become complementizers but not v.v., clitic pronouns become agreements markers but not v.v., and so on. Similarly, Roberts and Roussou (1999, 2003) argue that grammaticalization steps can be generalized to upwards reanalysis by the child in the hierarchical structure of syntactic heads (like van Gelderen’s Late Merge Principle, this instantiates Merge-over-Move; (Chomsky & Lasnik, 1993; Chomsky, 1995). For the present purpose, both of these approaches can be understood as proposals for learning biases. These proposals come from historical data and are thus back-engineered – what learning biases must children have in order for the L1 acquisition process to explain known innovations? Here, I ask, do children indeed show these biases? Is it possible that the acquisition path of the child learner drives grammaticalization? I will return to each of these proposals in §1.3 to discuss their predictions for the modal cycle.

The central concerns of researchers who focus on child language have not aligned with those of diachronic linguists. Acquisition research has rarely been interested in the potential

\(^2\) A recent sea change in acquisition studies has criticized earlier preoccupation with child errors on the grounds that learners are surprisingly accurate and make very few errors of omission; therefore focusing on errors skews our understanding of development (Snyder, 2007, Weerman, 2011, i.a.). Errors of omission contrast with omission errors: in an omission error something is left out (e.g., *(I) wanna go) while in a comission error an incorrect form is used (e.g., Him_{ACC} wants go). This criticism is well founded, however, I do not see it as a problem for the CRP because: (i) children do make some errors of omission and these are non-random, and (ii) errors of omission and distributional patterns that are not predicted by input frequencies (i.e. gonna precedes will in acquisition despite adults using more will than gonna, (Klecha, Jalbert, Munn, & Schmitt, 2008) are the norm in development and may well contribute to diachronic drift and changing the input of successive generations.

\(^3\) It is worth clarifying here that only the aspects of grammaticalization which concern innovation (or reanalysis) and, to a lesser extent drift (increased usage of newer forms), are under consideration in this thesis; the other components of grammaticalization more common in the sociolinguistic literature – transmission, incrementation, diffusion – are not directly addressed. See Kroch, 1989; Labov, 2001, 2011; Denis, 2015; i.a. A useful distinction is between externally-driven change, or change on the population level, which I do not address, and internally-driven change, or change at the individual level, which I do address.
diachronic effects of the acquisition process, and focuses rather on the processes and mechanisms behind the phenomenon of L1A. Several studies have discussed theoretical links and possible acquisition-related causes for change (Weerman, 1993, 2011; Clark & Roberts, 1993; Lightfoot, 1999; Kroch, 2006; i.a.), however, only a few acquisition studies, have addressed diachrony. For example, Baron (1977) aimed to find empirical evidence for historical change from actual children, the same broad goal as this thesis. She examines primarily the English causatives *make*, *have* and *get* in child corpus data. She finds some parallels in the way in which *have*, *make* and *get* developed historically and the way they emerge in L1A. She argues that diachrony often reflects ontogeny, but perhaps adheres too strongly to this forced-parallels view of constructions leading to implications that historical languages should follow individual development (see also Diessel, 2011). Her approach leads to an unclear relationship between the empirical facts she collected for L1A and the historical changes (see Lightfoot, 1980 for a critical review).

As concerns modality, Stephany ([1979] 1986) studied modal and mood acquisition in several languages, and argued for an ‘ontology recapitulates phylogeny’ view of modal change (see Papafragou, 1998:28 for a discussion). This view maintains that acquisition of modality in individuals follows the same pathway as development in the history of the language: root → epistemic. She concludes her article with the anecdotal:

> The priority of the deontic, as compared to epistemic, modality in the ontogenesis as well as in the history of languages can be considered as indicating the primacy of the social, as compared to the epistemic, function of language. (Stephany [1979]1986: 400).

This view can be related to usage-based explanations for deontic > epistemic, if we assume that the higher frequency of deontic (and other root flavours) comes from greater usage-utility (e.g., Nerlich & Clarke, 1992:12.) However, it is not clear why the primacy of the social over the epistemic role^4^ of language would cause individual lexemes, or sets of lexemes, to develop epistemic meanings diachronically when the language has alternative means of expressing epistemic meanings. On the same topic, Snyder (2007: 179), a generative-oriented linguist, points out that ordered acquisition in children, as with root before epistemic,

---

^4^ The epistemic role of language is the role language plays in allowing us to reflect upon and speak about our own knowledge states and the knowledge states of others.
“might correspond to a prediction of ordered appearance in the historical record for the language. The stipulation of “all else being equal” is crucial of course, but converging evidence from child language acquisition and language history, when this occurs, is quite compelling”.

This point is simply the converse of the point which historical linguists who discuss recapitulation make (c.f. Baron, 1977). Snyder suggests that the child pathways might predict parallel historical pathways; while historical linguists suggest that the diachronic pathway should show child correlates (e.g., van Gelderen, 2011: 21-26). Recapitulation theory (“ontology recapitulates phylogeny”, attributed to Ernst Hackel (1834-1919)) was long ago rejected for more sophisticated explanations in the field of biology to explain parallels between ontogeny and phylogeny (see Gould, 1977 for overview; see also Traugott & Dasher, 2002:42-44 for a language-oriented overview and critique of over-adherence to biology principles in historical linguistics). In language development, why should we expect ordered appearance in L1A to predict the same (rather than opposite, or unrelated) order in the historical record? How can we explain existing correspondences without resorting to recapitulation (which is purely descriptive) as an explanation in and of itself?

Diessel (2011, 2012; see also Ziegeler, 1997; Givón, 2009) provides relevant evidence and discussion on parallel developments in diachrony and acquisition. The evidence suggests that child pathways and diachronic pathways, at least for semantic developments, are strongly parallel in many different domains: modals (7), as well as relational nouns > adpositions and motion > future. In all cases, concrete meanings develop into more abstract meanings in predictable ways.

(7)  
   a. L1A: Root modals precede epistemic modals  (e.g., Papafragou, 1998)
   b. Language Change: Root modals occur before epistemic modals  
      (e.g., Traugott, 2006)

The many parallels Diessel discusses could be interpreted as causal evidence for a relationship between L1 development and language change. However, he maintains that “[t]here is no evidence that grammaticalization and language acquisition are directly related.” (Diessel, 2011:10). Rather, he argues that parallel semantic developments are the result of parallel psychological mechanisms – analogy, entrenchment, and categorization – at work in both child development and in diachronic development. The child’s conceptual developments from space >
time or motion > future parallel grammaticalization clines for individual words; Diessel refers to these as parallel “conceptual routes”\(^5\).

Conceptual development and associated overextensions are expected in the child, as part of normal cognitive development: in (8), a child erroneously overextends a spatial term to a temporal meaning. The child has a mind where psychological mechanisms operate, and metaphorical extensions from space to time are credible. The child must express herself with the lexical items she has available, providing an environment where the grammar can produce overextension mapping-errors (see Clark, 1993; i.a). In precisely these cases, a grammar internal bias can become apparent by producing a form that is not modeled on the input and thus must come from an internal source. In (8), the lexeme behind is mapped to a meaning (temporal behind-ness) that it is not mapped to in the input.

(8)  *Can I have any reading behind the dinner?* (=after)
(Bowerman, 1985:1292, cited in Diessel, 2011)

The same extension from space to time has been frequently observed in diachrony, but it is unclear why the same mechanism of conceptual development should underlie in historical development. A language continuum (i.e., English, including historical stages), unlike its speakers, does not have a mind where psychological mechanisms can operate over time. As far back as we have actual reconstructed records, any given stage of a language has some means of expressing temporal relationships, presumably making it unnecessary to innovate new temporal terms from existing spatial terms. In short, why would an adult speaker of English use behind when after is available?

In diachrony we see mapping changes whereby lexemes cover new meanings which were once covered by other lexemes (often with periods of overlap, see Hopper & Traugott, 2003); this overlap is generally unstable (see Kroch, 1989, i.a.; Wallenberg, 2013); the mapping relationships between form and meaning are altered; new mappings arise. New meanings, however, do not arise as they likely do for the developing child. In acquisition, conceptual routes involve cognitive developments and semantic extensions within the child’s mental landscape as a whole, while in diachrony, pathways are charted by specific lexical items or constructions;

---

\(^5\) He argues this parallel is apparent in semantic trajectories, but not in phonological or morphosyntactic changes (c.f. Bybee & Slobin, 1982) which “do not have parallels in child language” (Diessel, 2011). See Cournane (to appear) for a counterargument.
“conceptual routes” in diachrony are localized to lexemes entering new grammatical relationships, they are not conceptual changes.

Diessel’s evidence suggests to me that the child learner makes precisely the right kinds of overextension mapping errors, in the right direction, to be responsible for the semantic innovations that appear in diachronic pathways. Further, appeal to mechanisms beyond the null hypothesis that the child learner is responsible, such as to adult speaker innovations (e.g., usage-based or functionalist approaches to the modal cycle, e.g., Heine et al., 1991; Traugott & Dasher, 2002), may be avoidable. What is necessary is hypothesis-testing for the CRP, asking the right questions and assessing the plausibility of the CRP for child language, as in this dissertation.

For morphosyntactic changes, as for V-to-INFL in the history of modals, Diessel observes a lack of parallels in L1A and diachrony. For example, though children use motion going before future going, “there is no evidence […] that the acquisition of the be-going-to future presupposes the acquisition of an earlier complex sentence construction that is later reduced to a simple sentence [i.e. with gonna] as in diachronic change”. He subsequently claims that lack of parallels of this kind suggests that “[l]anguage acquisition does not recapitulate the diachronic evolution of grammar nor does grammaticalization originate from changes in child language”. This is an argument against a straw man; under CRP assumptions, the child is not expected to recapitulate completed changes, but rather to provide renewals to the linguistic cycle (see van Gelderen, 2011). When a child learner innovates she is not recapitulating the development of individual lexemes that have changed in the history of her input language. Rather she is learning which forms map to which meanings and occasionally she may map forms to meanings in ways that do not accurately reflect the input language (the example in (8) constitutes just such a potential innovation for behind). In order to claim that learner-divergence from the input can or cannot be responsible for diachronic innovations we need to look at

---

6 I agree with Diessel that there is little evidence for this claim, though there is little evidence in general for either the position that child learners are innovators, or that adult speakers are (as per Heine et al., 1991; Traugott & Dasher, 2002; i.a.).

7 I don’t believe adults play no role in language change, just that where parallels or other compelling alignments exist between ontogeny and diachrony (see Courmane, to appear), the null hypothesis is that child learners are innovators. Ultimately we have little understanding of what role children play and what role adults play and how the types of changes different groups are responsible for are apportioned. This problem is further complicated by the omnipresence of complex situations such as bilingualism, contact, L2 speakers, disordered language, etc. See Weerman (1993, 2011) for L2 acquisition and language change.

8 Anecdotally, use of behind for after appears regularly in the Baltimore, Maryland based TV show The Wire, e.g., “They lost their daddy behind what happened” (S1E02). I have not yet pursued whether this is a feature of native-speakers from the region or AAVE more generally.
systematic biases in, for example, the modal system of learners, and look to renewing items\textsuperscript{9} and how they are treated by the learner. What is also necessary is that a small volume of divergent learner analyses survive long enough to ‘catch-on’ in the speech community (Labov, 2001, i.a.).

Many researchers who support the CRP nevertheless maintain that it is untestable in child language because one cannot find the innovator-in-the-haystack or because one cannot predict when aspects of the input language are susceptible to reanalysis (David Lightfoot, p.c.). Or, they caution that it is at least very difficult to assess because of the local, micro-steps assumed by the CRP (Elan Dresher, p.c.; Roberts, 2010). I address these concerns in §1.4.

In summary, diachronic pathways have been well-described and generalized theories of cyclic change exist (Roberts & Roussou, 1999, 2003; van Gelderen, 2004, 2011; i.a.). The predictions that arise from these current versions of the CRP provide testable predictions for child language studies. These predictions are directional learning biases, not recapitulations. Assuming the CRP, I hypothesize that the robustness of directional change is caused by aspects of the normal process of first language acquisition. If the CRP is correct, we should see the underpinnings of reanalysis in typical child language.

\subsection*{1.2. Background}
\subsubsection*{1.2.1. Modality}

Modality is a functional category belonging to the tense, aspect, modality (TAM) complex; it serves with the other two categories to qualify events. Palmer (1986:4) describes modals and non-indicative mood markers (i.e. subjunctive) as indicating a speaker’s “degree of commitment to the truth of what is being said.” Modality expresses meanings along a continuum of possibility and necessity, including permission, ability, and obligation. The two most-discussed modal meanings (or flavours), are deontic (9a) and epistemic (9b).

\begin{equation}
(9) \quad \textit{You must be Irish...} \\
\cap \quad \begin{align*}
\text{a. ...to vote in the Irish election. (Deontic)} \\
\text{b. ...because you have red hair, freckles and green eyes. (Epistemic)}
\end{align*}
\end{equation}

Deontic modality refers to possibility or necessity according to a set of laws or rules in the world, in (9a) the laws according to the Irish government. Epistemic modality refers to

\textsuperscript{9} For modals, these are typically lexical verbs which denote mental states or states of obligation, potential, desire, etc., such as \textit{to owe, to know, or to want} (see Lightfoot, 1979; Tollan, 2013).
possibility or necessity according to the knowledge base, or evidence, of the speaker, in (9b) the knowledge the speaker has that Irish people frequently have red hair and green eyes.

Root modality is a cover term for several sub-flavours of modality, often further divided into two primary groupings: dynamic (ability and volition) and deontic (law- or rule-governed), (see Palmer 1986; Hackl 1998; i.a.). Teleological (goal-oriented) modality is also considered a root modality (c.f. anankastic conditionals, von Fintel & Iatridou, 2005); Examples are provided in (10) for ability (10a), volition (10b) deontic permission and obligation (10c), and teleological (10d) modal interpretations. Root modality is sometimes called subject-oriented modality because these subflavours usually direct their force on the subject of the main verb (Coates, 1983), although this is not always the case. Many researchers (Wurmbrand, 1999; Hall, 2001; Eide, 2003; Hacquard, 2006) distinguish between directed and non-directed deontic modality (11); directed deontics direct their force on the subject, while non-directed deontics are those with inanimate (11a) or expletive subjects (11b); non-directed deontics are still arguably agent-oriented (see Bybee et al., 1994).

(10)  
a.  
Paul can speak Spanish. (Root Ability)  
b.  
I can run to the store, if you need more hamburger buns. (Root Volition)  
c.  
You may/must leave after the bell rings. (Root Permission/Obligation)  
d.  
To get to the Plateau you should take the Parc bus. (Root Teleological)  

(11)  
a.  
Litter mustROOT not be left in the park.  
b.  
There mustROOT be a solution to this problem on my desk tomorrow.  

(Tollan, 2013:39)

Root modality can be thought of as event modality (Palmer, 1986; Hacquard, 2006, 2010) because it always relates to the verbal event, even in non-directed examples like (11a,b). By contrast, epistemic modality is independent from the subject and is linked instead to the speaker’s knowledge or available evidence. In (12), must refers to the speaker’s certainty about what she thinks happened. Epistemic modality can be considered propositional modality, as a modal with an epistemic interpretation qualifies propositional events, rather than verbal ones (e.g. must [you walked] for (12), vs. you [must walk] for a deontic obligation reading).

(12)  
You must’ve walked because you don’t have your bike helmet with you. (Epistemic)  

There are many ways to divide and label the conceptual subflavours of modality (see Lyons, 1977; Coates, 1983; Palmer, 1986; Bybee & Fleischman, 1995; i.a.), though the choice of
subflavours and locations of boundary lines between them varies between frameworks. Across
terminology and frameworks, however, there is consensus for the divide between modals which
qualify verbal events (root) and those that qualify propositional events (epistemic).

Modal flavours and sub-flavours derive from at least two major semantic components
(Kratzer 1977, et seq; Vander Klok, 2012). These are the modal’s *quantificational force* (QF),
either universal (\(\forall\); 13a) or existential (\(\exists\); 13b), and its *domain of quantification* (DQ), which
consists of a modal base (a set of worlds which may be epistemic (13a), or circumstantial (13b)),
and an ordering source which orders those worlds in the modal base according to certain criteria
(stereotypes (13a), deontic laws/rules (13b), etc.). Combinations of different modal bases and
ordering sources give rise to the various flavours of modals.

(13)  a. *John must be at home because the lights are on.*
     (\(\forall\), epistemic base, stereotypical ordering source)
     ‘Given what I know, it must be the case that John is at home.’
b. *You can have your dessert after your dinner.*
     (\(\exists\), circumstantial base, deontic ordering source)
     ‘Given the rules of the house, you can have your dessert after dinner.’

The future (e.g., *will, going to*) is frequently considered modal (Copley, 2002; Enç,
1996); I adopt this analysis of the future since future markers are well-known to participate in the
modal cycle (e.g., Bybee et al., 1994: 243-280). Simply, the future hasn’t happened yet, so
understanding the future involves notions of possibility and necessity, like other types of
modality. Formal analyses suggest that the future patterns more closely with modality than with
tense, for example, Copley (2002) argues that the future is a universal modal with a
circumstantial base that is either determined according to a bouletic (desire or satisfaction;
“intention”) or inertial (general properties of the world; “prediction”) ordering source (Copley,
2002:80; see also Dahl, 1985). This contrast is seen in the bouletic continuation in (14a)
compared to the inertial continuation in (14b). In short, future is an instance of root modality
(circumstantial modal base), and like other types of root modality it is future-oriented (Enç,
1996; Condoravdi, 2002; Laca, 2008).

(14)  *I think that I will go to Harvard Square tomorrow…*
     a. … *I've been meaning to get some shopping done.*
     b. … *that's just the kind of thing I might do.*  (Copley, 2002: 81)

Condoravdi (2002) provides an analysis that helps explain another robust relationship
between tense and modality. When the proposition a functional modal associates with is past or
present oriented (e.g., *John must’ve eaten his lunch already*), then that modal has to be interpreted as epistemic. She proposes the Diversity Condition to account for this fact. The Diversity Condition requires that modal operators applied to a prejacent $p$ be interpreted against a diversity of modal bases, i.e. there must be both $p$ and $\neg p$-worlds in the background (Condoravdi, 2002). In other words, the modal base cannot be uniform relative to $p$.

In future-oriented sentences (15a), the temporal unfolding of the event described by the proposition $p$ (here, feeding the baby) has yet to occur (*be fed* is a causative) so there are both $p$ worlds and $\neg p$ worlds open in the future actual world. For example, the root deontic interpretation of (15) has $p$ worlds (worlds where the baby is fed) and $\neg p$-worlds (worlds where the baby is not fed) still open. The deontic meaning comes from the availability of the speaker imposing the deontic obligation to feed the baby (future realizations of $p$ worlds are preferable to $\neg p$-worlds). The epistemic interpretation is also possible with future-oriented $p$.

(15) *The baby must be fed*…
   a. …*because she is hungry.* [Root Deontic]
   b. …*because she isn’t hungry.* [Epistemic]

Epistemic meanings associate with past and present tenses because epistemic reasoning is the only modal reasoning available in these otherwise realized tenses\(^\text{10}\). The truth of a past or present event is already determined already, but the Diversity Condition requires that for a modal interpretation there must be both $p$ and $\neg p$-worlds in the background. Therefore, when the prejacent is in the present or past tense all $\neg p$ worlds are relegated to mental states or depend on the availability of evidence (see Condoravdi, 2002). For example, in (15b) the speaker looks at a happy baby and says, “The baby must be fed”. The feeding event is in the past (for this reading *fed* is the past participle) so *must* has to be epistemic, and signal that the speaker has inferred from available indirect evidence (von Fintel & Gillies, 2010) that the baby is likely fed. In the actual world the baby either was or wasn’t fed, but there remains the possibility in the speaker’s mind that she is wrong ($\neg p$-world(s) remain open only in the speaker’s mind).

Modals come in the form of various morphosyntactic categories (16). Even within a language, multiple morphosyntactic categories encode modality, as in English (16a-d). Additionally, most modal lexemes express more than one flavour or force in a language (e.g.,

\(^{10}\) Manipulating the sentence further, or providing the right kind of context, can shift the temporal orientation for any of the sentences in (1) to change the modal interpretations (i.e., adding the temporal adverbial clause *by this evening* to (1b) shifts the temporal orientation to the future and opens up a deontic reading).
deontic and epistemic *must*) and more than one modal may cover a particular meaning within a language (e.g., deontic *have to* and *must*), giving rise to complex form $\leftrightarrow$ meaning mapping relationships.

(16) a. Modal auxiliaries [*INFL]: *must*, *might*, *can*, *could*, *shall*, *should*, *will*, *would*

b. Semi/Quasi-modals: [*v*]: *have to*, *ought to*, *got to*, *going to*, *supposed to*

c. Modal adverbs [*ADV]*: *maybe*, *possibly*, *probably*, *certainly*

d. Mental state verbs [*V*]: *know*, *think*, *believe*

e. Modal verbs [*v*]: French *devoir*, *pouvoir*, *falloir*

f. Irrealis mood markers: subjunctive, optative, imperative, conditional

g. Particles: Dutch *wel*, *maar*

h. Second position clitics: Gitksan *ima* (’a) (Peterson, 2010)

In English, the modal auxiliaries (16a) are standardly analysed as INFL elements (Pollock, 1989; i.a.), so I will henceforth refer to them as INFL modals, to accurately and transparently discuss their syntactic category. Likewise, the semi/quasi-modals are analysed as functional verb (or for short, *v*) elements (Tollan, 2013; see Bjorkman & Cowper, 2013 for an analysis of *have*), and I will henceforth refer to this set of modals as *v*-modals or functional verbs as it is more syntactically informative than the terms semi- and quasi-modals (there is nothing semi- or quasi- about these modals, they are as modal in meaning as the INFL set, they are just syntactically lower and less syntactically grammaticalized). The exact syntactic location of this set of modals is not of importance, little *v* is a convenient category label for this set as they are above lexical/content verbs and lower than INFL and Aspect (e.g., *John must*$_{INFL}$ *have*$_{ASP}$ *had to*$_{v}$ *leave*$_{v}$ *early*) and take verbal complements.

Syntactically, modal meaning is expressed by virtually any formal category. Is modality nonetheless encoded in the semantics in the same manner across the linguistic systems of the world? Which aspects of modality are universal, if any? These questions are critical to the learnability problem for modality as we need to endow the child with enough flexibility to specify the content and conceptual boundaries of major categories like modality from the input, while ensuring that their learning is restricted enough so as to ensure the observed uniformity across languages in the formal properties of this category (c.f. Ritter & Wiltschko, 2009 approach to INFL).

One valuable distinction for modal morphosyntactic category is whether modals are lexical or functional. Lexical modals are those modals which are fully specified predicates of events (Hacquard, 2013), for example the adverb *necessarily*. On the other hand functional
modals must interact with other semantic objects or the context in order to become specified for flavour (or force), for example the modal *should* is always existential, but its flavour is unfixed and may be root (e.g., *You should leave*) or epistemic (e.g., *The mail should be here by noon*). I return to this distinction in more detail in §1.2.2 after discussing formal approaches to modality. This distinction is of particular importance in the developmental corpus study presented in Chapter 3.

Many languages make use of evidential systems, which grammatically encode kinds of evidence for a proposition, for example hearsay or visual evidence (17), rather than modal systems, which grammatically encode strength of commitment to a proposition (18); Peterson, 2010; Vander Klok, 2012). In (17), the morpheme *ima* encodes epistemic\(^{11}\)-type evidence; the strength of the evidence is not fixed on the morpheme, so it may be weak (∃; 17a), or strong (∀; 17b). English, on the other hand, encodes force such that *has to* is always strong (∀), but its flavour can vary by context (18a vs. 18b).

(17) Evidential System

\[
\begin{align*}
\text{mukw}= & \text{ima}=hl\ maa'y... \\
\text{ripe}= & \text{mod}=cd\ berries \\
& \text{‘The berries might/must be ripe.’}^{12} (Peterson, 2010) \\
a. & \ldots \text{because they sometimes are this time of year.} \quad (\exists, \text{Epistemic}) \\
b. & \ldots \text{because people have berry-stains on their hands.} \quad (\forall, \text{Epistemic})
\end{align*}
\]

(18) Modal System

*Patrick has to\(^{13}\) be at the party…*

\[
\begin{align*}
a. & \ldots \text{because he promised he would attend and he owes me one.} \quad (\forall, \text{Deontic}) \\
b. & \ldots \text{because he’s the guest of honour! There’s no way he’d miss it.} \quad (\forall, \text{Epistemic})
\end{align*}
\]

In sum, modals express meanings of possibility and necessity and are either lexical or functional. Functional modals vary in their lexicalization; languages either use an evidential

---

11 Diagnostics show that evidential lexemes are epistemic modals (see Matthewson et al., 2007; Peterson, 2010 for details and discussion). Quantificational force is a component of all modals, so one parameter of variation for modal lexemes is whether they are fundamentally existential or universal. Some evidence shows that evidential languages may have default quantificational force across the modal system, for examples St’a’t’imcets (Lillooet Salish) may only have universal modals while Gitksan only existential epistemic modals\(^{11}\). All modals also reference domain of quantification (flavour, broadly root or epistemic); domain of quantification may be contextually defined (e.g., English, 12), or may be a presuppositional requirement of the modal lexeme (e.g., Gitksan, 11) (Matthewson et al., 2007; Peterson, 2010). Even in languages which appear to have modals fixed for domain but not for force (so-called evidential languages), researchers continue to argue for a quantifier analysis of modality (Kratzer, 1977 et seq.; see Rullmann, Matthewson, & Davis, 2008).

12 Variable modal force in evidential languages is conditioned relative to speaker-centered knowledge.

13 Modals are not truly ‘polysemous’. Rather they are unmarked and get their meaning from context (see Kratzer, 1991). However, it is convenient to refer to modals that have more than one meaning as polysemous.
system or a modal system and thus vary in which component (QF or DQ) forms the primary distinctive contrast in modal lexicalization\textsuperscript{14}; speaking in very general terms, languages may have mixed systems (see Vander Klok, 2012). For example, English functional modals have fixed quantificational force but context-dependent domains of quantification for modal lexemes. On the other hand, St’át’imcets has fixed domain of quantification (a presupposition for the modal lexeme which must be defined by the context (Matthewson, Davis, & Rullmann, 2007; Peterson, 2010)) and variable quantificational force for its modal lexemes (determined relative to speaker knowledge).

In what follows, I focus primarily on functional modals in languages that lexicalize modals according to force, like English, which is the language of the acquisition investigations in this dissertation. However, English must is known to also express indirect evidentiality (i.e., the speaker has indirect knowledge of the proposition), so the picture is more complicated than the above would suggest. Even within a language with a modal system, modal lexemes may contribute evidential meanings (von Fintel & Gillies, 2010).

For example, in (19) the speaker looks out the window and see direct visual evidence that it is raining. She can say (19a) without the modal, but she cannot say (19b). The modalized sentence is illicit in this direct-evidence scenario because must carries the presupposition that the evidence for the prejacent is indirect evidence (see von Fintel & Gillies, 2010). In (20), the speaker cannot see outside. Instead she sees people with wet rain gear and knows that rain is the only possible cause. In this indirect-evidence scenario the speaker can say either (20a) or (20b), depending on whether she chooses to signal the indirect evidence source or not. Indirectness is not weakness, but rather a different evidence source. Must is licensed if and only if it is presupposed that the evidence for the prejacent is indirect. This is discussed further in Chapter 4.

(19) [Seeing the pouring rain]
   a. It’s raining.
   b. ?? It must be raining. (von Fintel & Gillies, 2010)

\textsuperscript{14} This is an oversimplification; languages appear to have grammatical systems that are more evidential or modal, but languages have means of expressing both meaning types. For example, English has many ways of expressing evidentiality, most lexical (apparently/according to X/see/hear/was told/etc.) but some of which are more grammatical than lexical. For example, raised Perception Verb Similatives (John looks like he’s sick) encode direct evidentiality, while unraised they do not (see Rett & Hyams, 2014; discussed in Chapter 2). In addition, language may have mixed functional systems (see Peterson, 2010).
Evidential systems are empirically and theoretically very closely related to modal systems, and there is overlap for at least some lexical items. I discuss acquisition of evidentials in §2.3.3, and one of the experiments in Chapter 4 contributes to our understanding of evidential development (§4.4).

### 1.2.2. Functional Modals in the Syntax

How is modality, a semantic category, articulated into the syntax? Early approaches to the syntax of modals argued that epistemic interpretations arose from raising constructions, while root interpretations arose from control constructions. The observation behind this analysis is that root modals appear to give a theta role to the grammatical subject of a sentence (21a), while epistemics do not (21b; e.g. Ross, 1967; Roberts 1985; c.f. Wurmbrand, 1999; Tollan, 2013).

Wurmbrand (1999) shows that tests for distinguishing for control vs. raising verbs (e.g., expletive subjects, passivization, quirky case assignment) when applied to English, German, and Icelandic, demonstrate that both epistemic and root modals behave uniformly as raising verbs and therefore do not assign an external theta role. The intuition that root modals are control verbs comes rather from the semantic subject-orientation of this modal reading (see Wurmbrand, 1999; Hacquard, 2006, 2010; Tollan, 2013).

However, systematic differences between root and epistemic modals play out in the individual syntactic systems of languages, providing evidence for universals (see Hacquard, 2006: Chapter 3 for an overview; Tollan, 2013 for West Germanic languages). In keeping with the clear semantic divide between root and epistemic, most syntactic approaches divide modals conservatively into two positions in the clause (Jackendoff, 1972; Zubizarreta, 1982; Roberts, 1985; Picallo, 1990; Butler, 2003; c.f. Cinque, 1999). Hacquard (2006) argues that this two-way syntactic division reflects the LF restrictions on modals. A transparent example of two syntactic
positions with associated root and epistemic meanings comes from dialects of English which allow two overt modal auxiliaries, such as some Scottish dialects (22: Brown, 1991; i.a.), Southern U.S. English (Coleman, 1975; Di Paolo, 1986; Ellison, 2007; i.a.), African American English (AAE) (Labov, 1972; i.a.), and Atlantic Creoles (Cassidy, 1961).

(22) Hawick Scots
He would could do it if he tried.
‘He would be able to do it if he tried.’ (Brown, 1991:74)

In these double modal sentences the leftmost (=higher) modal is usually interpreted as an epistemic modal, while the lower is usually interpreted as a root modal (see Cinque, 1999; Coleman, 1975; Ellison, 2007, i.a.). In Southern U.S. English there are also some reports of Root > Root (23a) and Epistemic > Epistemic (23b) orderings which serve to emphasise root obligation or the speaker’s unwillingness to commit to the proposition, respectively (Coleman, 1975, cited in Tollan, 2013: 57). Tollan (2013) argues that Root > Root involves recursion at the LF root site (~vP), and Epistemic > Epistemic involves recursion at the epistemic site (~IP).

(23) Southern U.S. English
a. I should ought to go with him
   ‘I really feel obliged to go with him’
   (Coleman, 1975: 97)

b. I might could have been eating when you came this morning
   ‘I guess it’s possible that I was eating when you came this morning’
   (Coleman, 1975: 93)

Similarly, in modal verb stacking in Dutch there are two possible readings (24): Epistemic > Root, or Root > Root. This is also the case when English stacks little v modals with other v-modalas (He’s gotta have to pee after drinking that much water) or with auxiliaries (He must have to pee after drinking that much water). In all these cases, stacking two modals in a single clause is possible, showing evidence for two syntactic positions. What is not attested is a case of stacking where the modals are ordered as *Root > Epistemic.

(24) Dutch
Hij moet kunnen slapen
he must-3SG can-INF sleep-INF
Epistemic > Root: ‘He must be able to sleep’ (because tonight isn’t noisy)
Root > Root: ‘He has to be able to sleep’15 (because he has a big day tomorrow)
   (Barend Beekhuizen, p.c.)

---
15 Notice this also works in Standard English provided we make use of v-modalas.
In Turkish, it is possible to have two modal suffixes in the same word, with the epistemic further from the root than the root modal (25b; Hitay Yükseker, p.c.), as expected given the Mirror Principle (Baker, 1985). In (25b) the root ability modal –abil, appears closer to the root than the epistemic suffix, -meli. These examples provide some further evidence for two functional positions for modality, one low for root modals and one high for epistemic modals.

(25)  

a.  *Oku-y-abil-ecek-ti-m*  
read-epenthetic’y’-MOD’able’-fut-past-1sg  
‘I was going to be able to read/ I would be able to read’  

b.  *Oku-y-abil-meli-y-di-m*  
read-epenthetic 'y’-MOD’able’-MOD’must’-copular-past-1sg  
‘I should have been able to read’  

(Hitay Yükseker, p.c.)

In Sranam, an English-based creole with strong Dutch influence spoken in Suriname, the modal *kan* has an epistemic interpretation when above Tense and a root interpretation when below (Cinque, 1999:60). This shows the same morpheme systematically varying in interpretation dependant on whether it is higher or lower than INFL.

(26)  

a.  *A ben  kan  nyan*  
he  PAST can eat  
‘He could_ROOT eat’  

b.  *A kan  ben e nyan*  
he can PAST PROG eat  
‘He could_EPISTEMIC have been eating’

Most languages also exhibit syntactic splits between constructions that epistemics appear in and constructions that root modals appear in, with generally some measure of overlap; for example, in German the modals *müssen* and *können* vary in syntactic height depending on whether they are expressing root or epistemic modality (Kratzer, 2012:55). Speakers frequently express root modality by using the modal verb in the main clause (27), but epistemic modality by using the modal verb in a higher clause (28, i.e., *it may be that…, it must be that…*). In (27) both root and epistemic meanings are possible for some speakers but others require a modal particle like *wohl* to get the epistemic reading, but in (28) only the epistemic reading is salient.

(27)  

*Aus dieser Kanne Milch kann die Kathl ein Pfund Quark machen*  
from this can milk can the Kathl one pound cottage cheese make  
‘From this can of milk, the Kathl can make one pound of cottage cheese’  

(Kratzer, 2012:52)
(28) Es kann sein, dass die Kathl aus dieser Kanne Milk ein Pfund Quark macht
it can be that the Kathl from this can milk one pound cottage cheese makes
'It can be that the Kathl is able to make one pound of cottage cheese from this can of milk’
(Kratzer, 2012:52)

The presence of an aspectual morpheme can also effect the interpretation of functional modals. In (29) examples from German where modals appear without a perfect auxiliary (29a), and with a perfect auxiliary (29b) show that when a modal appears below the perfective auxiliary the modal is obligatorily interpreted as deontic. Wurmbrand (1999) argues that German has two syntactic positions which can host modals: IP (epistemic) and ModP (root). Modals spell-out the heads of these phrases.

(29) a. No perfective auxiliary
Sue muss zu Hause arbeiten
Sue must-PRES.3SG at home work-INF
✓Root: ‘Sue has the obligation to work at home’
✓Epistemic: ‘It must be the case that Sue works at home’

b. Perfective auxiliary above modal
Sue hat zu Hause arbeiten müssen
Sue has-3SG at home work-INF must-IPP
✓Root: ‘Sue had the obligation to work at home’
* Epistemic: ‘It must have been the case that Sue (had) worked at home’

c. Perfective auxiliary below modal
Moel muss die Oliven gegessen haben
Moel must-PRES.3SG the olives eaten-PP have-INF
✓Root: ‘Moel is obliged to have eaten the olives’
✓Epistemic: ‘It must have been the case that Moel ate the olives’
(Wurmbrand, 1998:256-8)

In (29c) we see that if a perfect auxiliary occurs in the same sentence as a modal in German the modal must be above the perfect auxiliary (in IP) in order to receive an epistemic interpretation (Tollan, 2013: 59); a root reading is also possible for a modal above the perfect auxiliary. The overt presence of a perfect auxiliary above a modal forces that modal to be bound by aspect (to be discussed below, Hacquard, 2006), and rules out the possibility of being bound by the speech act (Tollan, 2013:62). One cannot get an epistemic modal interpretation in the lower modal position in German when a perfect auxiliary is present.

While the root reading is available when the modal is in the higher position of German (given appropriate context), there is an out-of-the-blue preference for epistemic readings for
modals that occur higher than aspect (Eide, 2003, on Norwegian). Futurate temporal adverbials (e.g. *before he arrives, by tomorrow*) shift modalized sentences to root readings because root modals take complements with a future reference and are considered ‘future-oriented’. On the other hand, temporal adverbs which refer to the past (e.g., *before he arrived, two minutes ago*) associate with epistemic readings because they are not future-oriented.

Modal particles in Dutch and German facilitate epistemic readings of modal verbs. In (30), examples from Dutch show that in a modal sentence without the modal particle *wel*, the modal verb *moeten* is interpreted as a root modal (especially out of the blue), while the addition of *wel* facilitates an epistemic reading. The English cognate *well* (31) reinforces epistemic readings of *could or might*, rather than prompting an epistemic interpretation.

(30)  
\begin{itemize}
  \item[a.] \textit{Hij moet thuis zijn}  
  He must at-home be-INF  
  \text{“Out of the blue” reading: ‘He is obliged to be at home’}
  \item[b.] \textit{Hij moet wel thuis zijn}  
  He must well at-home be-INF  
  \text{“Out of the blue” reading: ‘It is highly likely that he is at home’}
\end{itemize}

(31) \textit{He could/might well be the murderer.}

What we see, at least for languages with modal systems, is that certain overt morphemes prevent the semantics from evaluating the modal according to context alone. For instance, when a functional modal occurs below a perfect aspect marker in the syntax, the modal is then prevented from scoping above aspect at LF, this enforces a root reading. Ramchand (2012) shows that the descriptive facts are more complex, in that some modals (Type I) are sensitive to state vs. event aspectual properties of the prejacent, while others (Type II, are not), a conclusion similar to that of Eid (2003) for Norwegian (see §1.2.3 below for English facts).

This state of affairs suggests that the interpretation of functional modals depends on their interaction with other semantic objects such as Aspect and Tense. There are clearly two relative modal positions at LF, one high which is keyed to epistemic interpretations and one low which is keyed to root interpretations. However, the exact nature of those positions in the overt syntax varies cross-linguistically.
1.2.3. English modals categories (and how they came to be)

In this section, I discuss the modals of Present Day English and their various histories, making reference to West Germanic (Dutch, German) cognates for expository purposes. At LF, English is like any other language and makes use of two semantic modal positions, under the assumption that the basic mechanisms and conceptual structure of the semantics is universal. In this thesis I treat several sets of English modals which belong to different morphosyntactic categories: INFL modals (*must, can*), v-modals (*have to, gonna*), verbal (pre-)modals (*want, know*), and adverbial modals (*maybe, possibly*). Of these, the INFL and v-modals are functional modals which have fixed force but context-dependent flavour. The premodals and adverbials are lexical modals which are fully specified for force and flavour. In this section I will discuss all of these in turn, laying out the syntax of English modals treated in this dissertation.

The set of INFL modals (e.g, *must, can, will*) are the oldest diachronically and have undergone wholesale change upwards in the structure from V to INFL. Their cognates in other West Germanic languages (e.g., Dutch, German, Frisian) remain verbal and have undergone far fewer changes since divergence from their common ancestor-group with English. Lightfoot (1979) discusses four critical changes that occurred to the Old English premodals (those verbs that became the INFL modals). Premodals typically denote mental states, states of obligation, or desire or potential acting on the subject (Lightfoot, 1979; Tollan, 2013:9). Old English premodals: (a) lost infinitival marking, (b) stopped appearing in clusters (in most dialects), (c) lost tense morphology and no longer could appear after *have* or other auxiliaries, and (d) ceased to appear with direct objects. Roberts (1985) argues that these descriptive changes can be explained by change from premodals subcategorizing for VP to direct merge in INFL. In English, this set of modals is in complementary distribution with other INFL elements (Roberts, 1985; Pollock, 1989; Cowper & Hall, 2007; i.a.).

I assume, following others (Roberts, 1985; Wurmbrand, 1998; Hall, 2001; Tollan, 2013), that English Finite IP has two major types with different features on the head: INFL [+PAST], and MOD [-Tense] (see also Cowper & Hall, 2007 who use a feature-geometric approach to INFL wherein modality entails finiteness). The modal type of Finite IP could be argued to have both [+PAST] because certain modals (*can/could* and *will/would*) retain remnants of an earlier system when these modals were verbs and could be inflected for tense (c.f. Hall, 2001; Bjorkman, 2011). However, the system as a whole is defective for this feature distinction and
most INFL modal do not show a distinction between past and non-past forms, and those that do only have two fixed forms and the meanings no longer correlate precisely with tense. The basic functional hierarchy of English is provided in (32), with INFL modals appearing as the head of IP, above Aspectual verbal phrases.

(32) English Functional Hierarchy (adapted from Tollan, 2013:20)

\[
\text{IP} > \text{PerfP} > \text{ProgP} > \text{vP} > \text{VP}
\]

In contrast, Dutch and German cognates to the INFL modals continue to show all four of the properties listed above for English premodals, and are thus more in line with Old English than Present Day English in this respect. Dutch and German cognates are not in complementary distribution with INFL; there are two modal heads in which modal verbs can merge in Dutch and German (33; see Wurmbrand, 1998), both of which are lower than IP.

(33) Dutch/German Functional Hierarchy (Tollan, 2013: 62)

\[
\text{IP} > \text{ModP} > \text{PerfP} > \text{ModP} > \text{vP} > \text{VP}
\]

However, it would be inaccurate to say that the English modal system as a whole cannot realize modal clusters, nor embed modals under aspect. English also possesses the set of v-modals (e.g., have to, need to, got to), often called quasi-modals or semi-modals because their syntax is more verbal than that of the older INFL set. The v-modals arose later in the history of English (Late Middle English/Early Modern English; see Brinton, 1991; Fischer, 1994; i.a.), providing a means for expressing modality below INFL at a time when the INFL modals had lost this ability, subjunctive mood marking had all but disappeared due to phonological reductions (see Lightfoot, 1979; Roberts, 1985, i.a.). As such, v-modal development is a good example of renewal along the modal cycle. The v-modals were reanalysed from V → v, and came to take verbal complements. Many members of the set of v-modals maintain both v-modal and main verb forms (e.g. to have with deontic meaning vs. have as a main verb denoting possession). The v-modals are a diverse set in a major respect, as some require a be-auxiliary, as in be going to or be supposed to, while other do not (e.g., have to, got to).

The v-modals enable modal stacking in standard varieties of English (34) because they provide an additional syntactic site for a modal to appear in (c.f. Dutch/German hierarchy in (33)). The restrictions at LF apply, so it is not possible to interpret stacked modals in the relative order *Root > Epistemic. The v-modals also allow modals to appear below aspect heads like
perfect *have* (35), and like in Dutch and German, the modal below the perfect auxiliary obligatorily receives a root reading.

(34)  
a. *I might have* to join you in London. (Reading: Epistemic > Root)  
b. *He should have* to go. (Reading: Root > Root)

(35)  
The puppy has *had* to sleep on his own for the past three nights. (∀ Root, *Epistemic*)

Present Day English also has several main verbs with premodal meanings (the lowest, most contentful, and least grammaticalized stage of modals; see Lightfoot, 1979). Notably, English has the set of current mental state verbs (*think*, *know* (*how*), *mean*, etc.) and the renewal candidates *want*, *owe*, and *try*; all of these verbal meanings are known to have grammaticalized into more functional modal meanings in more than one studied language history (see Bybee et al., 1994). Verbs of personal taste or desire (for example *love*, *like*, *enjoy*) are also associated with modal meanings (Stephenson, 2006, i.a.), though are not (frequently) shown to grammaticalize.

Incorporating the *v*-modals and premodals into our functional hierarchy for English, we get the revised hierarchy in (36). IP includes INFL modals from the canonical auxiliary set, while *vP*, includes the *v*-modals (semi/quasi-modals). VP includes lexical verbs which do not change meaning regardless of complement type, DP or CP (see Harley, 2004; Harves & Kayne, 2012; i.a; c.f. with functional verbs like *have* to); this category includes the mental state verbs (*know*, *think*, etc.) which are lexical modals because their modal meanings are invariantly epistemic (some attitude verbs are root modals, like *hope*, *need* and *wish*) and other premodals like *want*, *try* and *owe*.

(36)  
English Functional Hierarchy (revised)  
IP Modal Auxiliaries > PerfP > ProgP > vP Quasi-Modals > VP Premodals

English, unlike other West Germanic languages, has developed a progressive construction with –*ing* (37a). The *be*-progressive (ProgP) prompts an epistemic reading because the progressive aspect anchors the event to the moment of utterance (Condoravdi, 2002; Eide, 2003; Tollan, 2013:75) and so links to the speech act event and impedes a future-reference (associated with root modals). The perfect marker also affects interpretation similarly (38). However, while the readings in (37a) and (38a) are most natural, root readings are not ruled out with progressive and perfect preajcents for Type I nor Type II modals (Ramchand, 2012).
Progressive BE with
a. Michelle must be sleeping. (Epistemic)
b. Michelle must sleep. (Root)

Perfect Auxiliary HAVE
a. He must have gone. (Epistemic)
b. He must go. (Root)

Complement type, in particular the aspectual properties of the prejacent verb, also effects modal interpretations (e.g., Barbiers, 1995; Eide, 2003; Ramchand, 2012). A stative complement prompts an epistemic reading because the state holds of the present (39a), while with an eventive complement a deontic reading arises\(^\text{16}\) (39b), because without the be-progressive the English bare verbs are future-oriented (c.f. He must be playing Jenga with his cousins, which has an epistemic reading).

Stative vs. Dynamic Complements

a. He must be sick. (Epistemic)
b. He must\(^\text{17}\) play Jenga with his cousins. (Root)

While the interpretations presented above hold, the descriptive situation is more principled and complicated; the interactions between tense, aspect, and modality are fine-grained (Hacquard, 2006; Ramchand, 2012). Ramchand (2012) shows that Type I INFL modals (e.g., must, will, can’t) allow both epistemic and deontic readings for prejacent with stative lexical verbs (e.g., like; 40a, c.f. 40b), statives with BE (e.g., be tired, be in his office), progressives, perfects, and habituals (even of dynamic verbs; 41a, c.f. 41b). On the other hand, only root readings are available for Type I modals with dynamic verbs (e.g., activity run, accomplishment build, achievement win; 42a, c.f. 42b) and passives (43a, c.f. 43b). Type II INFL modals (e.g. could, might, should) do not have this restriction (40-43, all b examples). Type I modals are restricted from epistemic interpretations with dynamic and passive prejacent.

Stative Lexical

a. John must like Brussel sprouts very much. Epistemic (present), Root
b. John could like brussel sprouts very much. Epistemic (present), #Root\(^\text{18}\)

---

\(^{16}\) An epistemic reading is possible with a habitual interpretation.

\(^{17}\) Must is losing deontic ground in English, so most speakers would more naturally form a universal root deontic with have to. Despite this, the distinction between root and epistemic must still holds, albeit with a rather old-fashioned, or overly forceful, sound to sentences like (39b).

\(^{18}\) Type II modals like could consistently allow epistemic readings with both stative and dynamic prejacent but may not allow root readings with all statives, as with this reading for could.
(41) Habitual
a. *John must work hard for a living.*  
Epistemic (present), Root (future)
b. *John could work hard for a living.*  
Epistemic (present), Root (past)

(42) Dynamic Achievement
a. *John must win the race.*  
#Epistemic, Root (future)
b. *John could win the race.*  
Epistemic (future), Root (past habitual)

(43) Passive
a. *John must be arrested by the police.*  
#Epistemic, Root (future)
b. *John could be arrested by the police.*  
Epistemic (future), Root (past habitual)

(Ramchand, 2012: 3-8)

Generally, epistemic meanings associate with past and present tenses, and progressive and perfective aspects. This is because epistemic reasoning is the only modal reasoning available in these otherwise actual temporal/aspectual eventualities; any uncertainty is relegated to mental states or evidence availability and necessities or possibilities in the actual world are closed. In the future or future-oriented present statements (*He must go*), the temporal unfolding of the event has yet to occur (or complete) so the force of the modal may apply in other ways, for example deontic force (e.g. what you should do or are allowed to do).

English also makes use of a multitude of adverbial lexical modals (e.g., *maybe, perhaps, possibly, necessarily*) which may be used alone, or in addition to other modal types (see Cinque, 1999 for a detailed description and analysis of this set), in a relatively flexibly manner. Many of these adverbs have related adjectival predicates, such as *It is possible/necessary/likely*, though these are associated more with written and formal registers.

<table>
<thead>
<tr>
<th>Table 1.1: English modals under consideration in this dissertation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexical</td>
</tr>
<tr>
<td><em>Epistemic</em></td>
</tr>
<tr>
<td>ADV</td>
</tr>
<tr>
<td>possibly, maybe</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

27
In summary (Table 1.1), English has three major sets of modals, two sets are functional modals: INFL-modals and v-modals, while the third is lexical modal adverbs (there are other modal predicates like *it is possible*, but these are not relevant in the child studies of this dissertation). In addition, English has a number of verbs that qualify as premodals because of their semantics (*want, try, owe*). English modal root and epistemic interpretations arise from a combination of lexical properties of the modal, the aspectual and temporal properties of the prejacent, the presence or absence of temporal adverbials, and the context of utterance.

### 1.2.4. Explaining modal form-meaning mappings for functional modals

Currently, theories of modal representation divide according to two fundamental cross-linguistic observations (Hacquard, 2010); semantic theories of modality have typically abstracted away from most syntactic problems, aiming to explain how and why modal meanings are context dependent and typically represented by polysemous lexical items (like *must*, Kratzer 1981; Palmer, 1986; Condoravdi, 2002; i.a.). On the other hand, syntacticians have long observed that modals exhibit systematic distributional differences between root and epistemic modals (or interpretations for functional modals). They have argued that epistemic modals are instantiations of INFL (or higher heads), while root modals are lower than INFL. This structural contrast is based on the position of various adverbs (Cinque, 1999) or based on diagnostics which appear to provide evidence that epistemics take propositional complements while root modals do not, (see Jackendoff, 1972; Brennan, 1993; Butler, 2003). For example, root modals associate with the subject and thus appear to have an external theta role (see Wurmbrand, 1999 for a critique), while epistemic modals do not associate with the subject and therefore appear to take the whole sentence as their internal theta role.

Under his cartographic approach to syntax, Cinque (1999) argues for a range of functional positions for modals. He argues that every flavour of modal (e.g., *ability, obligation, epistemic*, etc.) is linked to a unique syntactic head (44). As distinct functional items, polysemous modals (e.g., *must*epistemic and *must*obligation) would have to have separate lexical entries with distinct merge sites (*ModEpistemic* and *ModNecessity* or *ModObligation*, respectively, see below), regardless of frequent distributional conflation.

\[(44) \quad \text{[Mood} \text{Speech Act [Mood} \text{Evaluative [Mood} \text{Evidential [Mod} \text{Epistemic [T} \text{Past [T} \text{Future [Mood} \text{Irrealis [Mod} \text{Necessity [Mod} \text{Possibility [Mod} \text{Volitional [Mod} \text{Obligation [Mod} \text{Ability/Permission}]\ldots}\]}
\]
Cinque’s syntactic approach doesn’t capture cross-linguistic lexical polysemy. Languages typically express sets of these heads with the same lexical item, for example, in my English, *could* can be associated with four of the six modal positions (ability/permission, volitional, possibility, epistemic) and *must* can appear in three (obligation, necessity, epistemic). Why would so many positions (six modal and four mood positions) be so commonly expressed by polysemous lexemes in the languages of the world? Simply linking modals to separate positions leads to an undesirable multiplicity of lexical entries for apparently the same word, without explaining rampant polysemy\(^\text{19}\) nor systematic differences between root and epistemic modals.

Kratzer (1977, 1981, 1991) relativizes modal lexemes to the context using possible worlds semantics. Making a modal’s flavour context-dependant allows her to capture the strong cross-linguistic tendency for root and epistemic modalities (and sub-flavours within) to be expressed by the same lexical items. For Kratzer, there are two modal bases (45): root meanings are associated with a circumstantial modal base (45a) and epistemic meanings are associated with an epistemic modal base (45b). The modal base is comprised of a set of worlds that represent certain types of circumstances (e.g., rules for deontics, desires for bouletics, facts about the physical world for circumstantials) or types of facts (for epistemics).

\[(45)\]
\[
\begin{align*}
\cap f_{\text{circ}}(w) &= \{w':w' \text{ is compatible with certain circumstances in } w\} \\
\cap f_{\text{epis}}(w) &= \{w':w' \text{ is compatible with what is known in } w\}
\end{align*}
\]

(Kratzer, 1991)

The full array of modal flavours can be derived in the semantics from a combination of the modal base (either 45a or 45b) with the ordering source (e.g., realistic, stereotypical, idealistic) (c.f. Domain of Quantification, Vander Klok, 2012, above). However, Kratzer’s approach does not address the distributional facts: why should context-dependent modals systematically vary such that epistemic modals are usually structurally higher than root modals? Is it possible to reconcile syntactic approaches with semantic? To maintain context-sensitivity and capture polysemy, the major modal classes should arise naturally from the formal properties of the modal lexemes themselves as they interact with other syntactic objects at LF.

Hacquard (2006, 2010) argues for an event-relative anaphoric approach to modality. She aims to derive the cross-linguistic syntactic facts while maintaining Kratzer’s semantic analysis, by relativizing modals to events rather than to worlds. Broadly, Hacquard links the interpretation

\[^{19}\text{Though see Roberts (2010) for a historical argument for polysemy that assumes a detailed Cinque-type functional hierarchy.}\]
of the modal lexeme to its compositional position, systematically deriving the modal bases from different regions of the syntax, without requiring lexical restrictions on the modal lexeme (contra Cinque, 1999). Modal lexemes have an event variable that is locally bound, thus functional modals are anaphoric. The modal bases, rewritten relative to events rather than to worlds, are provided in (46). The ‘CON’ refers to propositional content (an event e with a truth-conditional value); the epistemic modal base is only licensed for events that have propositional content (IP events but crucially not VP events).

\[
\begin{align*}
(46) & \ a. \ \bigcap f_{\text{circ}}(e) = \{w' : w' \text{ is compatible with the circumstances of } e\} \\
& \ b. \ \bigcap f_{\text{epis}}(e) = \{w' : w' \text{ is compatible with } \text{CON}(e)\}
\end{align*}
\] (Hacquard, 2010)

There are only two places in the clause that have the appropriate semantic argument type for a modal lexeme to take\(^{21}\): right above VP (=low, root modal), and right above tense (=high, epistemic modal) (Hacquard, 2010: 6). A third modal type, attitude-holder modality, comes from attitude verbs that embed high modals which are relative to the attitude-holder, not to the speaker. The 3 types of events that modals can be relativized to are the matrix speech event (47a), the embedded attitude-holder event (47b), and the VP event (47c).

\[
\begin{align*}
(47) & \ a. \ \text{The speech event (anchors the modal to the speaker and the speech time)} \\
& \quad [\text{CP } \lambda e_0 \text{ Mod } e_0 [\text{TP } T \text{ Asp}_1 [\text{VP } V e_1]]] \\
& \quad \text{John might have thought yesterday that Mary had taken the train the day before.} \\
& \ b. \ \text{The attitude event (anchors the modal to the attitude holder and the attitude time)} \\
& \quad [\text{CP } \lambda e_0 \ T \text{ Asp}_2 \text{ Att } e_2 [\text{CP } \text{Mod } e_2 [\text{TP } T \text{ Asp}_1 [\text{VP } V e_1]]]] \\
& \quad \text{John thought yesterday that Mary might have taken the train the day before.} \\
& \ c. \ \text{The VP event (anchors the modal to the subject and the time provided by Tense)} \\
& \quad [\text{CP } \lambda e_0 [\text{TP } \text{Asp}_1 \text{ Mod } e_1 [[\text{VP } V e_1]]]] \\
& \quad \text{John thought yesterday that Mary had to take the train the day before.} \\
\end{align*}
\] (Hacquard, 2010: 7)

By relativizing modals to events, the syntactic positions of modals become non-stipulative because the event variable on the modal lexeme is bound by a particular event-binder,

---

\(^{20}\) In order for her system to work, Hacquard needs to modify the definition of epistemic modals to be unmediated by a state of knowledge. “Thus a sentence like John believes that it might be raining would mean ‘It is raining in some world compatible with John’s beliefs’, rather than ‘It is raining in some world compatible with what John knows in his belief worlds’. If this is correct, an epistemic interpretation will only be available when the modal is relative to an event associated with propositional content (i.e., attitude and speech events), which in turn is only possible when the modal is in the ‘high’ position.” (Hacquard, 2010: 7)

\(^{21}\) For Brennan (1993) modals that merge above VP are of type \(<e,st>\) and take an event argument, while modals that merge above IP are of type \(<st>\) and take a propositional argument. Hacquard (2006: 72) argues that this split would require a lexical split which is not empirically founded (languages use the same lexical items), she argues that modals take either propositions and return propositions (above TP) or they takes predicates of events and return predicates of events (above VP), so they could be of type \(<\alpha,\alpha>\).
keying each modal to a different *individual-time* pairing according to where it merges. Local binding anchors the modal so as to restrict epistemic readings to above T and root meanings to above VP, deriving the corresponding *individual-time* pairings that exist in natural language. Other combinations, such as *subject-speech-time* or *speaker-tense-time* are logically possible, but are not attested, providing further substantiation for Hacquard’s event-relativity model. When the event variable of a modal is bound by the speech act event, the modal is necessarily interpreted as a speaker-oriented epistemic modal (47a,b). Inner aspect may also bind a modal event variable as inner aspect undergoes covert raising at LF due to semantic type mismatch (Hacquard, 2006: 56), allowing it to bind a low modal and force a root interpretation (47c).

For Hacquard (2013) functional modals are anaphoric to events while lexical modals are not: “the main difference between lexical and grammatical [=functional] modality is that lexical modals are fully specified predicates of events; grammatical modals are not, and thus they can appear in different positions. The aspectual/temporal constraints that grammatical modals are subject to are due to their anaphoric nature, rather than to the meanings they express.” In sum, functional modals appear above IP or below Aspect (48), by LF.

(48) **Functional modal structure (Hacquard, 2006, 2010)**

In the same spirit as Hacquard, Ramchand (2012) demonstrates that the aspectual properties of the prejacent also play a systematic role in determining the meaning of some functional modals. Functional modals come in two types, those in Type I (*must, will, can*) only allow epistemic readings for states, while modals of Type II (*should, could, might*) allow
epistemic readings for dynamic verbs as well. She argues that Type I modals are indexical, while Type II are anaphoric to situations (c.f. events for Hacquard, 2006). Situations are semantic entities that have world and time parameters (Ramchand, 2012:16), and can be viewed as expansions of event descriptions. In order to capture the two subgroups of functional modals, she argues Type II modals (e.g., could) are anchored anaphorically [-INDEX] to the modal perspectival base because of their fossilized past tense features\(^2\) (not surprising since these modals express feature bundles on INFL), while Type I modals (e.g., must) are bound to an indexical feature of INFL [+INDEX], and appear to be historically present tense. This distinction captures the epistemic interpretation restrictions on Type I modals (only with statives).

Taking stock, Hacquard’s model provides 3 natural classes of modals (epistemic, attitude-holder, root) from 2 possible LF positions (above vP, above IP) via a formal modification of Kratzer’s model wherein modal quantifiers are argued to be relative to an event of evaluation rather than a world of evaluation. She argues that there is no need to stipulate interpretation-specific heights for functional modal lexemes, rather the syntactic patterns show systematic height differences between root and epistemic readings (though the exact differences vary by language, see above) because the LF evaluation of root and epistemic readings is universal. With the same general agenda, Ramchand (2012) argues that in addition, some functional modals pattern with the present and other with the past, capturing differences between functional modals with respect to available epistemic interpretations.

In sum, modal interpretations are determined by both the context and other elements in the sentence. Languages have a universal semantics but vary in the syntactic expression of modals both in terms of category and number of available host heads. For example, German and Dutch have two syntactic positions which host modal verbs, while as we have seen (§1.2.3), the modal cycle has caused English cognates to diverge from their West Germanic cousins.

1.3. Diachronic Directionality: steps on the Modal Cycle

How do modal lexemes change in the historical record? What is the nature of the steps that children are thought to be responsible for under generative change analyses? How did the current modal system of English come into being and where might it be going? In order to make

\(^2\) Type I modals have the same distribution as the Simple Past in English.
a clear hypothesis about how children learn and potentially innovate in general, we have to look at what historical children are thought to have innovated.

The modal cycle offers a laboratory to appreciate and understand historically recurrent changes. In the diachronic literature, this cycle has enjoyed a place of prominence, forming the backbone of much of the key literature in both functionalist/usage-based and generative frameworks (Jespersen, 1961; Visser, 1963-73; Traugott, 1972, 1989; Lightfoot 1979, 1991, 1999; Shepherd, 1981; Plank, 1984; Roberts, 1985; Denison, 1993; Warner, 1993; Bybee et al., 1994; Fischer, 1994, 2003; Krug, 2000; Roberts & Roussou, 2003; among many others). Unidirectional changes are well-attested for modals, both from (a) content → root → epistemic meanings, and from (b) main verb → functional verb → auxiliary/INFL. The directionality exhibited by the modal cycle is part of the wider phenomenon of cyclic change and so should be viewed as a case study. The grammaticalization process results in considerable overlap, as is seen with modals in Present Day English (e.g., existential deontic modality: can, may, should, ought to…).

Generative studies have focused primarily on the syntactic reanalysis of modal verbs in the history of English (46) (Lightfoot, 1979; Roberts, 1985; Roberts & Roussou, 2003, i.a.)23. These studies argue that child reanalysis is responsible for recategorization in syntax. Generalizing, syntactic changes on the modal cycle show main verbs reanalyzed as functional verbs and then modal auxiliaries before they are subsequently lost (49a)24. An example, from English shall is given (49b). The reanalysis from V/v to INFL involves a structural reanalysis of a sentence from a biclausal structure to a monoclausal structure, as illustrated in (49c): the earlier stage is biclausal with two main verbs (the first modal) while the later stage is monoclausal.

23 See Von Fintel (1995) and Eckardt (2006) for discussion of regular semantic change; Eckardt covers the directional source of future modality (the ‘going to’ future).
24 This is likely a reflection of a much wider process of verbs becoming more functional with subsequent reanalyses up the tree, see Roberts and Roussou (2003).
In (49d) a biclausal Middle English sentence is provided, showing verbal inflection (evidence for the presence of a INFL head) on both verbs *mai* and *illimpen*. The V to INFL reanalysis is argued to have occurred because the evidence for the infinitival marking on the lower verb was lost with the phonological erosion of the OE inflectional system (see Lightfoot, 1979; Roberts, 1985 for further empirical evidence for triggers). Modal auxiliaries arose from the present-preterit premodal verbs (Table 2. below), a distinct, morphologically irregular set that often appeared to not enter into agreement relationships the way other verbs did; this property contributed to the reanalysis of these verbs as a set of modal auxiliaries. This, in conjunction with infinitival marking loss (*-en* no longer marks infinitives c.1550, Roberts & Roussou, 2003), made verbal constructions with the premodals no longer appear biclausal. The evidence to the L1 acquirer for a biclausal structure – agreement on the first verb and the second verb in non-finite form – was lost, giving rise to a monoclausal analysis (see Lightfoot, 1979).

Above I argued, in line with previous research, that English Finite IP has two major types: INFL[±PAST], and MOD[-Tense] (with some lexical idiosyncrasies wherein some modals retain fixed tensed forms). Previously, English IP was more like that of modern Dutch or German, only expressing Tense [±PAST]. When the premodals of Old/Middle English were reanalysed as direct-merged in INFL, the MOD flavour formerly associated with a verbal head

---

25 In Danish, the cognate to Eng. *shall* has become an evidential marker (1), possibly demonstrating a post-epistemic state on the semantic modal cycle (Palmer, 1986:72). See also Von Fintel & Gillies (2010) for English *must*.

1.  *Peter skal være en dårlig forsker*
   Peter skal+pres be a poor researcher
   ‘Peter is said to be a poor researcher.’  
   (Danish; Davidsen-Nielsen, 1986, in Palmer, 1986:72)
(of ModP) piggy-backed onto IP, creating the more complex IP of modern English (see Cowper and Hall, 2007, 2012; Ramchand, 2012).

The premodals of Old English were (with the exception of willan\(^{26}\)) present-preterit verbs with the meanings in Table 2. Other verbs in the present-preterite class were lost in English: \(\theta e ar f, d u g a n\) and munan (Denison, 1993). This set of verbs included verbs meaning \textit{suffice, avail, remember, love/grant, know}, and others which did not survive into Middle English.

Table 1.2: Modals and pre-modals\(^{27}\) in English (adapted from Tollan, 2013: 10)

<table>
<thead>
<tr>
<th>Old/Middle English verb</th>
<th>OE/ME full verb meanings</th>
<th>Modern English Modal</th>
</tr>
</thead>
<tbody>
<tr>
<td>motan</td>
<td>‘to have power/opportunity’</td>
<td>must</td>
</tr>
<tr>
<td>cunnan</td>
<td>‘to know’</td>
<td>can, could</td>
</tr>
<tr>
<td>willan</td>
<td>‘to want/wish’</td>
<td>will, would, won’t</td>
</tr>
<tr>
<td>sculan</td>
<td>‘to owe’</td>
<td>shall</td>
</tr>
<tr>
<td>magan</td>
<td>‘to be able’</td>
<td>may</td>
</tr>
</tbody>
</table>

The generalized semantic pathway for modal grammaticalization was provided in (1), repeated here as (50). This pathway has been most frequently studied by functionalist and usage-based linguists (Traugott, 1989, 2006; Bybee et al., 1994, i.a.). German \textit{müssen} (see Fritz, 1997:85-103, cited in Traugott, 2011, based on Deggau, 1907) remains a verb despite semantic grammaticalization along the modal cycle.

(50) German (Fritz, 1997)
O.H.G. \textit{müssen}_{ability} \rightarrow M.H.G. \textit{müssen}_{deontic} \rightarrow Mod.G. \textit{müssen}_{epistemic}

Usage-based theories, such as Traugott and Dasher (2002)’s Invited Inferencing Theory of Semantic Change (IITSC), primarily argue that metaphorization, metonymization and conventionalization of implicature (51; i.e. pragmatic inference becoming conventionalized, and thus semantically encoded) are the driving forces which create new stages for lexemes along the modal cycle. Two attested pathways through the semantic space are shown in (52). In (53), an Old English example of the predecessor of \textit{can, cunne}, is shown in a sentence where it is a main verb denoting mental ability (=\textit{to know}) and selecting a DP complement.

(51) Conventionalization of Implicature
\textit{He should do it} (=\textit{deontic}) \rightarrow \textit{Therefore, it should get done}. (=\textit{epistemic})

\(^{26}\) Though \textit{will} was not a present-preterit verb, it showed similar patterns of irregularity (Denison, 1993; Warner, 1993).

\(^{27}\) Note that \textit{could, should, would} and \textit{might} used to only have +PAST readings; – PAST readings arose from conflation with the subjunctive. Note also that not all present-preterit alternants were reanalysed (Denison, 1993).
Known semantic pathways of the Modal Cycle

a. mental/physical ability → ability → teleological possibility → epistemic
   (e.g., Eng. can, Fr. pouvoir)

b. deontic obligation → epistemic necessity
   (e.g., Eng. must)  
   (Bybee et al., 1994)

Binnan pryrm nihtum cunne [his mihta]$_{DP}$
within three nights know I his powers
Within three nights may I know his powers  
(MCharm 9.14; Denison, 1993: 306)

French devoir, like German müssen, has followed the historical semantic pathway from content verb → root modal → epistemic modal, originally meaning ‘to owe’, just like English shall (O.E. sceal), but unlike shall, devoir has retained all of its previous meanings to the present day. Consider also English modals that in some cases grammaticalized syntactically (V→INFL) prior to later semantic grammaticalization (ROOT→EPISTEMIC), further illustrating the independence of the overt distributional syntax and the compositional semantic components of the modal cycle. The mapping from syntax to semantics is flexible (except for noted interactions with overt tense and aspect which demarcate the underlying system), and so are the diachronic facts. For example, can became an INFL element when the English premodals developed into the set of INFL-modals, between the late OE period and the ME period. However, can does not appear to have developed epistemic meanings right away, rather epistemic meanings only appear after a significant interval of time when can was in INFL (see e.g., Goossens, 1992; Warner, 1993). For many speakers, un-negated can is still not possible (or is dispreferred) in epistemic readings (might and could are used instead).

Directionality in syntactic and semantic change is robust for modality, with parallel changes repeated over and over for different lexemes in different languages (seen not only for Indo-European languages, see Bybee et al., 1994; Heine & Kuteva, 2002). These separate primary foci of generative and usage-based historical linguists with respect to the modal cycle help illustrate that the syntax and semantics of modals change largely independently. However, whilst languages tend to show some alignment in syntactic and semantic height of modals, this alignment is not unconditional. Why is the direction of change unidirectional in the syntax and semantics? Why do epistemic meanings develop from root meanings and not vice versa? Further, if semantic change can occur along the modal cycle without concurrent syntactic change – and vice versa – then what is the formal relationship between the syntax and semantics of modality?
More specifically, in an event-relative analysis of modals (Hacquard, 2006, 2010), can the historical disjunction between the semantic and syntactic components of the modal cycle receive a natural explanation?

In usage, the modal system is always dynamic, with frequencies of usages waxing or waning (c.f. Kroch, 1989’s “Competing Grammars”), and with new modal candidates vying for space (consider the diachronic ‘recruitment’ of verbs of wishing or wanting (O.E. willan ‘to wish’ > PDE will) for modality and future (Warner, 1993; Denison, 1993). Newer innovations are preferred over older forms (have to has engulfed much of must’s deontic territory in Toronto English, Tagliamonte & D’Arcy, 2007), and older forms tend to have more epistemic meanings. For example, might is most commonly used for epistemic meanings usage in Present Day English (PDE). Furthermore, must is losing deontic ground in nearly all English dialects, and in some dialects is primarily used epistemically in spoken registers (e.g. Toronto, Tagliamonte & D’Arcy, 2007).

Usage facts suggest the syntactic and semantic cycles are linked, at least in the diffusion stage of change: semantic change can occur without syntactic change (e.g. German müssen), but appears to be expedited by prior syntactic reanalysis. For example, in Old and Middle English, German, Dutch modals are syntactically low (V/v) and there is a tendency for (low) root readings. In Modern English modals are syntactically high (INFL) and these modal tend towards more (high) epistemic readings in usage. Courmane & Tollan (in preparation) propose acquisition biases may be responsible for these facts, namely, the acquisition of modal meanings may be under pressures of economy in acquisition (van Gelderen, 2004, 2011), whereby the child prefers a straightforwardly compositional syntax-semantics where syntactic position directly reflects LF scope (c.f. Musolino, 1998, et seq.).

Evidence from the historical record as well as from sociolinguistic (e.g. Tagliamonte & D’Arcy, 2007) and corpus studies (Hacquard & Wellwood, 2012) present us with a problem: the flavours of modals in synchronic systems are well-explained by event-relative analysis, however, if and when modal lexemes are restricted to select either VP complements or IP complements, it

28 A clear counterexample is can, which is among the oldest set of modals and is in INFL, but is sometimes argued to be restricted to a circumstantial base. For many speakers can is root but when negated as can’t epistemic readings become available.
29 While usage facts show primarily epistemic might (at least for written corpora; see Hacquard & Wellwood, 2012), elicitation and grammaticality judgements show that might is also possible in some circumstantial sentences, when the circumstances are objective and metaphysical: e.g., flowers might grow here. While these uses may be less frequent, the grammar does not rule them out.
is not at random, as shown by synchronic evidence and the diachronic Modal Cycle. Rather, there appears to be three phases, defined in synchronic grammars as follows:

(a) ‘New’, lower modal lexemes are evaluated relative to VP events.
(b) ‘Full-fledged’ modal lexemes are evaluated relative to VP and IP events.
(c) ‘Old’, higher, modal lexemes are evaluated relative to IP events.

How can the systematic nature of these phases be accounted for in the event-relative system? Hacquard notes that, “[i]diosyncrasies of particular modals (e.g. might) are due to selectional properties hardwired into the lexical entries (Hacquard, 2010: 11 fn. 4)”. These phases may appear largely idiosyncratic in specific synchronic systems like Present Day English, but diachronically robust patterns of lexical restrictions reveal themselves over time and define each stage of the well-studied modal cycle (see Traugott, 1974, 1989, 2006, 2011; Lightfoot, 1979, 1991, 1999; Denison, 1993; Warner, 1993; Bybee et al., 1994; Fischer, 1994; Roberts & Roussou, 2003). Historical changes on the modal cycle have synchronic reflexes that a free-selectional theory of modals does not capture. Questions which arise for an event-relative analysis of modals from the diachronic perspective include: How can we explain the fact that modals begin restricted to selecting VP events and only later come free to select for IP events also? Also, why should a modal with unrestricted selection become restricted to IP events, but not VP events (i.e., lose its root meanings prior to losing its epistemic meanings)?

1.3.1. Explaining the modal cycle

How do historical linguists explain the modal cycle? In usage-based linguistics, Traugott and Dasher’s (2002) model for semantic change, the Invited Inferencing Theory of Semantic Change (IITSC), is a leading model that aims to explain the ROOT → EPISTEMIC directionality of the modal cycle. It is formulated to capture the observation that pragmatic inferences arising from root modals appear to get reanalysed (or conventionalized) as epistemic semantic meanings. They argue that this process of conventionalization of pragmatic extensions, called Conventionalization of Implicature (see also Traugott, 1989, 2006), is enacted by adults: “[Speakers/Writers] may innovate a metaphoric use of a lexeme in an utterance token. Creative writers in particular do this.” (Traugott & Dasher, 2002: 34). In this model, children are not

---

30 With the caveat that historical studies reflect written work, and modals in writing may behave differently than from in speech (sampling effects of written registers, e.g.). As noted in footnote 29, modern written corpus data may show us that lexemes like might are different in speech and writing. This is a difficult problem for any historical linguistics study.
considered pragmatically sophisticated enough to be innovators (Traugott & Dasher, 2002: 41),
though children have recently been shown to possess greater pragmatic sophistication than
previously thought (Noveck, 2001; Papafragou & Musolino, 2003; Gualmini, Hulsey, Hacquard,
& Fox, 2008; Salomo, Lieven, & Tomasello, 2010; i.a.). Rather innovation is linked to
“communicative-expressive need” (Nerlich & Clarke, 1992:127) and comes from online usage
via creative coinages. Children also face communicative-expressive pressures, arguably much
greater given their more limited grammars and other communicative repertoires. The relevant
difference appears to be between true holes in communicative ability (as for young children) that
will be corrected in the acquisition process, and more conscious adult creativity with
expressiveness (i.e. playfully/creatively/poetically, extending the existing system to beyond its
learned limits).

More formally, the IITSC works as follows (54): a given lexeme (L), say deontic must,
has a meaning (M₁) which is linked to a conceptual structure (Cₐ). This is the earlier meaning.
The later meaning, epistemic must, has a meaning (M₂) that is linked to a conceptual structure
(Cₐ). This is the later meaning. Over time, meaning 1 extends to meaning 2. As is commonly
assumed in usage-based models, when pragmatic meanings become conventionalized they
concurrently become part of the semantics.

(54) The Invited Inferencing Theory of Semantic Change (Traugott & Dasher, 2002:38)
L → M₁ + M₂

Consider the diagram:

```
   L
  /   \
 M₁ ——— M₂
  \   /  \
 Cₐ  Cₐ/b
```

Change occurs as follows: when a speaker uses e.g., deontic must (L, the lexeme in
question) she uses it with meaning M₁ (e.g., universal, deontic). Assuming must does not yet have
an epistemic meaning, it gains epistemic meaning because obligation leads to the carrying out of
an action (and not v.v.). M₁ associates with the interpretation that the subject has an obligation
(Cₐ). Pragmatically, an extension of M₁ is Cₐ. We can think of Cₐ as the epistemic reasoning of
must i.e. if someone has the obligation to do something, then it follows that that something will
probably be done (epistemic meaning: M₂). With increased usage the pragmatic extension of M₁,
Cₐ, will become conventionalized as M₂ (i.e. directly associated with the meaning M₂). In (54),
M₁/₂ ↔ Cₐ/b represents symmetrical entailments and a unique conceptual structure to meaning
mapping. Given this symmetry, unidirectionality along the modal cycle must come from
properties of the world (if someone has the obligation to do something, then it follows that that something will probably be done, but not v.v.), rather than the lexical items themselves.

Let’s compare generative analyses of the modal cycle, wherein the child uses universal guidelines to posit the simplest structure necessary to capture the facts of the input. For Roberts and Roussou (2003) these guidelines are an innate functional hierarchy and a simplicity metric (from Longobardi, 2001); grammaticalization is upwards, local, cyclic, and always target[s] functional heads (Roberts, 2010). For van Gelderen (2004, 2011) the guidelines are innate economy principles, framed within the Minimalist Program (Chomsky, 1995). If all children are endowed with the same learning heuristics we expect similar changes to occur throughout all language continuums (past and present). Van Gelderen (2004, 2011)’s economy principles can be understood as proposals for learner biases active in L1A. Relevant to all instances of cyclic change which are upwards in the structure, van Gelderen’s Late Merge Principle (LMP) is inspired by Chomsky (1995)’s merge-over-move economy principle; direct merging is less costly than moving (55) (c.f. Roberts & Roussou, 2003, upwards reanalysis).

(55) Late Merge Principle (LMP): Merge as late as possible.

If child learners make use of the LMP, they could be considered responsible for those cyclic changes which involve upwards reanalysis from head to higher head (c.f. Roberts, 2010). For example, direct merging a modal in INFL (or the middle field) when little to no evidence remains for treating the element in question as a verb (as with premodals in the history of English). Van Gelderen notes, "Children seem to turn lexical categories, such as prepositions, into grammatical ones such as complementizers, seemingly without explicit input. This means they are employing Feature Economy, reanalyzing semantic [=lexical, content] features as grammatical ones. (van Gelderen, 2011:23)."

For example, van Gelderen (2011) points out that for appears in PPs (A toy for John) before it appears as a complementizer (I’d prefer for there to be coffee, over tea) (Josefsson &

---

31 Otherwise, usage of M1 (deontic must) activates both Cₐ and, pragmatically, also Cₐₜ and also, usage of M2 also should activate both Cₐ and, pragmatically, Cₐ (giving epistemic > root directionality). In other words, if pragmatic extensions get conventionalized from root to epistemic, why not also from epistemic to root? What makes M₁ precede M₂ beyond the evidence that it does precede in the historical record? The opposite direction of pragmatic extension appears possible: for example, if something epistemically should get done, this implies that it, circumstantially or deontically, should be done by some force or agent. If increased conceptual activation links and subsequently semantically encodes meanings, we would expect that once we have epistemic might, with deontic meanings completely lost (as is the case), speakers/writers should be able to re-innovate lost root meanings from might (but this direction of change is not attested).
Hakansson, 2000) in children language, in line with the predictions of the LMP (though likely also predicted by input frequencies and clausal complexity). What about the change from one semantic type to another, as with ROOT → EPISTEMIC? Semantically, a version of the LMP could be active in ROOT → EPISTEMIC reanalysis (evaluated above VP → evaluated above IP). However, developmentally children seem to begin with root modalities and later extend to epistemic modalities, a direction which is not in line with the bias suggested by the LMP. The upwards aspect of the LMP, or of upwards reanalysis, is relevant, but loss of movement does not seem to be; rather the evaluation site (the probing head) is what appears to be changing (see Roberts 2011:23). For example, using a three-way modal head split (from low to high: ModAbility/Permission to ModObligation to ModEpistemic) for motan/must in the history of English, in reference to semantic changes of must, Roberts argues that “[w]hat changes is the position of the probing features rather than the surface position of the verb” (Roberts, 2010:23). He argues that features (marked features, specifically) can ‘move up the tree’.

In short, in usage-based models of change directionality comes from unidirectional pragmatic extensions, while in generative models unidirectionality on the modal cycle comes from the innate structural hierarchy and economy. The two modal pathways (syntactic and semantic) do not necessitate each other (Tollan & Cournane 2014, in preparation) and appear to rely on different types of reanalysis (i.e., one possibility is the Late Merge Principle for syntax but upwards reanalysis of marked features at LF for semantics). In summary, generative linguists and usage-based linguists have focused on different aspects of the modal cycle, the syntax and the semantics respectively, and from different perspectives. This, along with other theoretical differences, has lead to different models of change. Both models suffer from a lack of evidence from their innovating population (adult speakers/writers or child learners). Is there evidence that learner divergence from the input drives the modal cycle? Can child learning pathways explain the phases in the life-cycle of a modal lexeme?

1.4. Assessing child evidence for the Child Reanalysis Proposal

Can studying modern child language help explain historical reanalysis? In this subsection, I lay out my assumptions for why and how I think it is possible to study L1 innovation using contemporary children and contemporary languages. Many linguists have
reservations on the feasibility of this, so here I discuss three facts that I take to support and lend validity to this research agenda.

First, child learners are essentially the same everywhere and everytime since our species has had language; it would be untenable to argue otherwise. Old English or Latin learners must have had more or less the same approach to learning language as modern children do, exhibiting the same developmental milestones and cognitive growth and relying on the same types of evidence from the world around them. This means that what we know about language acquisition applies as well to former stages of a language, or to dead languages, as to the languages alive today. The input data is clearly different, but it is unlikely the child learners are different in terms of their mental capacities and developmental pathways when we look at the differences in a global way (focusing on the modal system, rather than particular lexical items).

Second, children appear to diverge from the input in similar ways across languages in relation to the properties of the language being acquired; for example, if a child is learning a contemporary language with infinitival inflection and V2 properties, then we expect the child to have a Root Infinitive (RI) stage where RIs correlate with adult modal meanings, as seen in German and Dutch (e.g., Becker & Hyams, 2000; Blom & Wijnen, 2000). Therefore, we can confidently predict that Old English learners, with infinitival inflection and V2 in their input likely went through a modal RI stage, just like modern Dutch and German. That the input is different between English and Old English is not more of a problem than the input being different between related contemporary languages.

The developmental pathway that child language exhibits, including both errors of omission and commission, are telling for the relationship between input and learner development. These pathways and error patterns may be compatible when we make adjustments to fit to the properties of the historical language under examination. In other words, if learners are responsible for reanalysis, then errors in contemporary children aren’t expected to exactly fit the hypothesised innovative errors made by Old English learners, they’re only expected to be in the right direction and of the right nature for innovations along the modal cycle generally.

Third, when studying contemporary languages, rather than looking at already changed lexemes or constructions we must look to other lexemes and constructions which resemble known earlier stages of linguistic cycles and thus represent potential renewing items (e.g. van Gelderen, 2011). In practice, this means looking to, for example, the modal system as a whole,
including potential renewing pre-modals or alternative means of expressing modality (e.g., imperatives, adverbs, etc.), rather than expecting recapitulations of former innovations. We cannot look to modern must and expect the same changes its predecessor forms underwent in Old and Middle English, but we can look to the contemporary modal system for renewal candidates.

Perhaps the strongest assumption this line of research makes is that children don’t always have the input evidence necessary to converge with the input grammar(s). When the evidence is not deterministic for a certain feature of the grammar, the grammar nonetheless fixes that feature. The divergent properties of the child grammar are expected to be biased in the right direction to become the changes that diffuse in the historical record. In those rare cases when divergence remains uncorrected, divergent properties are of the right type.

I expect that the vast majority of children have sufficient input and time to attain adult proficiency. However, it’s important to keep in mind that we know now that it is commonly tweens and teenagers, rather than adults, who spread innovations and increase their prevalence in a speech community (Labov, 2001; Tagliamonte & D’Arcy, 2009 for “Incrementation”; Cournane, to appear, for a more detailed discussion). Even without assuming a critical period for syntactic-semantic acquisition, errors that survive until they can spread to other speakers in a peer-group remain plausible at a low volume (this should be explored).

Given the CRP, what should our expectations for child divergence and child developmental pathways be in Present Day English? What kinds of errors do we expect to see children make in various domains given known grammaticalization pathways? Do typical developmental pathways support the CRP? The CRP can be explored with child data, and should be. Like any scientific theory it needs to be verifiable in the field where it applies.

The broad goal of this dissertation is to bring insights from diachronic theory to bear on child language and vice versa, a goal that I think – like modals – is both possible and necessary. Operationalization of this goal involves testing specific hypotheses that arise from what is known about how modal verbs change and how they are acquired. These questions and hypotheses are tested in a longitudinal corpus study in Chapter 3, and an experimental study in Chapter 4. The findings of all studies are synthesized in Chapter 5. Chapter 2 covers previous acquisition studies on modals and related categories.
Chapter 2: Learning Modals

2.1. Mapping a complex category

The central concern of child language research is to characterize and explain the human capacity to learn language. Research in this field seeks to describe the developmental patterns exhibited by learners and provide a unified account of how the young mind is able to decipher and internally represent any language (or languages) to which it’s exposed. A growing body of research addresses the acquisition of modals and related categories, such as evidentials and mental state verbs. In this chapter, I present what is known about modals and related phenomena in child language, and relate this body of research to the Child Reanalysis Proposal (CRP).

Learning to use and comprehend modals means linguistically encoding non-actual possible-worlds – worlds that are wanted, intended, required, briefly entertained, or expected to be true now or in the time to come – given available evidence or known facts. The difficulty of mapping meaning to even concrete nouns, wherein the referent is as close to stable-in-the-world as possible, has been stressed in the acquisition literature (Gleitman, 1990). Relational meanings, which associate between entities in the world (e.g., prepositions for spatial relationships) are a degree of magnitude more difficult to map because they have a more complicated world-to-meaning pairing than stable objects. Mental state verbs (MSVs; e.g., think, know) and modals are another degree of magnitude more difficult because they encode abstract relational meanings which exist between mental or perceptual states and the world or possible worlds (see Shatz, Wellman, & Silber, 1983; Papafragou, Cassidy, & Gleitman, 2007). As Gleitman et al. (2005:25) ask, “[h]ow can [the learner] “watch” or “observe” instances of probably?”

Relational meanings are generally difficult to learn because they cannot be acquired using observation alone (Gleitman et al., 2005; i.a.). Modal learning consists of mapping words-to-possible-worlds. To fully learn a modal a child must: (a) grasp the concepts of possibility and necessity, (b) learn to construct modal bases to flavour their modals in relation to possibility~necessity with respect to the real world (i.e., possible/necessary in relation to what factors? What factors are encoded in the input?), (c) learn to formally denote mental objects (e.g., knowledge states, belief states, desires), both their own and those of others so that these can be represented as propositions in sentences. To attain adultlike ability with mental objects the thought a speaker holds needs to be understood as distinct from the facts of the actual world (c.f.
True/False Belief Tasks; Perner & Wimmer, 1985; i.a.). And finally, (d) detect key aspects of the
input to assign the right semantics to each specific lexical item (i.e., is force fixed for the lexeme,
as for English modals? Or, is flavour fixed for the lexeme, as for Salish evidentials?). In sum,
modality can be considered a complex type of relational meaning which relates an event or
proposition that the modal scopes over to the set of events contained in the modal base.

Syntactic structures provide a means to narrow-down the search space for the mapping
problem of modal learning; syntactic bootstrapping is a theory that argues that syntactic verb
frames help the learner to infer – or bootstrap – the meaning of novel words; in other words,
syntactic frames are themselves a rich source of word-learning evidence for the learner
(Gleitman, 1990; i.a.). Once the child has learned the more basic word meanings, she can then
make use of relations between those words to infer more word meanings (relational meanings,
verb alternations, etc.; see Gleitman et al., 2005). Children have been shown to use syntax to
infer the meanings of nonce words differentially according to the syntax within which the nonce
word is placed e.g., *This is a zup* (NOUN) vs. *This is zupping* (VERB) (e.g., (Brown, 1957; Berko,
1958; Naigles, 1990; i.a.).

Does English provide syntactic evidence for modal meanings, in particular root vs.
epistemic meanings? Not straightforwardly. Mapping modal lexemes to modal meanings in the
structurally correct manner for the input language is complicated as functional modal lexemes
commonly map to multiple flavours (1) and in turn multiple lexemes may cover a single flavour
(2), albeit usually with other factors in the context and sentence influencing interpretation (see
§1.2.2 and §1.2.3).

(1)  a. John *must* be home by 10pm. He has a curfew.       [Root Deontic]
b. John *must* be home. His light is on.                   [Epistemic]
(2)  a. John *might/could* be home.                        [Epistemic possibility]
b. John *must/should/oughta/needsta* be home by 10pm.    [Deontic necessity]

In addition to associating modal meanings with the lexemes that express those meanings
in the input, the child, at least in languages like English that possess functional modals (those
anaphoric to events with polysemous instantiations), must also uncover patterns of polysemy and
it remains unclear how this is achieved. Hacquard lays out the learning problem as follows,

The child has to figure out whether modals in her language are polysemous [=functional]
or not, and has to associate certain modal meanings with certain scope positions: modals
with epistemic meanings scope high, modals with root meanings scope low. Such a
mapping should be particularly difficult when the same words are used to express both

epistemic and root modality. Hence, the hope is that the meaning/scope association is principled - if indirect - as I have argued here. If the association were arbitrary, we would expect incorrect meaning/scope mappings, and the ordering of modals and tense and aspect to flip over time. However, diachronic patterns show that this is not the case: modals develop in systematic ways.

[...]

If the child figures out that the same modal can scope in two positions (which should be easy at least in languages where syntactic scope transparently reflects semantic scope), knowing that this modal is anaphoric (because functional) should help her figure out the correct flavor/scope mappings.

(Hacquard, 2013:7-8)

Is English a language which transparently reflects semantic scope in the overt syntax? Again, not straightforwardly; modal interpretations are only indirectly linked to syntactic frames (see §1.2.2). Syntactic bootstrapping, in addition to evidence from context and experience (see Glietman et al., 2005; Papafragou et al., 2007a), should provide at least some relevant evidence to associate flavours with LF-scope positions. For example, the sentence *She must be eating* with overt progressive aspect gets an epistemic interpretation (see Heizmann, 2006; Chapter 4) because the functional modal *must* scopes higher than aspect (and thus is not bound by Aspect for a root interpretation). In addition, input like *It must be [that they just don’t like him]*, where the functional modal is overtly in a higher clause than the proposition it scopes over, is also clear evidence for a structure-flavour association; this evidence is particularly robust in the input for German functional modals (e.g., *können*), as noted in corpus work by Nuyts (2001). Double modal constructions, including those that occur with INFL and v-modals in standard varieties of English (e.g., *He must have to leave now*), are also relatively clear evidence, as a root modal cannot be computed above an epistemic (though both modals can be epistemic or both deontic; see §1.2.2).

In sum, when learning a modal a child must determine its:

a) syntactic category (e.g., V, v, ADV, INFL), including its status as either lexical or functional.

b) quantificational force (existential or universal)\(^{32}\).

c) flavour based on context and in keeping with possible worlds semantics (e.g. ability, deontic, epistemic; see Kratzer (1977, 1981, 1991, 2012), Hacquard, (2013).

d) evidence source (e.g., Ø, inference, hearsay, visual, auditory). This is relevant for evidentials (Matthewson, 2010; von Fintel & Gillies, 2010).

\(^{32}\) Kratzer (2012:49) suggests that if the child is exposed to variable modal force, as in St’át’imcets, they might need to assume a degree modal.
This chapter is organized into five subsections. In the first, I survey the experimental literature on modal force development. This component of modal semantic development bears on the complexity of acquiring modal meanings. The majority of L1 acquisition research on modals has addressed this parameter of meaning. In the second section, I cover the naturalistic and experimental evidence on the development of root and epistemic modal flavours. Within this section, I also discuss the literature on evidential acquisition. Evidentiality is closely related to epistemic modality and so relates to our understanding of modal flavour development. The third subsection covers the theoretical proposals for explaining the empirical findings laid out in the previous section. These proposals address the Epistemic Gap – the period of time between about 2;00 and 3;00 when children have been observed to use only root modalities. I present and critique conceptual approaches to explaining the epistemic gap and lay the groundwork for a grammatical approach. I discuss expected links between clause-structure development and modal flavour development, which are tested in Chapters 3 and 4. Finally, I discuss my previous study, Cournane (2014), which directly tested the Child Reanalysis Proposal in two acquisition tasks.

2.2. The force contrast in children’s comprehension of modals

The acquisition of modal flavour (root vs. epistemic) and the acquisition of modal force (existential vs. universal) are treated separately in most previous studies, and make up two largely separate traditions. While the focus of my research is modal flavour, modals are fundamentally quantifiers (see Kratzer, 1991) so acquisition studies on the development of force are considered here. These studies provide evidence directly for the force component of modality, but also indirectly for flavour as they often include both a deontic and an epistemic condition (e.g., Hirst & Weil, 1982). Further, some languages encode modal lexemes with fixed flavour and a variable force (see §1.2.1.). It is possible that English-learning children entertain hypotheses about modal force that are in-line with these cross-linguistically available alternatives. The development of modal force, and related pragmatic implicatures, has been approached experimentally within a particular paradigm which explicitly contrasts statements of different modal forces (first used in Hirst & Weil, 1982). I call this the Contrasting Modal Statement Paradigm.
Hirst and Weil (1982) tested the strength contrast between an existential modal (may), two universal modals (should, must), and the declarative (is) in deontic and epistemic contexts, assuming the strength scale \( \text{is} > \text{must} > \text{should} > \text{may} \). In the deontic context, the child was asked to direct a puppet based on contrasting statements from two teachers (e.g., He must go to the red room vs. He may go to the blue room); in the epistemic context, the child was asked to find a peanut based on contrasting sentences (e.g., The peanut is under the cup vs. The peanut may be under the box). Across both conditions the greater the difference in modal force, the earlier the contrast was understood. For example, is vs. may is understood earlier than must vs. should or is vs. must. Children of all ages behaved more adult-like in the epistemic condition. Hirst and Weil and subsequent researchers have attributed this asymmetry to a task effect, whereby the epistemic task was simpler than the deontic (which involved interpreting the role of an authority figure in addition to choosing between the two modals).

Byrnes and Duff (1989) replicated Hirst and Weil (1982), but contrasted lexical items which were more natural for child language (i.e., they changed deontic must to the more frequent deontic have to, and omitted the relatively formal deontic may). Despite practical lexical adjustments, the findings remained much the same. Noveck, Ho and Sera (1996) also replicated Hirst and Weil’s study using a different set of modal lexemes to comprise the contrasts for their scale, in particular, is > has to > might. They found that five-year-olds are able to rely on their understanding of these contrasts when asked to decide on the trustworthiness of speakers’ statements, but it is not until around age 9 that children are reliably adult-like. Extending the paradigm to Italian, Bascelli and Barbieri (2002) found that Italian learners behaved comparably to English learners, despite the form differences between Italian modals (functional verbs potere, dovere) and English modals (primarily INFL-modal, and some v-modal, used in these studies).

Recent studies have extended this experimental paradigm by exploring scalar implicatures that arise from modal usage. Modals are ordered according to informational strength and form a scale (Horn, 1972; Grice, 1975). The sentences in (3) encode epistemic necessity (3a) and possibility (3b). Stronger modal statements entail weaker ones: (3a) entails (3b).

(3)  
  a. It has to rain in the afternoon.
  b. It may rain in the afternoon.  

(4)  
  It does not have to rain in the afternoon.  

(Papafragou & Ozturk, 2006)
The weaker statement (3b), but not the stronger one (3a), implicates the statement in (4). This is because, according to Grice’s Maxim of Quantity, if a speaker uses (3b) instead of (3a) it is because he or she is not in a position to use the stronger statement (i.e., lacks certainty as to the proposition). Hence, (4) is a scalar implicature for (3b), but not (3a).

Noveck (2001) studied modal scalar implicatures in five-, seven-, and nine-year-olds and adults. Participants were presented with two open boxes and one closed box. The open boxes contained either the same items (e.g. both stuffed parrots) or two different items (e.g. one with a stuffed parrot, one with a teddy bear). The participants were told that the closed box contained the same contents as one of the open boxes. Following this, the participant heard 8 modal statements of varying strength; they were asked to agree or disagree with each statement. Children in all three age groups accepted weak statements (e.g., There might be a parrot in the box) even when the stronger statement was acceptable (e.g. There has to be a parrot in the box), as in the condition where both open boxes contained the same contents (=parrots). Adults, on the other hand, rejected weak modal statements when a stronger statement was more informative.

Papafragou and Ozturk (2006) replicated the scalar contrasts of Noveck (2001) in two experiments, both of which simplified the design and presentation of the modal statements. The first experiment contrasted two epistemic modals of varying strengths. Participants saw a video of a stage with Minnie and Donald on either side, and two boxes at center stage. For each item an animal came onstage and the curtains closed. The experimenter told the participant that the animal was hiding in one of the boxes. The curtains were then lifted and one of the boxes was opened either revealing the animal or not. Minnie and Donald offered contrasting statements, such as The mouse has to be in the pink box and The mouse may be in the pink box. The scale used was may < have to < plain assertion. Participants included 21 children (mean age of 5;03), and 20 adults. Children performed significantly better than chance on the may < have to contrast and the may < is contrast, but not on the have to < is contrast (similar to Hirst & Weil, 1982 and subsequent studies). Papafragou and Ozturk conclude that children as young as five years old are generally sensitive to conversational requirements of modals, and appear to abide by Gricean informativeness requirements. However, the contrast between epistemic necessity and plain assertions remains unclear for children. Noveck et al. (1996) and Papafragou and Ozturk (2006) suggest that in many usage contexts adults use epistemic necessity and plain assertions interchangeably, perhaps prolonging the acquisition of this contrast.
Children have been shown to be more sensitive to scalar implicatures when the goals of the experimental task are made explicit, and when the contrasted statements resemble naturalistic conversation (Papafragou & Musolino, 2003), see also (Guasti et al., 2005). The second experiment reported in Papafragou and Ozturk (2006) examined children’s ability to infer speaker certainty from contrastive modal statements. In this experiment the participant saw twins onscreen, facing each other. The twins looked identical, but each one told the participant something different (e.g. *I will give you ice cream!* vs. *I may give you ice cream!*). Some items were desirable, like ice cream, while others were undesirable, like cauliflower. Participants included 15 children (mean age of 4;10), and 15 adults. Adults performed as expected, choosing the weak statements for negative items and the strong statements for positive items. Children only performed above chance in the negative condition, which suggests they are subject to situational variables in their pragmatic reasoning; namely, they pay more attention to avoiding undesirable outcomes than to a stronger chance of a desirable outcome.

The broad findings from the Contrasting Modal Statements paradigm have been (a) that children appear to understand the possibility (*might*) ~ necessity (*must*) ~ certainty (*is*) continuum as more polarized than it is for adult speakers, such that more extreme contrasts (e.g., *might* vs. *is*) are understood earlier than less extreme contrasts (*might* vs. *must*) (Hirst & Weil, 1982, and subsequent). The contrast between necessity and a plain assertion (*must* vs. *is*) is the most difficult. And, (b) children as young as 3 generally understand the pragmatic inferences associated with modal verbs (specifically, scalar implicatures which arise from contrastive modal forces) with an “avoid negative outcomes” advantage, and by approximately age 5 they successfully choose the strongest (most informative) modal statement over weaker (but still true) statements (Noveck et al., 1996; Papafragou & Ozturk, 2006, and subsequent). Finding (a) affects finding (b), as children are worse at pragmatic inferences for the epistemic necessity ~ plain assertion (e.g., *must* vs. *is*) contrast than for other contrasts (Papafragou & Ozturk, 2006).

Modal force and inference acquisition occurs in parallel in all flavours, allowing us to confidently assume that the learning of flavour (Domain of Quantification) is relatively independent from the learning of force (Quantificational Force). This is not surprising given cross-linguistic modal systems (§1.2.1 above) where, oversimplifying somewhat, it is observed that languages vary in whether QF or DQ is primary in lexicalization (see Vander Klok, 2012).
2.3. The development of modal flavour and the “Epistemic Gap”

Flavour acquisition has primarily been linked to the emergence of specific lexical items in naturalistic data (e.g., Wells, 1979; Kuczaj, 1982; Bliss, 1988). Several studies have also focused on the development of the set of future markers (will, gonna e.g., Klima & Bellugi, 1966; Kuczaj & Maratsos, 1975; Shepherd, 1982; Gee & Savasir, 1985; Klecha et al., 2008). This line of research has consistently identified what I call the Epistemic Gap. The epistemic gap refers to an approximately year long period of time from age two to three during which children use modals (e.g., have to, must) with exclusively root meanings. These studies report that no epistemic modals occur during this stage of development (c.f. O’Neill & Atance, 2000).

2.3.1. Early naturalistic evidence

Longitudinal naturalistic studies make the general observation that modals and mood-marked verbs with root meanings (e.g., desire, ability, permission) precede those with epistemic meanings (Kuczaj & Maratsos, 1975; Kuczaj, 1982; Stephany, [1979] 1986; Valian, 1991; Papafragou, 1998). Children are first observed to omit modals when adults would likely use them, as part of the panoply of omissions observed in the telegraphic speech phase (see Hyams, 1986, 1989; for the concurrence of subject omission with modal omission; Valian, 1991). Then, the pathway of emergence is roughly from bouletic verbs denoting desires (e.g., want) and ability modals (e.g., can; typically negated at first), to deontic modals (e.g., have to, must), and finally to epistemic modals (e.g., must, might). Examples are provided in (5).

(5) a. Root Ability:  
   Tree can’t dance.  
   (Adam 2;08,16)  

b. Root Deontic:  
   You must have pencil.  
   (Context: urging his mother to take a pencil, Adam 2;11,28)  

c. Epistemic:  
   He must be ready for his lunch.  
   (Context: his baby brother is crying, Adam 3;05,01)  

In general, can (5a) and want first occur soon after age two, correlating with the development of basic desire-intentional psychology (see Halliday, 1975; i.a.). Shatz & Wilcox, (1991) and Wells (1979) both report can (or can’t) and will (or won’t) as first used for ability and

33 See Palmer (1986) for evidence that modals and mood markers should receive a unified treatment.
intention meanings, respectively; *gonna* also appears very early with intention meanings. Closer to age three children begin using more deontic-flavoured modals like obligation *have to, need to* or *must* and permission *can* (5b; Gerhardt 1991). Finally, usually after age three, children begin to use epistemic modals like *must* or *might* (5c). Kuczaj (1977) reports very low frequencies of likely epistemic modals (*could, must, should,* etc.) as early as 2;06 for his child, Abe (see §3.2 for discussion of these utterances). Modal adverbials (*possibly, necessarily, it is necessary,* etc.) continue to develop as late as twelve years old (Wells 1985; Perkins, 1983; Papafragou, 2001).

The English findings are mirrored in cross-linguistic studies. Stephany ([1979]1986) looked at the acquisition of modals and mood markers in Greek, Turkish, and Finnish. She found that the aorist in Turkish, the conditional in Finnish, and other markers of epistemic modality, all appear around age three, like epistemic INFL and v-modals in English. The subjunctive in Greek occurs with root meanings, and the verbs *boro* (existential modal) and *prepi* (universal modal) are likewise restricted to root modality in young children (Stephany, [1979]1986).

In German, root meanings with *wollen, können, sollen,* and *müssen,* tend to precede epistemic ones (Stephany, 1993). In Bassano (1996)’s study on a French child, epistemic interpretations of *devoir* (universal modal) and *pouvoir* (existential modal) increase sharply after 2;08. In Mandarin, Guo (1994) finds that children begin with expressions of ability and volition, and later use deontic modal expressions, and lastly epistemic in a striking parallel to the English findings. Likewise, in Korean the root modal auxiliaries are nearly all present and productive by three, while only one of the five epistemic modals in the language is present at that age (Choi, 1995). Across languages, root meanings appear after age two, while epistemic meaning appear after age three (with some child and/or language variation, as for example with Bassano’s French child whose epistemic gap resolves at 2;08).

Looking specifically at future-markers, *gonna* is used productively earlier than *will* (Stephany, [1979]1986; based on Klima & Bellugi, 1966; Bellugi, 1971, 1974; Kuczaj & Maratsos, 1975; Kuczaj & Daly, 1979; Pea, Mawby, & MacKain, 1982; Shepherd, 1982; Gee & Savasir, 1985). Klecha et al. (2008) studied eight children on CHILDES for development of *will* and *gonna.* They hypothesized that *gonna* is the unmarked future of English, and *will* is context-restricted and therefore harder to acquire (c.f. Copley, 2002)\(^34\). Representations requiring

---

\(^34\) For Copley (2002), *gonna* includes a progressive operator which scopes over FUT. For Copley, “*will* denotes a proposition true in all worlds branching from now (for present tense)” while “*gonna* denotes a proposition true in all
integration with context may be more difficult to master, therefore they expect that will will be more difficult to acquire than gonna, despite the fact that adults use will more frequently than gonna. Klecha et al. (2008) found that for all children the use of gonna increases earlier and more rapidly than the use of will; furthermore, the youngest children used gonna in an adult-like manner, while will was only adult-like in the oldest children. There is more will in the input but more gonna in young children’s speech, so in line with Klecha et al.’s hypothesis, frequency effects in the input are not responsible for the prevalence of gonna in child speech. Rather, gonna appears to be somehow easier to acquire than will.

Valian (1991) found that for all children she studied (two sessions of child-adult speech with 21 American children aged 1;10-2;08), can and will were the most commonly used modal auxiliaries, and children used both modal auxiliaries and semi-auxiliaries (=v-modals: gonna, wanna, hafta, gotta) from the beginning. Children were also observed to use a different proportion of subjects before modal auxiliaries (= INFL) than before semi-auxiliaries (= v) and other verbs, showing they likely categorize them differently even at this young age (Valian 1991:61; see also §3.4).

2.3.1.1. **Modal Adverbs**

The above studies inadvertently all focused on functional modals because these are the modals which are most frequent and commonly discussed in works on modality. Consider that in many texts and papers the term “English Modals” by default refers to the set of INFL modals. Modal adverbs are a type of lexical modal (see §1.2.1), commonly used to express modal meanings cross-linguistically. Modal adverbs are lexically encoded for both force and flavour (i.e., probably is universal and epistemic, maybe is existential and epistemic), and is syntactically adjunctival (e.g., Cinque, 1999). Some examples of modal adverbs in English are maybe, probably, certainly, necessarily, and definitely. Only one acquisition study (to my knowledge), O’Neill and Atance (2000), has focused on modal adverbs. Other studies have touched on the topic as part of larger studies (Bowerman, 1986; Bruner & Lucariello, 1989; Nelson, 1989).

---

worlds branching from an interval which overlaps now, i.e., branching at and before now”. In contrast, Klecha et al. (2008) argue that a high progressive operator for gonna is unnecessary. Rather gonna is unmarked, and will qualifies only over salient worlds.
O’Neill and Atance (2000) examined the use of modal adjuncts expressing uncertainty in 10 children from CHILDES spanning from 2;00 to 4;11. The goals of their paper were twofold, (a) to examine the use of modal adjuncts by children, erstwhile an understudied category, and (b) to examine the development of children’s expressions of uncertainty. The authors examine *maybe*, *possibly*\(^3\), *probably*, and *might*. *Might* is not adjunctival, although it does express uncertainty (see Green, 1979; Bliss, 1988; Moore, Pure, & Furrow, 1990, who also classify modals primarily by function rather than form). Still, it is unclear why *might* was included but not other non-adjunctival modals which also express uncertainty (e.g., *could*). This study is concerned with situations in which children use uncertainty markers. They coded modals according to temporal reference of the event/state to which it referred (present, past, future) and whether it referred to the physical world, or to a mental state (intention, desire, epistemic reasoning).

Across the 10 children studied for uses of *maybe*, *probably* and *might* (517 total instances), *maybe* was the most commonly used lexeme (59% of total), followed by *might* (32%), and then *probably* (8%). The majority of all utterances came from Abe, Mark, Ross, and Adam (in that order). All three modals increased significantly between the period 2;00 to 2;05 and the period 2;06 to 2;11. The total number of utterances increased less than twofold while modals studied increased sevenfold. No child used *might* before 2;05, and it is unclear from their study when the first uses of *might* (18 total) occur in the 2;06-2;11 window since all items are reported together. It is not reported when in the 2;06-2;11 window the instances of *might* appear, which is problematic because as we saw above children may resolve the epistemic gap for functional modals\(^3\) in the latter half of this window (e.g., Bassano, 1996).

Their findings include: (a) expressions of uncertainty first emerge in relation to ongoing physical events (*maybe it’s dark*) and future intentions the child herself has (*probably I will go to that big sand pile*), and (b) next emerge in relation to future events external to the child herself,

\(^{3}\) No child used this adverb.

\(^{3}\) *Might* may have been included in O’Neill and Atance because it is monosemous, rather than because it is adjunctival. This status separates *might* from the other functional modals which cover possibility meanings (e.g., *could*). This is a good point to note that while lexical = monosemous, functional ≠ polysemous, although these terms tend to overlap. Lexical modals are full predicates of events and can stand alone (A. *You wanna play?* B. *Maybe*). Functional modals get their flavour via binding and cannot stand alone (A. *You wanna play?* B. *Might*). Lexical modals should never be polysemous, but polysemous modals may be monosemous if binding is only licit in one of two binding positions (like for *might* which is only epistemic). This appears related to meaning loss along the modal cycle (see §1.3.1)
notably about others (maybe he’ll want it later)\textsuperscript{37}, and finally, (c) after 3;06, the children use significantly more might to refer to future possibilities (we might see him again). Similarly to these findings for English equivalents, in Polish, adjectival epistemic modals –\textit{chyba} (‘probably’) and \textit{na peuno} (lit.‘for sure’) show up around 2;00 (Moore, Pure, & Furrow, 1990). Likewise, in French, Bassano (1996) found that \textit{peut-être} (‘maybe’) was among the earliest expressions for uncertainty, appearing at 2;06. Most importantly for the broader picture on modal acquisition, O’Neill and Atance’s findings, along with those of Smoczynska (1993) and Bassano (1996), raise the possibility that the epistemic gap may be an artefact of the focus on functional modals in previous studies and meta-analyses.

Referring to the epistemic gap of previous studies, O’Neill and Atance (2000:47) argue that deontic meanings may not precede epistemic, and rather earliest modals focus on present physical states and future physical intentions. However, their conclusion is limited with respect to addressing root modalities, like deontic, because they did not study any root modals. Their data do bear on the epistemic gap as adjunctival epistemic modals occur earlier than found in previous studies. They do not address the syntactic differences between the adverbs (\textit{maybe, probably}) and INFL-modal \textit{might}. The uses of \textit{maybe} and \textit{probably} commence from 2;01, while \textit{might} appears to be later (72\% of uses occur after 3;06), further suggestive of the developmental priority of lexical over functional epistemic modals.

\subsection*{2.3.2. Experimental evidence}

Fond (2003) tested four-year-olds’ comprehension of the deontic and epistemic meanings of \textit{must} in English and \textit{deber} in Spanish. She investigated whether there is a clear preference for the deontic interpretation over the epistemic interpretation in young children, given ambiguous contexts. She designed sentences that were ambiguous and corresponding visual scenarios that were not. The child was asked to point to the picture that illustrated the sentence, thus showing the child’s interpretation of the sentence. For example, the sentence “The dog must eat a lot” is compatible with a skinny dog who is obliged to eat a lot (deontic interpretation) or with a fat dog who is surmised by the speaker to be fat because of excess eating (epistemic interpretation). Two

\textsuperscript{37} These are examples from O’Neill and Atance. While overall the child’s utterances change from only physical references to including mental state references, it is unclear whether this reference shift is tied to the presence of will, rather than the adverb, at least for these examples. The adverbs may qualify the child’s whole utterance, with the content of that utterance as orthogonal to the epistemic usage of the modal adverb.
distracter pictures were also included for each sentence, for a total of 4 picture choices for each sentence.

In neither English nor Spanish did any child choose solely epistemic or deontic interpretations. In the English experiment, on average children picked deontic pictures for 50% of the sentences. In the Spanish experiment, that number was 60%. In English, total epistemic responses ranged from 25% to 70% of each child’s responses. For the Spanish children, epistemic responses ranged from 5% to 35% of each child’s responses. While deontic responses were comparable across language groups, the difference between English and Spanish epistemic responses was significant (Spanish children chose both more deontic and distractor pictures).

Fond argues that the Spanish children support the hypothesis that deontic meaning is acquired first because of the low prevalence of epistemic picture-choices in this group, but that English children appear bi-modal and do not support the hypothesis. She also points out that *deber* can cover the meaning of English *should* (‘weak must’ of Silva-Corvalán, 1995) in deontic contexts; therefore the carefully constructed scenarios that work well for English *must* have an extra available interpretation in Spanish (Fond, 2003:72). She furthers notes that the deontic contexts in Spanish examples might have been better phrased with *tener que*. This may have caused the children to reject the deontic reading for *deber* in these cases (Fond, 2003:72). There is a similar problem for the English contexts as *must* is less common than *have to* in deontic contexts and holds a stronger, more formal connotation. English children may have preferred the epistemic readings to the deontic because *must* has lost much of its deontic footing in American English.

We can conclude that Fond (2003) shows that four-year-old children can access both root and epistemic interpretations of *must* and *deber*, and differences between English and Spanish children are possibly due to: (a) differences in the form of the modal tested (INFL vs. functional verb), which is not fully parallel across groups, or (b) differences in usage patterns between English *must* and Spanish *deber*.

In Fond, all sentences in the English study used *must* followed by a bare verb complement (*The dog must eat a lot*). However, modal flavour is more naturally determined in usage via interactions with other elements in the sentence, like aspect markers or temporal adverbs (see §1.2.3). There is little experimental work which addresses these aspectual or temporal properties of the modal constructions used in experimental test sentences. Heizmann
(2006) explored whether syntactic structures may also play a role in the root before epistemic developmental pathway (consider also de Villiers & Pyers, 1997, 2002; de Villiers & de Villiers, 2009), in particular, she asked whether unambiguously epistemic constructions are understood as epistemic by young children who otherwise exhibit a root-bias (leaving aside modal adverbs).

Heizmann’s study used a scenario-preference task to examine English *must* and German *müssen*, which have comparable semantics but are polysemous in different syntactic frames. In English, the sentence, ‘Who must be eating a banana?’ receives an epistemic reading, while ‘Who must eat a banana?’ is deontic. An equivalent contrast is not possible in German, which lacks the present-progressive. ‘Wer müsste ne Banane essen?’ (= ‘Who must the banana to eat?’) translates both English sentences. In both languages, the addition of ‘every night’ makes the modal sentence habitual (‘He must go to the icebox every night’); this sentence can describe an repeated obligation or an inference about habitual behaviour in both languages. Heizmann found that even the youngest children (age 3) understood the unambiguously epistemic sentences (87% epistemic interpretations). With structures compatible with both readings (like the habitual), there was an early preference for deontic readings over epistemic in both languages (three-year-olds chose deontic interpretations 18:4, or 82%, while four- and five-year-olds were are 57% and 41% for deontic interpretations; statistics for significance were not conducted). Heizmann argues that these results suggest that both syntactic evidence and Theory of Mind development are involved in modal development.

In sum, Heizmann’s findings replicate Fond (2003) for structures compatible with both readings, as these show a comparable root bias albeit with availability of epistemic interpretations. Heizmann also shows that children as young as three understand that progressive marked sentences give rises to epistemic interpretations. Her experiment is the first to show that grammatical factors contribute to the modal interpretation, and it is not simply the case that modal lexemes are either root or epistemic for the child. However, as no statistical analysis was performed, one question that remains is how robustly the presence of aspect marking correlates with epistemic interpretations, and whether aspect-marked sentences may trigger epistemic readings of functional modals (see Chapter 4).

---

38 In Heizmann’s paper, she argues that only an epistemic reading is possible, however many argue that a deontic reading is possible here. Recall, however, the deontic reading requires very salient context or the addition of an adjunctival phrase such as, ‘Who must be eating the banana when the nutritionist arrives?’ Context or additional phrases can shift the meaning because they shift the force of the modal from present tense to future.
2.3.3. The development of evidentiality

Evidentiality, like epistemic modality, encodes the speaker’s assessment of the proposition and can be a weak or strong assessment (though need not encode force, see Gitksan and St’át’imcets (Lilooet Salish), §1.2.1). The development of evidential markers has direct implications for the development of closely-related epistemic modality. Both are domains which express internal states and speaker viewpoint so the learning challenges they pose are a priori expected to be analogous. In both cases, researchers have been trying to determine the relative contribution of conceptual development and grammatical development.

About a quarter of the world’s languages grammatically express evidence source via evidentiality markers (Aikhenvald, 2004). Evidentiality differs somewhat from epistemic modality: evidentials, unlike epistemic modals, (a) encode the information or evidence source for the speaker’s assessment of the proposition (visual, auditory, inference, etc). Also, they (a) cannot be denied (Von Fintel & Iatridou, 2007), and (b) do not weaken the proposition (Davis, Potts, & Speas, 2007). Like epistemic modals, they quantify over propositions and are speaker-oriented.

In its most basic form, evidentiality morphemically contrasts direct evidence (I saw…) from indirect evidence (I heard-from-someone or I inferred…). Languages without grammatical evidentiality can express information source lexically (I see you’re in a good mood), constructionally (copy-raising constructions: John seems like he is cooking; Rett & Hyams, 2014), or through parataxis (Sandy’s in town, at least that’s what I heard). Evidentiality is so closely related to epistemic modality that it is currently debated as to whether they are essentially the same or different (Matthewson, 2010; Peterson, 2010; Aikhenvald, 2014 for discussion). Grammatical evidentials piggyback on other morphemes, typically tense or aspect. For example, evidentiality is obligatorily marked on past tense morphemes in Turkish (Aksu-Koç, 1988), but not in present tense.

Several studies have explored the acquisition of evidential markers in languages which grammatically encode this category like Turkish (Aksu-Koç 1988; Papafragou, Li, Choi, & Han, 2007), Korean (Choi, 1991, 1995), Tibetan (de Villiers, Garfield, Gernet-Girard, Roeper, & Speas, 2009), and Quechua (Courtney, 2008). The overall findings have shown that evidential marking emerges between two and three years old, as with modal expression. In experimental studies, both production and comprehension, children are more delayed than in naturalistic
studies by about a year. This delay for experimental studies may be due to the difficulty of the tasks (for example, perspective-shifting is normally involved) (Papafragou et al., 2007b; Aksu-Koç, Ögel-Balaban, & Alp, 2009). Alternatively, the delay may be due to the polysemy of evidential morphemes, which also express tense or aspect. Thus, the child may spontaneously use evidentials early for tense or aspect purposes without understanding their evidential component in an adult-like way (de Villiers et al., 2009; Rett & Hyams, 2014). Evidential studies also consistently show that children acquire direct evidentials (based on direct or first-hand evidence) prior to indirect evidentials (based on indirect, or second-hand evidence). This is normally attributed to the more difficult cognitive requirements of indirect marking, as indirect evidentiality requires making inference; c.f. conceptual accounts of the epistemic gap, e.g. Papafragou, 1998, see §2.3 below).

Choi (1991, 1995) studied the acquisition of five sentence-ending evidential suffixes in three Korean children. She found that these appear between 1;03 and ;003, with the first 2 suffixes appearing before two years. The findings of Choi (1991) have been taken as evidence against a cognitive constraint on early acquisition of epistemic meaning because evidential processing is of a similar nature. However, these sentence-ending suffixes are obligatorily present in all sentences and perceptually salient given their sentence final position, which may account for their early acquisition. It is unclear from this study whether the evidential meanings are adultlike.

Turkish evidential morphemes have been studied by Aksu-Koç (1988) and Papafragou et al. (2007b). In Turkish, evidentiality is only grammatically expressed in the past tense; speakers must indicate on the verb whether past events were directly witnessed (-dī) or learned through hearsay or inference (-miš). Aksu-Koç (1988) ran an experiment where she showed three- to six-year-olds balloon-popping events. The children saw either a puppet show where the balloon popped in plain sight, or a puppet show where the actual popping was hidden but the popped balloon was shown after. Even the youngest children preferred the direct marker for the witnessed event and the indirect marker for the hidden event, and by 3;08 the children were uniform with the oldest children studied. In another experiment Aksu-Koç (1988) had children listen to a doll report an event. The doll either used the direct or the indirect marker. The participants were asked to say whether the doll had seen the event or had been told about it. Children performed less well on this task, with very few three-year-olds performing above
chance, and performance improving only by around age four. Papafragou (2001) attributes these improved results to ToM development, and suggests that the doll task is more difficult because it involves a third party’s viewpoint (the doll’s, as opposed to the child themselves in the balloon popping task).

De Villiers et al. (2009) examined the development of Tibetan evidential marking. Tibetan has a four-way distinction: direct, indirect, ego (for reporting personal mental or physical states), and neutral (which gives no evidential information but is infelicitous when the direct or ego marker is felicitous; de Villiers et al., 2009:33). They ran a series of experiments assessing Tibetan children’s production and comprehension of evidential marking. Overall, they found that the Tibetan evidential system remains non adult-like until about ten years old.

Even the youngest children understood that evidentials were not deniable, only accepting narratives that made sense when the main proposition was denied (and not those which only made sense if the child could interpret the denial as referring to the evidential marker itself). Direct markers were found to vary according to the child’s knowledge certainty, rather than the certainty of their evidence-source. For example, child use of the direct marker ‘dug was seen to vary according to how certain the conclusion in a discourse-based task were, not according to whether the child had direct vs. indirect evidence. Further, children were found to judge scenarios based on their own available evidence, rather than that indicated by the evidence marker used (this was assessed via a prompt question directed at the children). Like in the Turkish findings, direct marking is adultlike earlier than indirect marking, and for both, evidence is first assessed relative to the child herself. The complexity of the Tibetan system may delay complete acquisition longer than in the two-way Turkish split.

Rett and Hyams (2014) examined evidential constructions in English, a language which lacks a morphological evidential system (see also Koring & de Mulder, 2011; Koring & de Mulder, 2014 for a study on Dutch). Rett and Hyams (2014) examined the acquisition of English perception verb similatives (or copy-raising constructions), like in (6a).

(6) a. John seems/looks/sounds like he is cooking. \([\text{raised}]\)

asserted proposition: There is visual/audio evidence that John is cooking.

evidential component: I have seen/heard John

b. It seems/looks/feels like John is cooking. \([\text{unraised}]\)

asserted proposition: There is visual/audio evidence that John is cooking.

evidential component: \(Ø\)

(Rett & Hyams, 2014:177)
Both the raised (6a) and its unraised counterpart (6b) are felicitous when the speaker has seen or heard John cooking. If John was not directly witnessed, however, the speaker must use the construction in (6b). This is because the raised construction in (6a) marks direct evidentiality. Unlike morphological evidentiality, the English construction is not polysemous with any other semantic category; Rett and Hyams reason that this construction can thus help tease apart the “polysemy problem” and “directly test knowledge of evidentiality” (p. 180).

Rett and Hyams (2014) verified the robustness of this evidentiality contrast between raised and unraised perception verb similatives (PVS) in a felicity task with adults; the contrast was demonstrated as significantly robust (i.e. it is clear to naïve speakers that direct evidence is necessary to use the raised construction). They then conducted a corpus study on 45 American-English children from CHILDES (MacWhinney & Snow, 1985), from ages two to seven. They found a total of 70 PVSs, mostly with the verb look (55/70). Of the 55 items that were unambiguous with respect to their syntax and evidence source, 21 were raised and 34 were unraised. Only 14 marked indirect evidence, all of which were unraised.

Children appear to understand that both the raised and the unraised constructions are compatible with direct evidence, but only the unraised construction can express an indirect evidence source. Comparable to previous studies, children begin using perception verbs to mark direct evidence at around age two, and indirect evidence at around age three. The adult input is very similar to the child findings, with direct evidence more frequently marked than indirect.

To summarize this subsection, functional modals occur with root uses as early as 2;01, and epistemic uses emerge sometimes as early as 2;08, but more typically after age three. Lexical epistemic modals like maybe occur from earliest modals. Earliest epistemic modals refer to physical states or events, while mental state uses increase sometime after 3;06. In experimental studies, children exhibit a root bias when both the sentence and the context allow interpretation to be root or epistemic. When the sentence contains progressive aspect, even three-year-old children show an epistemic bias. In parallel to epistemic modals, evidential markers first occur with direct meanings around age two, while indirect evidentials occur after age three. Polysemous evidentials (parasitic on tense or aspect markers) show adult contrasts later than clear grammatical cases (like perception verb similatives in English). This is also parallel to the contrast between functional modals and lexical modals, the former of which appear to take longer to show adult-like meanings (likely because of variability in the input). Both evidentials
and epistemic modals show a protracted development with marked usage increases around age four and continuing development into the pre-teen years.

2.4. Explaining the epistemic gap

Explanations for the epistemic (and the parallel indirect-evidential) gap fall into two main approaches, the conceptual approach and the grammatical approach. Under the conceptual approach (Austingon, Harris, & Olson, 1990; Moore, Pure & Furrow, 1990; Astington, 1993; Papafragou, 1998, 2001; i.a.; Aksu-Koç & Slobin, 1986 for evidentials) advancements in Theory of Mind open up the possibility for epistemic modals (Wellman, 1990; i.a.). Theory of Mind refers to the ability to ascribe inner states to oneself and others; it is a cover term for many cognitive capacities which develop in stages from infancy through late childhood. Moore, Pure, & Furrow (1990) argue on the basis of ToM trajectories that only after conceptual developments around age 4 will children be able to use modal expressions with adult-like meanings. In short, the conceptual approach argues that children do not use epistemic modals during the epistemic gap because they do not have epistemic thoughts.

Papafragou (1998) is a meta-analysis that looks at the relationship between modal acquisition and developing theory of mind in children. In her analysis, children before about 3;05 do not yet have a ToM that can compute epistemic meaning. She argues that epistemic reasoning requires understanding the contents of another’s mind, or “thinking about thinking”; it is for this reason, and not a grammatical reason, that root modality precedes epistemic modality in acquisition. However, epistemic modals do appear in normal child language before age 3;05, as we saw for modal adverbs and earliest functional modals above. In light of this evidence, we can weaken the conceptual approach: it is possible that prior to approximately age 3;05 children use epistemic modals without fully grasping their meaning, or without the full range of adult-like meanings, as O’Neill & Atance (2000) suggest for physical reference occurring prior to inner state reference.

Under the grammatical approach, grammatical development is a catalyst for conceptual advances, or allows for expression of previously concealed thoughts (de Villiers & Pyers, 1997; 39 Other contributing factors for the root → epistemic direction of development, such as the social role of prohibitive deontic statements from the parental input, pragmatic pressures, and desire-intentional motivation in the child, may also be significant factors in the early dominance of root modality in child language. These are beyond the scope of this dissertation.
de Villiers & de Villiers, 2000; i.a.). For modals, this would mean that children during the epistemic gap lack the representations necessarily for epistemic modals (at least for functional epistemic modals). In this view, children are capable of epistemic reasoning, but cannot express those epistemic thoughts (at least not with functional modals).

The grammatical development approach has primarily been explored for belief reasoning. This refers to the ability we have to attribute beliefs to others, including ones that are not true (false-beliefs); in other words, to understand that others may not have the same information about the world as we do, and indeed that they may hold false beliefs about the world. In the classic false belief task, the child knows where a candy really is, but a character in the story holds onto an out-of-date belief that the candy remains in an earlier position where it has since been moved from (Wimmer & Perner, 1983). Children are asked where the character will look for the candy. Until age four, children answer where the candy really is, despite the fact that the character holds an outdated belief; these children cannot yet process false beliefs.

In this field, as in modal development, conceptual development in Theory of Mind has been argued to explain why four-year-old children pass tasks which require false-belief reasoning, but younger children do not (c.f., the argument that child older than three years can entertain epistemic thoughts, while younger children cannot). The conceptual approach has been challenged by evidence showing that the ability to pass false-belief tasks is correlated with the ability to embed sentential complements in syntax (de Villiers & Pyers, 2002; i.a.). De Villiers and Pyers (2002) maintain that ToM development is involved, but they argue that complex complementation is a tool that aids in the representation of others’ beliefs (e.g., *He thinks that X*).

De Villiers (2007) argue that grammatical and conceptual influence is bidirectional and each exerts more or less influence at different developmental stages (see also Markson & Bloom, 1997). Early on Theory of Mind development, particularly understanding others’ intentions, may help with word learning (see also Tomasello, 1995; Tomasello & Carpenter, 2007), allowing children to understand the purpose of language. And, for example, prior to age four, linguistic development in complex complementation may help with representational abilities and thus aid false belief understanding. For the time when modals and evidentials develop, de Villiers says the following:

Between ages 2–4, there are multiple potential connections between the conceptual and linguistic development, but the direction of influence is much less clear. This is primarily because nonverbal indices either do not exist or have not been used to explore
directionality or even correlation with language tasks. Secondly, studies of language-delayed children have not focused on this period with ideas of the interface with language in mind. No particular theories of how language might assist cognition have emerged for the domains of, e.g. complex intention, desire or true belief, but it is likely that dialogue plays a role in fixing the meanings of the terms and perhaps then, a fuller grasp of the concepts themselves. Study of evidentiality and epistemic markers and how they relate to access to sources of belief provides an exciting new arena in which to explore direction of influence. (de Villiers, 2007: 1873)

In short, the epistemic gap (like belief reasoning) has largely been approached conceptually, with researchers arguing primarily that conceptual development in the domain of ToM reasoning enables epistemic interpretations of modals. There remains a lack of grammatical development exploration in this domain. This is particularly pressing because there are two problems with the conceptual approach.

First, there is a sampling problem. The evidence for the conceptual approach comes almost exclusively from linguistic development in the domain of functional modals (e.g., studies examined in Papafragou, 1998’s meta-analysis), and thus misrepresents modal development. Functional modals are variable in the input, appearing with both root and epistemic meanings, and thus present with a more complex learning task than lexical modals. Lexical modals like adverbs and mental state verbs (e.g., think, know) express modal meanings but have respectively (a) received little attention, and (b) been studied separately (discussed in next subsection). Further, functional modal interpretation is determined in relation to other functional elements (like aspect and tense marking, or temporal adverbials; see §1.2.3), any of which may help trigger epistemic meanings, so it is important to investigate whether grammatical developments play a role in modal meaning development, as the studies in Chapters 3 and 4 do.

Second, epistemic reasoning is broader than the ability to reason about other people’s inner states (ToM) and these two developments should not be equated on conceptual grounds. Epistemic reasoning involves having a thought about a thought, or qualifying a proposition. While we rely on epistemic reasoning (and modals which encode this reasoning) to talk about the inner states of others (e.g., He must be hungry), we also use epistemic reasoning when we talk

---

40 You do not need to understand that you or others have mental states to qualify a proposition. What you do need to be able to do is have a thought about a thought. This involves the ability to understand that thoughts are mental objects which can be manipulated and/or qualified in relation to other thoughts. This may be an implicit ability long before it is an explicit one. This ability is possibly related to level-one ToM development (understanding that you have inner states and be extension that your mind has thoughts, feelings, etc), but is not the ToM development that is discussed in the literature on the conceptual approach to the epistemic gap (Level-Two developments, understanding that others have inner states like your own). I leave this question for future research.
about physical states or events (e.g., *The toy might fall*). O’Neill and Atance (2000) found that children first use *might, maybe* and *probably* to refer to physical events, and only after 3;06 do references to mental states rise significantly (see also Shatz et al., 1983; Papafragou, 2001). This suggests that young children are capable of epistemic reasoning, and that the epistemic gap resolves up to 6 months earlier than the increase in mental state references, at conservative estimates. The data suggest that ToM changes affect what children talk about (physical first > mental later), but not their basic reasoning abilities.

In sum, there are problems with the conceptual approach to explaining the epistemic gap on empirical and conceptual grounds. It is conceivable that children are conceptually able to entertain epistemic thoughts but are not able to express these thoughts using the canonical set of INFL and v-modals because epistemic interpretations of these modals rely on the complex grammatical ability to formally quantify over a full proposition (see Hacquard, 2006). I conduct my own study on lexical modals in Chapter 3. In addition to refuting the conceptual approach, we need clarification and support for the grammatical approach.

2.4.1. Clarifying the grammatical approach to explaining the Epistemic Gap

What kind of grammatical development might trigger epistemic uses of functional modals? Functional modals can scope over either predicates or propositions at LF (Hacquard, 2006, 2010, 2013); a functional modal that scopes over a predicate (=VP in the syntax) receives a root interpretation, as in (7a). On the other hand, a functional modal receives an epistemic interpretation when it scopes over a proposition (=INFL in the syntax), as in (7b). Learning functional modals should accordingly relate to the development of propositional embedding.

(7)  

\[
\text{The baby must be fed.}
\]

\[\begin{align*}
\text{a. } & \text{The baby } \textbf{must} \text{Root } \text{[be fed]} \text{PRED} \\
& \text{‘The baby is obliged to be fed (because he is hungry)’} \\
\text{b. } & \textbf{must} \text{Epistemic } \text{[the baby be fed]} \text{PROP} \\
& \text{‘It is necessarily the case that the baby has been fed (because he is not hungry)’}
\end{align*}\]

When do children show evidence for propositional embedding? When do children demonstrate that they can compute linguistic material over propositions? Matrix verb complements develop in well-studied stages. From earliest collocations children use verbs with nominal complements, such as *eat cookie* and verb-verb collocations, such as *want go*. The earliest multiple clause (e.g. with more than one verb) utterances appear at around two years old.
for most children. These first verbs are bare or root infinitives. The complexity of phrases grows steadily, with the verbal domain eventually including various tenses and verbal complements expanding to include more complex objects, and small clauses, eventually including subjects, inflected verbs, complementizers, embedded wh-words.

This section reports on the development of utterances that contain two main verbs (V+V). In particular, for the second verb in the V+V utterance, which I will henceforth call the verbal complement, I discuss (a) finiteness (bare want go, infinitive want to go, finite Mommy says she knows), (b) the presence of embedded subjects (I want Daddy to read), and (c) the presence of embedded complementizers or wh-words (I know that he’s hiding, I know what you doing). In addition, for the first verb in an utterance with two verbs, which I will henceforth call the matrix verb, I discuss the development of mental state verbs (also called attitude verbs or cognitive verbs) that embed sentential complements (e.g., [John knows [that Mary is lying]]). These verbs are lexical modals (e.g., epistemic: know, think; root: hope, wish).

The development of V+V utterances gives insight into the structure of the embedded clause, particularly whether the embedded clause contains its own INFL projection. The reasoning is that if the child can represent a sentence under a matrix verb, then she can perform the requisite scoping and binding operations necessary for epistemic interpretations of functional modals (see §1.2.2). This developmental step is represented in the trees in (8).

(8) Binding domains for functional modals pre- (left) and post- (right) sentential embedding

At the stage on the left the child can only bind must’s event variable with Aspect, keying a root reading (as in (7a) above). With the ability to embed a TP under linguistic material, the
child can raise *must* above the TP and bind its event variable by the Speech Act event. In short, a reasonable hypothesis for child language, based on Hacquard (2006, 2009, 2013), is that children use epistemic functional modals after they acquire the ability to scope linguistic material above sentences.

### 2.4.1.1. Developments in verbal complements

From earliest collocations children use multi-verb clauses (e.g., *want play*), but the complexity of multi-verb utterances grows steadily as the child’s grammar develops. In this subsection I focus on developments of the verbal complement. These developments show increasing complexity. Earliest verbal complements are bare verbs. Soon after objects are overt, while later on the child expresses more complex VPs small clauses. Verbal inflection develops steadily, with a clear increase in variety and productivity after age three (Brown, 1973, i.a.). Finally we see evidence of embedded sentences.

One developmental marker in this domain is the child’s first use of distinct subjects for each verb in a multi-verb clause. Disjoint subjects provide evidence for the child’s understanding of the semantics of embedding because the child must ascribe the two verbal events to two different agents. Speculatively, when the child is presented with embedded SCs with matrix-disjoint subjects, her understanding of perspective and intention forces her to attribute a distinctive (view-point correlated) truth-value to the embedded complement. This ability is likely critical in understanding epistemic modality, where the force of the modal is not on the subject, but rather must be linked to the speaker. Diessel (2004) reports that Sarah’s first use of an utterance with a pronominal intervening between the two verbs in a multi-verb utterance is the utterance in (9).

(9) *Watch me do horsie* [2;11] (VP-NP-VP)

The imperative nature of the matrix verb shows disjoint subjects for the matrix and embedded clauses: *you watch me do horsie*. The children studied in Diessel (2004) first use the construction NP-want-NP-INF (as in 9) on average around age 2;07. First uses of *that*
complementizers, giving overt evidence for an embedded CP, occur after age three in most children (Diessel, 2004). Further evidencing an embedded CP, Wh-pronouns vary widely in first appearance, as early as 2;03 or 2;04 with verbs of perception (Nina 2;04; See where my monkey is) and after age three for most Mental State Verbs (MSVs). First if complements appear after 2;10 (Nina; …and see if I’m tall).

Finally, using inflection such as –ing or to in the verbal complement also provides evidence of T-elements in the second clause, suggesting that the child has progressed from small-clause complements to sentential complements. Diessel (2004:63) reports first uses of these morphemes by verb. Explicit infinitival-to appears first with like, at around age 2;05, soon after with try, and past 2;09 with be hard, stop, need and start. Wanna, hafta, and gotta are considered as unanalyzable wholes, with bare infinitival complements, which is a controversial analysis (I take a different approach, see §3.4.3, 3.4.4). The progressive marker –ing occurs first around age 2;05 in the verbal complement (e.g., like dancing; Brown, 1973; Diessel, 2004: 66).

In sum, children begin with simple V+V constructions and, focusing on the verbal complement, they then develop in sequence: overt objects, infinitive-to, progressive –ing, subjects, wh-pronouns, and finally that- and if- complementizers. I consider these clause structure development findings in practice in my comprehensive corpus study on Sarah (Brown, 1973), in Chapter 3.

2.4.1.2. Development of embedding mental state verbs

Mental state verbs (MSVs) are a subset of attitude verbs, sometimes called cognitive verbs, and are embedding verbs which encode inner states; for example, think, know, believe, feel. Several of these verbs can be considered lexical epistemics because they encode mental states of the speaker or attitude-holder, for example think, know, guess, mean42, and bet (Diessel & Tomasello, 2001). The development of these verbs is relevant to the studies undertaken in this dissertation both in terms of their semantics as lexical epistemics and their sentential embedding properties; they take sentential complements in the adult language (they involve recursion; see Sowalsky, Hacquard, & Roeper, 2009) and scope above sentences.

42 Mean has a discourse flavour to me, like the speaker wants to clarify what they said. This doesn’t strike me as epistemic but rather more broadly speaker-oriented.
MSVs qualify the proposition relative to the mental state held (10). Some formal differences exist, for example, *know* presupposes the factivity of the proposition it scopes over, while *think* and *guess* do not; (11b) makes a stronger more trustworthy claim than (11a). *Know* is further different from the others as it more readily takes DP complements (*I know John*) and is factive.

(10) I *guess/think/know/bet* [Joanna is happy].

(11) a. I *think* Joanna is happy.
    b. I *know* Joanna is happy.

In an early study on mental state verbs, Shatz et al. (1983) argued that the first mental state verbs which take sentential complements (*know, think, wish, wonder*, etc.) used by children serve communicative functions, rather than true cognitive functions. Diessel and Tomasello (2001) and Diessel (2004) also analyze early, zero-marked complement clauses (e.g., *I think* [Ø I'm go in here], Sarah 3;01) as variously functioning as performatives, epistemic markers, attention getters, and markers of illocutionary force (see Austin, [1962] 1975).

Shatz et al. (1983) conducted two studies, one on the spontaneous speech of Abe (CHILDES: Kuczaj & Maratsos, 1975) from 2;04 – 4;0, and another examining 30 additional children in order to corroborate Abe’s data. They coded Abe’s mental verbs as either: mental state (e.g. ‘cept I tricked you!, in the context of having lied to his father causing his father to have a false belief), modulation of assertion (e.g. *I think this is a lamb*), directing the interaction (e.g. *Know what?*), clarification (e.g. *I mean the other one…*), expression of desire (e.g. *I hope we have popcorn*), action-memory (e.g. *Don’t forget mine home*), or *I don’t know* (frequent and formulaic enough to receive its own code).

Many of these codes other than “mental state” arguably also refer to mental states, particularly “modulation of assertion” which Shatz et al. (1983:308) describe as utterances which “modulate the degree of certainty with which a speaker makes an assertion”, in other words an evidential or epistemic use (c.f. Diessel, 2004 who considers these uses as such). Also “action-memory” which appears to presuppose that the hearer has, for example, forgotten something which involves mental representations. However, those examples that they do code as mental states are those that explicitly and therefore unequivocally reference the mental state of the child or interlocutor. For Abe, mental verbs were present from 2;04, but explicit mental reference only occurs at 2;08 (Shatz et al. 1983:314). In their second study they found that no child used mental
verbs for true mental reference before the age of 2;06 (consistent with earlier studies: Bretherton, McNew, & Beeghly-Smith, 1981; Limber, 1973). This is also the lower bound for first functional epistemics, see §2.3.1.

Diessel and Tomasello (2001) and Diessel (2004) argue that early utterances with embedding verbs do not involve true embedding, but are rather parentheticals (c.f. early negation – another scope marked operator – which begins external to the proposition (Klima & Bellugi, 1966)). Parenthetical MSVs do not select for a CP complement, but collocate either before or after the proposition that they relate to (12a) (see Ross, 1973; Emonds, 1976; Stowell, 1987; Culicover & Jackendoff, 1997, i.a., for discussions on the formal properties of parentheticals). On the other hand, embedding MSVs select for sentential complements, as shown in (12b).

(12) Parenthetical and embedding MSVs

a) Parenthetical

\[ \text{TP} \]

\[ \text{I} \quad \text{VP} \]

\[ \text{Parenthetical} \quad \text{CP} \]

\[ \text{I know} \quad \text{John is happy} \]

b) Embedding

\[ ([\text{that}] \text{John is happy}) \]

Diessel and Tomasello (2001) and Diessel (2004) argue young children only use the structure in (12a) on the basis of early MSVs showing a lack of diversity in forms, uses, and meanings. The subject of early MSVs is usually 1st person singular. Further, parenthetical clauses with early cognition verbs are typically short (e.g. just \textit{know} or \textit{I know}), in the present tense only, and may precede or follow the associated proposition. When parenthetical, the ‘matrix clause’ can be omitted (though sometimes then needs a modal or discourse marker to support the ‘embedded clause’). In (13a) a parenthetical ‘matrix’ verb is used to express the same meaning as (13b), likewise, a parenthetical verb is used in (13c) to express the same meaning as (13d).

(13) a. I promise that I will help you with this work.

b. I will (definitely) help you with this work.

c. I suggest that we leave before it begins to rain.

d. We had better leave before it begins to rain.  \hspace{1cm} (Diessel, 2004: 82-3)
However these findings for child uses of embedding verbs also hold of adult uses; adults use mostly parenthetical MSVs (Thompson & Mulac, 1991). For child learners, Diessel (2004) maintains that the complement cause is not actually semantically embedded under the matrix verb until past age 3; instead the ‘complement’ clause is the main proposition and the ‘matrix’ clause “provides some instructions as to how to interpret the utterance” (Diessel, 2004: 86). Other researchers argue these are structural embeddings (e.g., Pinker, 1984), or at least that the use of embedding verbs signals an ability to embed even if many or most embedding verbs are used as parentheticals.

It has long been noted that early utterances with embedding verbs do not contain a that-complementizer (c.f. Limber, 1973; Phinney, 1981; Pinker, 1984; Bloom, Rispoli, Gartner, & Hafitz, 1989; Diessel & Tomasello, 2001). Of the 1238 apparent complement clauses in their corpus (from six children in CHILDES, ranging from 1;02 – 5;01), only 14 contain overt that-complementizers (Diessel & Tomasello, 2001). Children at first don’t use that at all, and then use it rarely. The verbs that first appear with that-complementizers are the sub-group of speech-act verbs say, tell and pretend, which have more concrete meanings than other embedding verbs, like mental state verbs think or know (Diessel & Tomasello, 2001). Even before these verbs appear with that-complements they exhibit more variation (e.g. they occur in different tenses, with different subjects, with modals, and/or with adverbs) than the other cognitive verbs. In other words, these verbs are less parenthetical, using Diessel and Tomasello’s criteria. That-clauses throughout the whole corpus they looked at were 7 times more likely with these verbs of saying than with other embedding verbs. With only one exception, all that marked clauses appeared after age three.

Diessel and Tomasello (2001) categorize five MSVs as evidential markers, or markers which indicate the speaker’s degree of certainty (later in the paper they call this same set epistemic markers, c.f. Diessel, 2004): think, guess, bet, mean, and know. One-third of all

---

43 The use of parenthetical matrix clauses is also common in adult speech; in fact, the vast majority (~97%) of MSV clauses are zero-marked in the mothers’ speech as well in the CHILDES sample studied (Diessel & Tomasello, 2001:96). Thompson and Mulac (1991) have argued that in adult speech phrases such as I think or I know are frequently employed as parenthetical epistemic markers as well (as cited in Diessel, 2004: 77), and they further liken this use of mental state verbs to epistemic adverbs, such as maybe.

44 Diessel (2004:96) notes that know appears to be less grammaticalized, or more contentful, than the other epistemic marking cognitive verbs. Unlike the other, know only occurs before its complement clause (never after), and is often negated. I posit that something special may occur with know because it is also more frequently linked with the modal cycle (at least in the language families studied); can originally meant to know, and in other West Germanic languages its cognate (können, kunnen), and in some dialects of English, can (‘ken’) maintains this pre-modal
sentential complements occur with these epistemic marking mental state verbs; Sarah’s (CHILDES: Brown, 1973) first two uses of *think* are given in (14) (Diessel, 2004:92).

(14)  a.  *I think I’m go in here.*  Sarah 3;01  
b.  *Think some toys over here too.*  Sarah 3;03

The MSVs *wish* (15a) and *hope* (15b) appear somewhat later (approx. 3;05), and Diessel and Tomasello categorize them as deontic markers; they show up about a year after the functional modal deontics like *must* or *have to*.

(15)  a.  *I wish I could play with dis [= a Christmas present].*  Adam 3;05  
b.  *Hope he tipped again.*  Adam 3;06

Complicating matters, a zero-marked complement clause to a matrix verb is not necessarily parenthetical, as even in true embedding English always allows the possibility of a null complementizer for embedded assertions. Diessel considers overt marking a necessary condition for true embedding of finite clauses (e.g., *I know that he runs every day*); but not for nonfinite ones, as nonfinite clauses cannot exist without integration into a matrix clause. That the adult-input in CHILDES is parallel to the children’s suggests that children may also be zero-marking true embedded clauses, rather than using only formulaic MSVs in their earliest uses. Further, a parenthetical matrix clause still scopes above the proposition it associates with at LF because the relationship of what-qualifies-what must be established; this means that even if the syntax is paratactic (and even if the parenthetical is post-sentential), height relationships are established at LF.

Functional modals have an event variable that must be bound by the speech act event at LF. Lexical modals themselves scope above propositions and give epistemic interpretations, while functional modals get their epistemic interpretations from semantic compositionality at LF. The child can use epistemic lexical modals earlier than functional modals because she doesn’t need the CP layer (for binding; Hacquard, 2006; see Percus, 2000) for the former.

Diessel remains somewhat agnostic as to how his work fits in with the conceptual development hypothesis (e.g. Papafragou, 1998): “[s]ince the formulaic use of mental verbs does not presuppose a fully developed theory of mind, it can emerge before children have the cognitive prerequisites for the performative and assertive uses [of mental verbs]” (Diessel, 2004: 114). In this statement, Diessel is perhaps acknowledging that by analyzing early mental state
verbs as epistemic markers, he is going against the dominant argument that ToM development is necessary for epistemic computations. ToM is not monolithic, so he claims that some development is necessary for early epistemic uses, but not necessarily full development. Compare this with Bassano (1996) and O’Neill and Atance (2000) who both argue that early epistemic modals express immediate future intentions or ongoing physical events. An utterance with a parenthetical MSV does not have sentential embedding, but is nonetheless as epistemic as one which does as far as the conceptual hypothesis is concerned. The parenthetical matrix clause semantically weakens the proposition it is associated with.

What other evidence could help independently determine whether earliest MSVs take embedded sentential complements or not? What is relevant is that the complements are propositional and that the child can embed propositions within propositions. Dudley, Orita, Hacquard, and Lidz (2015) used an interactive game to test whether three-year-old children understood the factivity differences between think and know. Know presupposes the truth of its complement, while think does not. Three-year-olds were bimodal, some understood this difference while others treated both MSVs as non-factive (like think).

To summarize this subsection, MSVs emerge at approximately the same time as functional modals with epistemic interpretations (around age three; see also Papafragou, 2001), usually somewhat later in most children. Verbs of saying (e.g., say, tell) occur earlier, and in more variety (i.e. less formulaic) than MSVs (Diessel 2004). These earliest embedding verbs may be parenthetical; however, what is critical is that uses of embedding verbs show that the child can represent complex linguistic material (a subject and a verb, e.g. I think) above a proposition. This may begin as parenthetical but I expect that as soon as the child can do this she is in a position to make the step to syntactically representing propositions as sentential complements because even if this is parenthetical it requires asymmetry at LF (the MSV qualifies the proposition, not v.v.). This would allow for event binding of functional modals in the high, epistemic, position; in Chapter 3 I test this hypothesis by examining sentential embedding and MSV developments in a single child (“Sarah”, Brown, 1973), in parallel to her modal developments.
2.5. Directly testing the Child Reanalysis Proposal

In a previous study, I tested two hypotheses arising from the CRP in child language. Both related to the mapping problem for functional modals: do children make mapping errors that, if left unchecked, are compatible with the Modal Cycle innovations we see in the historical record (e.g., deontic > epistemic; V > T)? This study tested two hypotheses, one semantic (I) and one syntactic (II).

I. The error patterns of children will show lexemes like can extending upwards from root domains (e.g., deontic) to nonroot domains (e.g., epistemic) where adult controls prefer established epistemic lexemes like might. The opposite direction, nonroot to root, is not predicted. (Cournane, 2014: 106)

II. Child error patterns will show syntactically low elements, for example, lexical verb like or functional verb have, used in contexts where adult controls prefer established higher elements, for example, INFL-modals can or must respectively. The opposite direction, high to low, is not predicted. (Cournane, 2014: 106)

Two tasks were run, a sentence-repair task and a sentence preference task. Sixteen monolingual English children from the Toronto area participated, aged 4;09 to 6;04 (M = 5;5, SD = 5.36). In addition, 16 adults controls participated. In the sentence repair task participants listened to a story on a laptop with Elmo and Elmo’s dog, Zappy onscreen. The experimenter asked Elmo a question about the story and the modal lexeme in Elmo’s response was obscured by Zappy’s barking. For example, one story depicted a scaly tail coming out of a cave. The experimenter said, “Oh my! There is a big scaly tail coming out of a cave. What do you think, Elmo?” to which a sound file of Elmo speaking replied, “It <<woof woof>> be a dragon.” The participant was prompted to repair the sentence with, “Oh no! Zappy barked, what did Elmo say?” The target sentence-repair was, “(Elmo said), ‘it must be a dragon.’”

The task had five semantically-defined conditions, three root (ability, deontic, teleological) and two non-root (future\textsuperscript{45}, epistemic), each with 4 items (5 in the epistemic). The participant could use any modal that fit the sentence frame (e.g., “It _____ be a dragon”), including both INFL and v-modals (referred to as “AUX” and “Functional Verb” modals, respectively, in Cournane (2014)). For example, the repair could either be, “It has to be a

\textsuperscript{45} Future was considered “nonroot” because it patterns later than other root modalities in the Modal Cycle; it is often the latter stage of a lexeme’s pathway, like English shall which went from deontic to future. This is in line with epistemic meanings, which also may follow deontic (like Romance languages’ devoir/deber/dovere/etc.).
“dragon” or “It must be a dragon”. This allowed me to measure both syntactic category choice and lexeme choice.

The main findings were: (a) Children exhibited a more varied mapping from context to lexeme than did adults. Adults mostly used INFL-modals, and relied on primarily 1-3 lexemes for each condition (e.g., adults exclusively used can in the ability condition and used 95% might, must and could in the epistemic condition); (b) Children opted for alternative strategies to capture the modal nature of the context. For example, they used imperatives in the deontic condition, (e.g., “Andy Ø wear mittens!” instead of “Andy should wear mittens”) and habituals in the ability condition (e.g., “Mr.Bird flies” instead of “Mr. Bird can fly”); these did not conform to the sentence-frame presented to the child. And, (c) children showed a slight preference, though not significant, for directional errors consistent with the syntactic hypothesis. This means that children used lower items than adults overall, using more main verbs (like, love, know how) in root conditions (Table 2.1) and more v-modals (here called “functional verbs”, have to, got to) in the nonroot conditions (Table 2.2). This shows a slight preference in learners for “recruiting from below” (see Roberts & Roussou, 2003; van Gelderen, 2004, 2011), while adults used established higher elements.

Table 2.1: Syntactic category by group: root contexts (from Cournane, 2014)

<table>
<thead>
<tr>
<th>Group</th>
<th>AUX</th>
<th>Functional</th>
<th>Lexical</th>
<th>INFL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>172</td>
<td>13 (7%)</td>
<td>4 (2%)</td>
<td>0</td>
<td>189</td>
</tr>
<tr>
<td>Child</td>
<td>84</td>
<td>13 (10%)</td>
<td>10 (7%)</td>
<td>29 (21%)</td>
<td>136</td>
</tr>
<tr>
<td>Lexemes</td>
<td>can, might, have, need, like, love, PRES,</td>
<td>must, should, going, know (how) IMP</td>
<td>would, could supposed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.2: Syntactic category by group: non-root contexts (from Cournane, 2014)

<table>
<thead>
<tr>
<th>Group</th>
<th>AUX</th>
<th>Functional</th>
<th>Lexical</th>
<th>COP/INFL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>137</td>
<td>1 (&lt;1%)</td>
<td>1 (&lt;1%)</td>
<td>1 (&lt;1%)</td>
<td>140</td>
</tr>
<tr>
<td>Child</td>
<td>80</td>
<td>11 (10%)</td>
<td>2 (2%)</td>
<td>18 (16%)</td>
<td>111</td>
</tr>
<tr>
<td>Lexemes</td>
<td>must, should, have, need, like, love, is, PRES</td>
<td>going, knowhow</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Removing the non-frame-fitting child responses because adults made no such errors, the between group differences in category choice are significant in both the root condition and the non-root condition. An examination of the residuals shows in order to determine contributions to the χ2 shows that in the nonroot condition, the choice of functional verbs by children approaches significance. In the root condition, the choice of lexical verbs by children is less robust but perhaps still suggestive that children prefer lower elements than adults.
The preference task introduced participants to two aliens who were living in Toronto and learning English. The participants were told that the aliens were very good at English but needed some help. An illustrated story was shown on a laptop in which the two aliens each provided a comment on the event. For example, one story showed a boy reading a book about snakes and making a scared face. The experimenter said, “This is Chris. He is reading a book about snakes. Why is he making that face?” The aliens responded to the experimenter’s question with near-identical sentences (He must be scared of snakes and He has to be scared of snakes), differing critically only by the modal used. The child was asked to choose the alien who said a better sentence.

The aliens looked identical except for color (green vs. blue). There were two lexical contrast pairs (might ∼ can, must ∼ have) contrasting a nonroot modal (might, must) to a root modal (can, have). There were 8 trials with 4 nonroot contexts (2 with target might; 2 with must) and 4 root contexts (2 with target can; 2 with have). Table 2.3 provides a summary of the data, with error counts and percentages for both groups.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lexical Contrast</th>
<th>Sample Target Sentence</th>
<th>Competitor Modal</th>
<th>Error Type</th>
<th>Error Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>must ∼ have</td>
<td>“He has to put choco-chips in the batter”</td>
<td>Must</td>
<td>must ∼ have</td>
<td>Adult: 12  Child: 12</td>
</tr>
<tr>
<td></td>
<td>might ∼ can</td>
<td>“I don’t want it, you can drink it”</td>
<td>Might</td>
<td>might ∼ can</td>
<td>Adult: 11  Child: 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>Adult: 23  (18%)  Child: 22  (18%)</td>
</tr>
<tr>
<td>NonRoot</td>
<td>must ∼ have</td>
<td>“He must be scared of snakes”</td>
<td>Have to</td>
<td>must ∼ have</td>
<td>Adult: 1  Child: 9</td>
</tr>
<tr>
<td></td>
<td>might ∼ can</td>
<td>“She might’ve hurt herself on the swings”</td>
<td>Can</td>
<td>can ∼ might</td>
<td>Adult: 1  Child: 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>Adult: 2  (2%)  Child: 18  (14%)</td>
</tr>
</tbody>
</table>

The “Condition” indicates the flavor of the story as Root or Nonroot (=Epistemic), while “Lexical Contrast” indicates which two lexemes were heard in opposition spoken by the aliens. Two sample target sentences are provided per condition, one representing each lexical contrast.
The competitor modal (the other member of the contrast) and what error-type preference for the competitor modal would indicate are listed for each sample sentence. Upward errors are predicted by the CRP, while downward errors are not. Error type counts are shown separately for each lexical contrast; for example, a downward error could have been either preference for must in a have context or preference for might in a can context. Children had identical rates of downwards errors as adults (18%) with comparable counts for both lexical contrasts. However, for the errors predicted by the CRP, children were more likely to choose an upwards competitor modal in both lexical contrasts than adults (14% vs. 2%). Logistic mixed-effects modelling revealed that for the downward nontarget choices, group was not statistically significant; a child was only 1.1 times less likely to pick the target than an adult in the downward error condition. On the other hand, for the upwards nontarget choices, group was highly significant; a child was \( \sim 14 \) times more likely to pick the upwards-extended error than an adult.

The fact that children were more likely to choose upwards-extended lexemes than adults in the preference task, and that they were more likely to use less grammaticalized syntactic categories (i.e. more \( v \) and \( V \) than adults) is promising for the CRP. However, the first finding was based on a small study with only a few lexical items, and the latter was statistically weak.

2.6. Conclusion

At the beginning of this chapter, we discussed what learning a modal entails, and laid out the following four components for the child to acquire:

(a) the concepts of possibility and necessity,
(b) modal bases for distinct modal flavours
(c) grammatical representation of mental objects (e.g., knowledge states, desires)
(d) lexeme-specific aspects (e.g., lexical or functional? evidence-marked?)

Addressing (a), modal force, we learned that children first understand the possibility (might) vs. certainty (is), then possibility (might) vs. necessity (must), and lastly necessity (must) \( \sim \) certainty (is). Children as young as three years old generally understand the scalar implicatures which arise from contrastive modal forces; by approximately age five they successfully choose the strongest (most informative) modal statement over weaker (but still true) statements (Noveck et al., 2001; Papafragou & Ozturk, 2006, and subsequent). Addressing (b), modal flavour, we learned that from just after two years old children use functional modals with
root meanings and epistemic lexical modals. After about three years old children use functional modals with epistemic meanings. Mental state references increase after 3;06.

Studies addressing (a) and (b) are largely separate and acquisition pathways are distinct. However, we know languages may lexicalize modality primarily according to quantificational force (as English does), or primarily according to domain of quantifications (as Salish does) (Vander Klok, 2012). It is therefore possible that learners entertain hypotheses in-line with the language-type they are not learning. For example, errors with force seen in English learners may be caused by children ascribing a fixed flavour to must, rather than a fixed force (perhaps probabilistically, see Yang, 1999, 2002). This may account for force being non adult-like in studies addressing (a) as the child would accept both weak and strong readings of must (as per Salish-type modals). It is likewise possible that force-centred hypotheses affect early flavour development in ways we have not yet explored. I leave these questions to further research.

With reference to (c) we discussed the shortcomings of the conceptual approach to explaining the epistemic gap. The child does not seem to need to be able to explicitly refer to inner states to use lexical nor functional modals; mental state reference increases after first uses of both. However, the child does need to be able to have a thought qualify another thought in order to perform epistemic reasoning. This relies on the implicit ability to relate two propositions in the mind; this ability may exist well before first linguistic markers of epistemic reasoning emerge. In Chapter 3 I redefine the epistemic gap as pertaining only to functional modals, not to lexical ones, as most children use lexical modals in spontaneous, appropriate, epistemic contexts during their so-called epistemic gap. I rule out the frequency hypothesis and show that relevant grammatical development (sentential embedding), occurs prior to first functional epistemic modals.

For (d), lexeme-specific acquisition, we saw some previous attempts to disentangle how children figure out the meanings of polysemous lexemes in the input. In Heizmann (2006), for example, progressive aspect was shown to aide children in tuning in to epistemic interpretations of must. In Chapter 4, I present a more extensive study of the role of aspect marking in determining the flavour of the functional modal must. This study uses a picture preference task (c.f. Fond 2003) to address a gap in our current understanding of modal development: whether children use aspectual information to bootstrap the scopal properties of functional modals, like must, as predicted by Hacquard’s event-relative modal (2006, 2013).
Finally, we discussed the findings of my previous paper that directly addressed the CRP. This study shows that children prefer lower syntactic categories than adults to cover modal meanings. Children also are significantly more likely to upwards overextend meanings from root-to-epistemic in the direction of diachronic change. Both Chapter 3 and Chapter 4 continue this line of research.
Chapter 3: In search of naturalistic evidence for diachronic reanalysis: longitudinal corpus study

3.1. Introduction

This chapter investigates whether there is longitudinal naturalistic evidence for biased modal acquisition in keeping with the Child Reanalysis Proposal (CRP). If the CRP is correct, then the persistence and diffusion of learner input-divergence should drive the Modal Cycle. In the semantics, learner input-divergence is expected to exhibit overextensions in the meaning coverage of modal lexemes such that premodals extend to root interpretations and root modalities extend to epistemic interpretations (1), but not vice versa. Child overextension is the logical source of the semantic modal cycle (Cournaane, 2014; c.f. Diesell, 2011, 2012).

(1) Overextension: \textit{Premodal} $>$ \textit{Root Modal} $>$ \textit{Epistemic Modal}

In the syntax, learner input-divergence is expected to show re-categorization of lexical verbs as functional verbs and functional verbs as inflectional elements (2), but not vice versa. Child re-categorization up the functional structure is the logical source of diachronic upwards reanalysis (e.g., Lightfoot, 1979; Roberts & Roussou, 1999, 2003; van Gelderen, 2004, 2011). Do young learners exhibit patterns of overextension or of upwards re-categorization in the direction of cyclic modal change?

(2) Upwards re-categorisation: \textit{V} $>$ \textit{v} $>$ \textit{INFL}

Before addressing patterns of divergence from the input language, some open questions concerning the fundamentals of modal development remain unresolved (Chapter 2, §2.2, 2.3). Foremost, a more systematic exploration of the developmental facts is necessary: do lexical epistemics (e.g., adverbs \textit{maybe, probably}) occur earlier than functional epistemics (e.g., INFL \textit{might, must})? If so, what explains the lack of functional epistemics during this Epistemic Gap (3)? There are three hypotheses for explaining the epistemic gap, laid out in (4a-c) below.

---

\footnote{I use the term \textit{input-divergent} to refer to any analysis by the child that does not conform with the grammars of the speakers who comprise the child’s input. Input-divergent analyses are normally referred to as child “errors”. The term “error” is problematic for many reasons, perhaps the most egregious of which is that these apparent errors only become erroneous when compared to the “correct” analyses of other people’s grammars; when analysed within the grammar which produces them (i.e., the child grammar at its relevant state) then they are fully consistent. The term “error” also carries a judgement of inaccuracy relative to some goal that is not consistent with a descriptive and non-teleological view of language development.}

---
The Epistemic Gap:
The period of time from $\approx 2;00$ to $\approx 3;02$ when children produce modals with root meanings, but not modals with epistemic meanings.

The Conceptual Hypothesis:
The epistemic gap occurs because children are as yet incapable of the reasoning necessary to support epistemic meanings.

The Frequency Hypothesis:
The epistemic gap occurs because children hear significantly fewer epistemic modals in their input than root modals.

The Grammatical Hypothesis:
The epistemic gap occurs because children lack the grammatical structure necessary to support epistemic modals

In this chapter, I present three naturalistic corpus studies addressing each of these hypotheses and exploring patterns of input-divergence predicted by the CRP. The first corpus study was conducted to better understand the relationship between lexical and grammatical epistemic forms in modal development. The conceptual hypothesis is widely accepted (e.g., Shatz & Wilcox, 1991; Bartsch & Wellman, 1995; Papafragou, 1998, 2001), however there are several reasons to question it in its strong form, primarily that it is formulated from evidence from functional modals only (see O’Neill & Atance 2000; Cournane, 2015). The research questions are:

I. Does the epistemic gap apply to all modals, or only to functional modals (e.g., must, could)?

II. Do children use epistemic adverbs (e.g., maybe, probably) in appropriate contexts during their so-called epistemic gap?

The second study addresses whether frequency effects explain the epistemic gap. The frequency hypothesis has not been tested (though see Shatz et al., 1983; O’Neill & Atance, 2000), but given the preponderance of root meanings relative to epistemic meanings, it is important to test this possible grammatical source for the epistemic gap. The study compares Sarah’s (Brown, 1973) modals with root and epistemic meanings to see if they are acquired concurrently or in succession. Her mother’s speech is also sampled to test for input frequency effects. The research questions are:
III. Is the order of acquisition from root > epistemic explained by the relative frequencies of root and epistemic modal meanings?

IV. Are root and epistemic modals used at the same relative frequency as in the input?

Finally, the third study addresses the grammatical hypothesis, which is undertested (though see Heizmann, 2006; de Villiers, 2007; Cournane, 2014), and addresses input-divergent grammatical patterns predicted by the CRP. The third study explores the complete modal inventory of a single child from 2;03 to 5;01 (“Sarah”, Brown, 1973). I examine her premodal verbs (V; e.g., want, try), functional verb modals (v; e.g., have to, gonna), INFL modals (INFL; e.g., must, might), and adverbs (ADV; e.g., maybe) to look for patterns of development in the syntax and semantics of modal expressions. I report general measures for form and meaning developments across Sarah’s modal system, focusing on input-divergent patterns. The first research question explored in Study 3 addresses the expected basis for the grammatical hypothesis (epistemic meanings scope above propositions; Chapter 1, §1.2.2):

V. Does naturalistic evidence show that the resolution of the functional epistemic gap is linked to the development of propositional embedding?

The second research question in Study 3 addresses Form ↔ Meaning mapping patterns:

VI. Do input-divergent form-to-meaning mappings show patterns of semantic overextension or syntactic upwards re-categorization, as predicted by the CRP?

Grammatical changes in the mapping relationship between meaning and form are the predicted source of diachronic modal changes (Chapter 1). Thus, providing evidence that child modal development is best explained by grammatical changes, in accordance with the Grammatical Hypothesis, provides foundational support for the CRP. Further, input-divergent Form ↔ Meaning patterns in the direction of Content > Root > Epistemic overextensions and/or V > v > INFL upwards re-categorizations are also expected if the CRP is correct.

3.1.1. Assumptions: mapping words to modal meanings and modal meanings to words

A corpus study is a study of uses of particular lexemes (and their grammatical and environmental contexts) from a regularly sampled database of a developing child’s utterances. By following a child’s production of modal items throughout the timespan of her samples, we get
a collection of her earliest attempts with modality and the progress she makes as her mind and grammar develop. Her task is bidirectional: she must map the words she hears to meanings she possesses, and map meanings she possesses to words (or constructions), in accordance with available evidence; this is the classic mapping problem in first language acquisition (see Clark, 1973, 1993; Bloom, 2000; Gleitman et al., 2005).

If the CRP is correct and children are responsible for innovations like Content > Root > Epistemic, then children must overextend the meaning coverage of lexical items. In other words, child learner meaning extensions must create the new mapping relationships for Form ↔ Meaning that arise in the historical record (e.g., must\textsubscript{ROOT} > must\textsubscript{ROOT}/\textsubscript{EPISTEMIC}). With modals (as with be-going-to or adpositions like after), the earlier historical meanings typically remain when the newer meaning arises, giving rise to one-to-many Form ↔ Meaning\textsuperscript{47} mappings (Hopper & Traugott, 1993).

I argue that necessary L1 acquisition mechanisms which create productivity in the grammar, such as the generalization of a morphological rule or the extension of a word’s meaning to a wider set of referents (generalization and extension, respectively), routinely give rise to innovative Form ↔ Meaning mappings in child language (overgeneralization and overextension; e.g., Bowerman, 1982; Clark, 1993).

The CRP predicts overextensions for meaning coverage from Content > Root > Epistemic. To develop semantic productivity, we know that the child must extend meanings learned within contexts to novel referents. For example, when learning the word ‘kitty’ with one referent (the family cat Darwin) the child is tasked with extending that meaning (to all cats, including Darwin). How far does the meaning extend, or, which set of referents is correct? Extension is necessary for productivity; however, if the child also calls dogs kitties, she has overextended the meaning coverage of kitty to include too many possible referents (albeit in a principled way). This indeed happens in normal acquisition of both lexical and functional items.

\textsuperscript{47} Given the bi-directional nature of the Form ↔ Meaning mapping task, the following scenarios are logical possibilities: a) the child may have a concept (such as epistemic reasoning) but not enough grammatical understanding yet in place to access the target means of expressing that concept, or b) the child may have learned a grammatical computation (i.e., propositional embedding) but does not yet have the conceptual ability to exploit this tool to its fullest. In the case of (a), the child may rely on other grammatical means in an effort to express thoughts without the adult tools (perhaps circumlocutions or parentheticals). In the case of (b), the child may show productivity of a certain abstract ability (like propositional embedding) in some linguistics domains, but not the full adult complement. In other words, early attempts at labelling concepts may be input-divergent because the child does not yet have the necessary grammatical abilities or because the child does not have the necessary conceptual abilities.
(e.g., Bowerman, 1985; Clark, 1993). In (5), the child overextends the meaning coverage of *behind* from input-convergent physical meanings to an input-divergent temporal meaning (this is the unidirectional pathway of innovation for adpositions in diachrony; Heine et al., 1991).

(5) *Can I have any reading behind the dinner? (=after)* (Bowerman, 1985:1292)

The English modal *must*, for example, has both deontic and epistemic meanings. The child first learns the root meanings and then extends to epistemic meanings (Papafragou, 1998). Just as is the case with nouns like ‘kitty’, however, she can also overextend the meaning coverage of modal lexemes: for example, even if *must* only has deontic meanings in the (adult) input (as was once the case in English and for West Germanic cognates), the semantic grammar still allows modals to merge in two positions (Hacquard, 2006, 2010 for details), and the child can thus grammatically and productively extend the meaning of *must* to cover epistemic usage. The semantic grammar of functional modals predicts the grammatical availability of root > epistemic extension (nothing formally restricts a modal quantifier from scoping over either a predicate or a proposition and the meanings both concern possibilities and necessities); consider the rampant cross-linguistic polysemy of modal lexemes, which is best analyzed as non-stipulative in nature (see Hacquard, 2006, 2010).

What does the CRP predict for innovations along the syntactic modal cycle, V > v > INF? Unlike for parallel pathways where the child needs to overextend meaning coverage beyond the input, in syntactic pathways, it appears that the child needs to re-categorize a lexeme as higher in the syntactic structure (Roberts, 2010; see also Roberts & Roussou, 2003 and van Gelderen, 2004, 2011). In order for recategorization to be possible, the resultant structure needs to be input

48 Overextension errors are not mutually exclusive with underextension errors in the development of individual lexemes. Take for example, the English future markers *will* and *gonna*. Encoding future with an adult distribution of *will* and *gonna*, where each form covers a subset of future meanings and interacts with other elements of the grammar in a principled way, is not possible without an adult-like concept of future time, modal necessity, and a complete grammar. Children begin coding futures – which indeed appear appropriate for the context – soon after age 2. *Gonna* is initially only used with motion paths in the immediate future (Schmidtke-Bode, 2009), which can be considered an underextension of *gonna* relative to its adult usage. However, later on when the child uses *gonna* for future intentions and predictions, and also begins to make use of *will*, the child relies significantly more heavily on *gonna* than the adult input, which relies more on *will* (Klecha et al., 2008) and appear to lack many conceptual distinctions that adults make use of. A lexeme may thus first be constrained by conceptual ability, and then later overused, perhaps because of *gonna’s* availability as a future marker generally it can extend to new concepts within an increasingly nuanced conception of the future. Only later, with more familiarity with *will*, are *gonna’s* exceptions and *will’s* meaning coverage fully fleshed out.

49 Why might the child do this? Possibly because the grammar (here the semantic compositional properties of the modal lexeme) allow it. Also, because the child is under pressure from expressivity forces: the child needs to express herself with a limited lexicon and grammar and will thus be more likely to co-opt morphemes with meanings close to the desired meaning in her thoughts.
compatible for the argument structure (and other compositional elements). For example, consider the recategorization from verbs to INFL elements (as in the history of the canonical English INFL modals like must, will, can). This reanalysis from V/v > INFL was concomitant with a reanalysis of the entire clausal structure. Prior to reanalysis constructions with modal verbs were biclausal with the modal verb embedding an infinitival verb. After reanalysis, the structure is monoclausal because the newly INFL modal is the inflection marking for the lower main verb. In the innovative structure, the modal has no argument structure, and does not itself inflect. The same string (6a) can be accommodated by either structure in (6b) (see Chapter 1, §1.2.2.). Recategorization was possible because morphology which distinguished embedding verbs as such was becoming increasingly deteriorated due to phonological levelling (see Lightfoot, 1979; Roberts, 1985).

(6) Structural reanalysis of two clauses into one (higher V/v > INFL):

a. sone hit mei illimp-en
   soon it may3SG happen-INF
   M.E. a1225 (?a1200) Lay. Brut 2250 (Denison, 1993: 299)
b. Modv > Modal and concomitant structural reanalysis

```
  CP...
 V_MOD  CP...
 V_MAIN  XP     CP...
 I_MOD   CP...
 V_MAIN  XP
```

The innovative syntactic analysis, with recategorization of the modal, eliminates a lot of structure that had become increasingly vacant. The new structure is also simpler in some respects, (a) it has only one clause, and (b) it has less agreement dependencies. Diachronically, particular constructions appear to get simpler analyses (e.g., OE modal verb constructions), while in the child there is a clear development from simple structures > complex structures (see Brown, 1973; Diessel, 2004; Gleitman et al., 2005; among many others).

In a non-parallel, or oppositional, alignment between the L1 acquisition pathway (complexification) and the diachronic pathway (simplification), for the child to advance the diachronic pathway she must stay at an earlier stage of analysis. For example, a ME- learning
child under age three would be at a stage without complex sentences (see Diessel, 2004); her analysis of modal-containing sentences like (6b) would differ from that of contemporary adults; if this analysis sufficed for meaning coverage and preserved the meaningful features present in the string (e.g., a modal possibility feature, a main verbal event, an agent) there would be no reason to complexify her analysis of these strings despite her general grammatical development (see Fuß, 2005 for a detailed account of how pronominal arguments can be reanalysed as non-argumental agreement markers with preservation of meaningful features and of linearization).

Under conditions of opacity of input analysis (i.e., where the input language properties are unclear due to weakening cues50), diachronic innovations align with normal child development when the child is at an earlier analysis stage. If the child has an analysis for a string and it suffices for capturing the meanings and is consistent with the rest of her grammar, weak cues may not trigger a child reassessment and reanalysis, of complexification of the data. If a child stays at an earlier stage of analysis then that analysis would advance the modal cycle for oppositional pathways. This is plausible; consider that children are known to wait to produce sentences that are unclear in the input until they have gotten enough input evidence (see Snyder, 2007 for evidence of Avoidance; compare with opacity conditions). In sum, throughout development the child has interim analyses (Forms) consistent with her grammatical stage; an interim analysis becomes her ultimate analysis if it captures the compositional meaning of the string (Meaning) and is consistent with the rest of the grammar. In morphosyntactic reanalysis the child posits a new form for an existing meaning.

Child input-divergent analyses remain a promising source of both directional semantic changes and directional morphosyntactic changes. In this chapter, I first address two gaps in our understanding of modal development with respect to epistemic adverbials (Study 1), and frequency effects (Study 2). Then, in Study 3, I present a comprehensive study of the semantic and syntactic properties of all of Sarah’s (Brown, 1973) modals: in Part A, I address the grammatical hypothesis, and in Part B I address the Form ↔ Meaning input divergent properties of Sarah’s modals.

50 This type of reanalysis is expected to be fed by phonological changes that level inflectional marking paradigms, as in the history of English (see Lightfoot, 1979; Roberts, 1985 for effects of loss of infinitival and subjunctive marking on verbal reanalysis).
3.2. Study 1: In search of epistemic lexical modals

3.2.1. Questions and Hypotheses

The epistemic gap is the period of time from about 2;00 to 3;06 when children have been observed using modals with root meanings but not with epistemic meanings (e.g., Papafragou, 1998). In §2.4 we discussed how the existence of this gap is based on studies of functional modals (e.g., v, INFL) and not to lexical modals (e.g., ADV, V). While it is likely that conceptual development (ToM) and modal development are intertwined (e.g., de Villiers, 2007), the evidence for the conceptual explanation for the Epistemic Gap rests overwhelmingly on the grammatically distinct set of functional modals which are independently more complex than the set of lexical modals.

Studies that examine dedicated epistemic markers, lexical modals like maybe or probably, provide evidence relevant to the epistemic gap as they abstract away from the independently difficult task of learning from polysemous input data. Bassano (1996) notes early child usages of French peut-être (‘maybe’) at 2;06. More recently, O’Neill and Atance examined maybe and probably in naturalistic corpora from multiple children and found that children use these from as early as 2;01 (“Eve”, Brown, 1973). These studies suggest that children may be able to use dedicated epistemic markers earlier than complex functional modals.

With this study, the goal is to determine whether children are using epistemic adverbs (maybe, probably) in adultlike contexts during their individual epistemic gaps (as defined as the period of time before the first epistemic usage of a functional modal). If so, children may not be conceptually limited – at least not categorically – from epistemic reasoning. This study addresses the following two questions:

- Does the epistemic gap apply to all modals, or only to functional modals (e.g., must, could)?
- Do children use epistemic adverbs (e.g., maybe, probably) in appropriate contexts during their epistemic gap?

No previous study has approached the data looking at the entire set of modals with a systematic separation of lexical modals from functional. If children produce lexical modal

\[51\] O’Neill and Atance’s study also included the modal might along with maybe and probably, making a somewhat disjoint group. Unlike the adverbs maybe and probably, might occurs in a fixed position in the syntax (Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005; Landau & Gleitman, 1985) and cannot standalone. Might does share one important property with lexical modals: it is uniformly epistemic in the input (see Wellwood and Hacquard, 2012 for evidence). It is unclear from their data groupings when exactly might occurs for each child.
expressions, like adverbs, in epistemic contexts earlier than functional modals in comparable epistemic contexts, this finding would provide evidence against the conceptual approach in two ways. First, if during the epistemic gap the child uses lexical epistemics, then the argument that the onset of epistemic reasoning is revealed by the onset of linguistic forms that express epistemic meanings falls apart. Rather, we must question whether early epistemics are indeed fully adult like in meaning for all epistemic-type meanings, regardless of form (ADVs, v, INFL). And further, (b) a distinct gap between first lexical epistemics and first functional epistemics suggests that grammatical differences which divide lexical from functional also underlie the child’s modal development.

In summary, the hypothesis for this study has two interrelated parts: First, I expect epistemic-type uses of lexical modals to occur earlier than for functional modals. This is a plausible expectation because lexical epistemics are grammatically simpler than functional epistemics (see §1.2.1). Second, earliest uses of lexical epistemics are expected to be context-appropriate, implying that children may be capable of epistemic reasoning from as early as age two (only on the assumption that earliest uses are adultlike, which is not possible to fully assess with corpus data).

3.2.2. Methods

I examined corpus data from 5 North American English children with relatively large corpora from CHILDES: Adam, Eve and Sarah (Brown, 1973), Abe, and Naomi (Sachs, 1983). For each of the 5 corpora, I used the *freq* command from CLAN to extract a list of all lexical items used by the child in the corpus up until 3;06 (past when the epistemic gap was expected to be resolved). I examined the *freq* output and noted all modal lexemes used by the children, both lexical and functional. I grouped the modals according to their status as either lexical (7a) or functional (7b) modals. Note that both the modal adverbs used at this age are typically epistemic in the adult language.

(7) All modal expressions in the child corpora, until 3;06
a. Lexical: *maybe, probably*
b. Functional: *can, could, may, might, must, should, will, would, got, have*

Then, each child’s functional modals were exhaustively extracted and context-examined working chronologically until I could identify the first clear epistemic-compatible use of a
functional modal (e.g., in the absence of disambiguating context, a sentence like *The baby must be fed* is ambiguous). I used the following criteria to determine epistemic uses: the force of the modal had to be at the propositional level. Evidence for this was the previous discourse (e.g., *I wonder X, What’s the noise?*) and converging contextual information (e.g., the child is looking for something, everyone hears a noise). For example, at one point Sarah’s father returns home with groceries and a surprise for Sarah, she is guessing what it is and uses “got to” (see example 20 below). This is in a guessing-based-on-evidence content. The first epistemic usage of a functional modal determined the end of the individual child’s epistemic gap.

Then, all instances of *maybe* and *probably* during the child’s EG were extracted and context-examined to verify epistemic-compatible usage. To count as a clear epistemic-compatible use the adverb needed to be (a) spontaneously used by the child and (b) fully compatible with an adult-like epistemic analysis. For all the modal adverbs, I coded whether the proposition the modal qualified was about a physical or mental event or state (e.g., *Maybe [The envelopes fell]*) vs. *Maybe [The baby is tired]*, respectively).

### 3.2.3. Results

The first clear epistemic uses of functional modals are provided in (8) for each of the children. Eve did not use any functional epistemics, likely because her corpus only runs from 1;06 to 2;03, thus falling entirely within her epistemic gap. The other four children use their first epistemic functional modal within a 4 month timeframe of each other, between 3;00 and 3;04. For Adam, Naomi and Abe the first functional epistemic lexeme used is *might*, while for Sarah it is *must*.
First spontaneous epistemic uses of a functional modal

a.  *FAT: find them? [them=play dish set]
    *CHI: no. [returns without the dishes]
    *CHI: where my dishes?
    *FAT: I don’t xxx
    *CHI: must be gone (Sarah, 3:00)

b.  *CHI: you might get sick when you eat peelings (Abe, 3:01)\(^{52}\)

c.  *URS: I'm upstairs.
    *CHI: you might fall down on me (. ) Ursula. (Adam, 3:01)

d.  *CHI: it might fell down if he stand on the edge
    *CHI: it might fell down if he stand on the edge (Naomi, 3:04)

The search of utterances within the EG stage yielded between 2 and 3 epistemic adverbs per child, for a total of 9 epistemic adverbs. Sarah uses no epistemic adverbs during her epistemic gap. Among the epistemic adverbs, 6 were instances of maybe, and 3 were probably. All but one of these uses (12a) qualifies a proposition about a physical event. Given their small number, I provide all of the uses of maybe and probably below (9-12).

Eve’s lexical modals during her EG

a.  *CHI: that outside.
    *MOT: I don't hear anything. What is it?
    *CHI: probably Cathy. (Eve, 2;01)

b.  *CHI: I can't see it.
    *MOT: no. too far away to see.
    *CHI: when we go to his home (. ) we maybe see it. (Eve, 2;02)

Of note, Abe also produced the utterance in (1) at 2:07 (see also Kuczaj, 1977). This is earlier than expected relative to other English learning children. This use of must could be epistemic because it follows the mother’s use of clear epistemic could, without being a repetition, and the child’s must is followed by be as is very common in epistemic uses. In addition, Abe seems to first make an educated guess about the bird sighting in question form (a mother bird feeding a baby worm for her baby bird?).

\(^{52}\) However, it is difficult to determine what Abe intends to communicate in the next line with must because he seems to be disagreeing with his mother’s epistemic could-statement (judging by the near-repetition, and the use of “Mom” at the end). He may be strengthening her epistemic statement, disagreeing with the weaker commitment of could compared to must, though it is unclear whether children this age are capable of force shifts of this type (see §2.1). Or he may be using must to express some kind of obligation, though what is unclear because Abe is talking about big worms feedings baby worms (perhaps an error where he meant to say “bird”?). Abe’s use of must in (1) is less clearly epistemic than the uses in (1), though this conclusion should be taken with a grain of salt.

90
Adam’s lexical modals during his EG
a. *CHI: where go? [=a pen]
   *CHI: probably in (th)ere                    (Adam, 2;06)
b. *CHI: where envelopes (.) huh?
   *MOT: you one envelope's on the floor (.) by Ursula's foot.
   *CHI: what dat [: that]?
   *CHI: maybe fall?                            (Adam, 2;09)
c. *CHI: fix it.
   *CHI: maybe does fit.
   *CHI: let's fix. Mommy.                      (Adam, 2;11)

Naomi’s lexical modals during her EG
a. *CHI: who's crying?
   *CHI: maybe it's Kimberly                  (Naomi, 2;06)
b. *FAT: I'm looking for my shoes (.) that's why I can't leave yet
   *MOT: do you know where Daddy's shoes are?
   *CHI: no. maybe they're in the bathroom    (Naomi, 2;11)

Abe’s lexical modals during his EG
a. *CHI: uhhuh I wan(t) (t)a taste one (.) Mom (.) I would probably like some cheese+balls
   (Abe, 2;09)
b. *CHI: maybe these fit in here nope they don't fit in here .
   (Abe, 2;10)

All of these uses are adultlike in terms of appropriate usage contexts (abstracting away from some grammatical errors like uninflected fall in (10b)). For example, in (9a) Eve’s attention is drawn to a noise outside, which her mother doesn’t hear. When her mother asks what it is, Eve makes a guess that Cathy is making the noise, and she qualifies this guess with probably. In (9b), Eve’s use of maybe involves viewpoint and a when-clause. She uses the negated root modal can’t, stating that she cannot see something, and her mother concurs, adding that it is too far away. Eve then reasons that a change of viewpoint (when we go to his home) will change the circumstances and, we maybe see it.

In both cases Eve is weakening the strength of her assertion for evident reasons, in the first case because the audio evidence and what she knows about Cathy suggest (but do not prove) that Cathy may be outside. In the second, change of location suggests (but does not prove) that she and her mother will be able to see Boston (the it under discussion). Both of these uses show the child making guesses as opposed to assertions and are compatible with adult-like epistemic reasoning about physical events.
Also of note is Naomi’s use of *maybe* in (11b). The family is looking for Daddy’s shoes, and the mother asks Naomi if she knows where they are. Naomi first answers *no*, but quickly follows that with a guess that they are in the bathroom. This is an adultlike use of *maybe*, where one offers a guess in the hope of being helpful but qualifies that guess with a modal so as not to seem deliberately misleading if the guess is wrong.

Sarah, unlike the other 4 children, does not use any lexical modals during her epistemic gap, and never uses *probably* in her corpus (2;03 – 5;01). The meaning of her first *maybe* is unclear (13a) and occurs 2 months after her first functional epistemic (*must* at 3;00, 6b). Another month later she uses a clear *maybe* (13b).

(13)  a. He’s *maybe* (.) see two (Sarah, 3;02)
b. I *maybe* lost it (Sarah, 3;03)

In conclusion, four of the five children spontaneously use *maybe* and *probably* in contexts that are fully compatible with adultlike epistemic reasoning. These occur at low frequencies but a qualitative analysis of each use shows that the contexts are adultlike. Of the 9 uses, only 1 refers to an inner state, and this inner state is that of the speaker (Level-1 Theory of Mind). The others mostly qualify propositions about locations or spatial relationships.

### 3.2.4. Discussion

This study has addressed two questions, repeated here:

*Does the epistemic gap apply to all modals, or only to functional modals (e.g., *must*, *could*)?*

*Do children use lexical epistemic adverbs (e.g., *maybe*, *probably*) in appropriate epistemic contexts during their epistemic gap?*

We can answer Question I affirmatively: the epistemic gap appears to apply only to functional epistemic modals, but not to lexical epistemic modals. This confirms that the discussion in the literature on root modality preceding epistemic modality is a consequence of a sampling error, whereby previous studies focused on functional modals and conclusions were thus about functional modals rather than about epistemic meanings.

The answer to Question II is also affirmative: the results show that most children use lexical epistemics during their individual epistemic gap in appropriate adultlike contexts. These findings corroborate evidence from O’Neill and Atance (2000) for English *maybe* and *probably*,
Bassano (1996) for early uses of French *peut-être* (ADV, ‘maybe’), and Smoczynska (1993) for early uses of Polish –*chyba* (ADJ, ‘probably’). In Table 3.1, we see children show two stages, an Epistemic Gap stage where dedicated epistemic markers occur in epistemic-type contexts; and then, sometime after three years old they enter the Full Flavour Stage when functional modals gain their epistemic uses.

**Table 3.1: Expected epistemic uses by developmental stage**

<table>
<thead>
<tr>
<th>Epistemic Gap Stage</th>
<th>Full Flavour Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>(∼ 2;00 → ∼ 3;02)</td>
<td>(∼ 3;02 → )</td>
</tr>
<tr>
<td><strong>Lexical Modals</strong> (ADV)</td>
<td><strong>Yes</strong></td>
</tr>
<tr>
<td><strong>Functional Modals</strong> (INFL, v)</td>
<td><strong>No</strong></td>
</tr>
</tbody>
</table>

Together these findings provide evidence against the conceptual approach to the epistemic gap because (a) children appear to have and express fledgling epistemic thoughts with lexical modals *maybe* and *probably*, and (b) the epistemic gap applies only to functional modals that are grammatically, rather than conceptually, different from lexical modals. The above utterances appear to involve epistemic reasoning. However, it is difficult to assess how adultlike these uses actually are from corpus data because it is hard to be wrong when one uses the word *maybe* (Papafragou, p.c.). The children may simply be signalling some component of epistemic reasoning, like that they are not making a full assertion, for example. However, there is still a difference between lexical modals and functional modals; no child uses the latter in epistemic-type contexts before 3;00 while most children use the former from 2;06 or earlier.

Lexical modals are likely easier for the developing grammar for three reasons. First, and perhaps most importantly, lexical modals are standalone items that are fully specified for both flavour and force. Because these modals do not rely on binding to determine their flavour, as with functional modals, they are grammatically simplex. Both *maybe* and *probably* can occur on their own (qualifying a proposition from the discourse) or integrated within the same sentence as the propositional content they qualify.

(14)  
A: *Is the dog hungry?*  
B₁: *Probably*  
B₂: *Probably, since he hasn’t eaten since breakfast*
Second, relatedly, lexical modals are stable in meaning in the input (*maybe* is always an existential epistemic). And third, they are more frequently modelled in the input than either INFL or *v* modals in English, though not when both functional modal types are considered together (these results are from Study 2, see Figure 8 below).

The majority of the modal adverb uses qualify propositions about physical events, mostly about locations or spatial relationships. Some indication that early uses may not be fully adult-like in meaning include the fact that there is a marked increase in explicit, clear mental state references after 3;06, both for mental state verbs (Shatz et al., 1983; Diessel & Tomasello, 2001) and for *maybe, probably, and might* (O’Neill & Atance, 2000). This suggests that early uses are guesses which weaken a proposition, but which may not involve full understanding of propositions about inner states of oneself or others. At the time that increase in explicit mental state references occurs (3;06), the epistemic gap is resolved and children have already been using linguistic forms which express epistemic meanings for several months (*think, know*; Diessel & Tomasello, 2001; *maybe, probably*; O’Neill & Atance, 2000; *must, might*; Wells, 1985, i.a.). The presence of the linguistic forms does not signal conceptual development of epistemic reasoning, but rather lexical forms precede functional forms and the grammatical development is suggested (Study 3 explores this hypothesis explicitly).

Of the four children who used a functional modal in an epistemic-type context, the age of usage is not surprising, but the lexeme might be. The first clear use contained *might* in three cases (Adam, Naomi, Abe) and *must* in the fourth (Sarah). It is possible that children understand epistemic *might* earlier than other epistemic uses of functional modals (e.g., *could, must*) because *might* appears to be used with in epistemic contexts much more frequently by adult speakers. This makes it functionally more like a dedicated epistemic marker, albeit one that is formally a functional modal.

Lexical modals occur at very low frequencies for each child, making it difficult to make reliable claims about the types of epistemic reasoning the child is doing (physical vs. mental). For example, young children may be able to use lexical modals to modify their inner states, but since they occur at such low frequencies (only 1 in 9 utterances) it is quite possible that they just don’t show up in the sample. Also, it is possible that Sarah does use lexical modals during her epistemic gap, like the other children, but because they occur at such a low frequency none are
captured in her transcripts. The other children go months between each use of a lexical modal within their epistemic gap, lending plausibility to this possibility.

Turning now to how this data relates to the CRP, the most striking finding is that the child’s modal development does not mimic the development of modal lexemes in the historical record, contra common assumption (Bybee & Slobin, 1982; Croft, 2001; Diessel, 2011, 2012). Rather, only functional modals show parallel meaning development pathways in the child (root precedes epistemic) and in the history of modal lexical items (root precedes epistemics). However, when all modal terms are considered, the child uses both root and epistemic modals early in development, albeit perhaps not with fully adult meanings.

The results of Study 1 also suggest a grammatical explanation, which is explored further in Study 3. Since child development for functional modals progresses from root to epistemic for grammatical reasons, if children make input-divergent overextensions in this development those overextensions are expected to be grammatical in nature, namely mapping innovations.

### 3.3. Study 2: Addressing the Frequency Hypothesis

#### 3.3.1. Questions and Hypotheses

In this study I test the frequency hypothesis. Epistemic modals are less frequent in usage than root modalities (see Stephany, 1979; Wells, 1985, i.a.) and arguably even less frequent in child-directed speech which may contain an elevated number of directives (=deontic utterances, e.g., You shouldn’t hit your brother). However, no previous study, to my knowledge, has statistically assessed whether or not this epistemic gap is an effect of usage frequencies. This study addresses the following questions:

*Is the order of acquisition from root > epistemic explained by the relative frequencies of root and epistemic modal meanings?*

*Are root and epistemic modals used at the same relative frequency as in the input?*

To address the first question, we must determine the likelihood, given the low frequency of epistemic modals relative to root modals, that the child is in fact acquiring both meanings concurrently. We may observe an apparent epistemic gap simply because epistemic modals are very rare relative to root modals.

To address the second question, I explore whether child usage rates match input frequencies for epistemic and root modals, once they are both used productively (following the
I also explore whether the child uses the same proportion of INFL modals, v modals, ADVs to express epistemic meanings as in her maternal input. In short, I explore whether (a) epistemic meanings are delayed, taking into consideration their low rates, (b) whether epistemic uses remain lower than expected relative to the input rates, and (c) whether the child uses the same modal strategies to express epistemic meanings as her mother does.

3.3.2. Methods

This study uses data from Sarah (Brown, 1973; MacWhinney, 2000). Her data was collected regularly from 2;03 to 5;01, in the Boston area in the early 1960s. This corpus contains 139 files from 2;03 to 5;01 with a total of 37,021 child utterances. I used the freq command to extract a list of all lexical items used by the child in the corpus. I examined the freq output and noted all modal adverbs, functional v modals and INFL modals.

**Target Category** (INFL, $v$, V, ADV). The target category of the modal was coded as INFL, v, ADV, or V. It is possible that the child re-categorizes (as predicted by the CRP) but evidence for this will come from the structures in which these lexemes appear (see §3.4.4.3), the target category is thus important. These modals are provided and divided by category in (15).

(15) Sarah’s modal lexemes by category
   a. INFL
      *better, can, could, may, might, must, shall, should, will, would*
   b. Little v
      *got to, have to, ought to, be going to, be supposed to*
   c. Adverb
      *maybe*

All of the modal-marked utterances (n=1858) were extracted with five lines of previous context and three of following. Modal usage as either root or epistemic was determined by manually reviewing each item. Where the *kwal*-extracted discourse context was not enough, the transcript was examined to look for context-disambiguating information.

---

53 The time discrepancy between Sarah’s data, as well a geography discrepancy, with the contemporary Toronto children studied in Chapter 4, is expected to lead to some variation when I compare Sarah’s data to the experimental evidence. However, the development of Sarah’s modal system is meant to be an in-depth exploration of a single child with respect to her syntactic and semantic development, as such, the idiosyncrasies of her dialect should not be problematic. The lexical items themselves at the time recorded are not of particular importance, what is important is how they cover the meaning space and discrepancies between the learner and the input. Looking at the nature of generalized patterns and input-divergence in learners is, at present, the only way to examine current child data to test the CRP.

54 Mental State Verbs can express epistemic meanings; they were not included in the current studies; they are well-studied elsewhere, including for Sarah (Diessel, 2004).
Modal meaning (Root, Epistemic). Each modal’s meaning was determined by manually reviewing each item. Where the kwal-extracted discourse context was not enough, the transcript was examined to look for further context-disambiguating information. It was relatively straightforward to ascribe Sarah’s modal uses to the major flavours (Root, Epistemic). In determining a modal’s meaning, the most compatible meaning was chosen; that is, for example, if the child said the utterance in (16), both the sentence form (the INFL modal is above an aspect marker) and the context (Sarah is making a guess about what happened to a missing toy) are compatible with an adult epistemic usage (over a root one).

(16) An epistemic-compatible modal
  I must’ve lost it in the bed (Sarah, 3;05)

Sarah’s mother’s speech was also semi-randomly sampled for lexical and functional modals (v, INFL, ADV; n=253 items). Items were taken from the beginning, middle and end of the corpus. These were coded for meaning as for Sarah’s modals.

3.3.3. Results

Sarah’s first root modals occur from the beginning of her corpus at 2;03 (17). She uses no epistemic modals, neither lexical nor functional, prior to 3;00, when she uses her first clear, spontaneous, epistemic with must (18).

(17) *CHI: can’t take down  (Sarah, 2;03)
(18) *FAT: find them? [them=play dish set]  
    *CHI: no. [returns without the dishes]  
    *CHI: where my dishes?  
    *FAT: I don’t xxx
    *CHI: must be gone  (Sarah, 3;00)

In order to test whether the epistemic gap is a usage frequency effect, I used the binomial test for concurrent acquisition (Snyder, 2007: Ch. 5). This test addresses the question of whether

---

55 Modal quantificational force (∃, ∀) was not explicitly coded for three reasons. Firstly, it is near impossible to tell in a corpus whether the child intends a weak or a strong use of a modal lexeme. In the majority of contexts, assumptions can only be drawn based on lexical choice (e.g. if Sarah chooses will to express a particular future, rather than could, we can assume based on lexical selection that she intends a strong meaning, but with no real certainty on our part as we are imposing adult meanings on child utterances). Second, it is known from experimental studies that children have difficulties with more nuanced modal contrasts along the possibility–necessity continuum (Hirst & Weil, 1982, a.o.). In combination with the difficulty in guessing, this evidence suggests that guesses based on lexical choice have a high likelihood of being wrong. Finally, quantificational force appears to be formally separate from flavour (see Chapter 1) and is not often discussed diachronically (though see Yanovich, 2013).
the acquisition of root and epistemic modals is concurrent (both are acquired at the same time, epistemic just seems later because it is lower in frequency) or ordered (root before epistemic). A non-significant, null result would suggest that the apparent later emergence of epistemic meanings is due to chance, while a statistically significant result refutes the null hypothesis and would allow us to confidently search for a grammatical explanation for the difference between root and epistemic modals.

Of Sarah’s 1858 modal utterances, only 36 (<2%) are probable epistemic uses (because they fully resemble adult uses of epistemic modals in terms of context appropriateness), and of those, 25 are instances of maybe. Sarah uses 180 root modals before her 1st epistemic56 (18). At a steady state following her first epistemic use, from 37 months to 56 months, she uses 26 epistemic modals and 1372 root modals. The binomial test57 refutes the null hypothesis (p=0.03). We can thus argue that epistemic meanings are delayed, at least for functional modals (taking into consideration evidence from Study 1), and that the epistemic gap has a likely grammatical basis (to be directly tested in Study 3).

The next thing to determine is whether Sarah uses root and epistemic modals in the same relative frequencies as they are used in her maternal input. Of Sarah’s mother’s 253 modal utterances, 16 are epistemic. Table 3.2 shows the counts by meaning for Sarah and her mother. When the relative frequencies of Sarah’s post-EG modals (36 epistemic, 1858 root) are compared to those of her mother using a χ2, the result is significant (X-squared = 14.7644, df = 1, p-value <0.0001). Pearson residuals point to lower than expected epistemic modals for the child (p<0.001; R=14.052875). This is visualized in Figure 3.1 below.

56 Snyder (2007) uses the first of repeated uses (FRU) to determine 1st use. The first of repeated uses is the first use that is followed within a month by a repeated use (to rule out early outliers which may not be productive). However, epistemic uses are very infrequent and remain so. Thus, the 1st epistemic modal for Sarah occurs shortly after her 3rd birthday (18). Her next indisputable epistemic modal appears just over 2 months later (I maybe lost it, 3;3.13), however, this frequency of epistemic uses remains stable from here on out in the corpus and the context and utterance converge for a clear epistemic usage of the modals in both cases, therefore I took the item in (18) as the FRU of epistemic modality for Sarah. She also uses maybe in a fragment which is possibly epistemic (he’s56 maybe (. see two, 3;2.23), between these two uses.

57 Binomial Test \( p = \frac{X}{(X + Y)} \), where X corresponds to the number of times root modals are used in the twenty transcripts following the first clear epistemic use of a functional modal, Y stands for the number of times epistemic modals occur in the twenty transcripts following the first clear epistemic use of a functional modal, and Z stands for the number of root modals prior to the first clear epistemic use of a functional modal.
Table 3.2: Root and Epistemic modal counts

<table>
<thead>
<tr>
<th></th>
<th>EPISTEMIC</th>
<th>ROOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHILD</td>
<td>36*</td>
<td>1858</td>
</tr>
<tr>
<td>MOTHER</td>
<td>16</td>
<td>237</td>
</tr>
</tbody>
</table>

Figure 3.1: Root and epistemic modal counts by group

What about the form strategies (INFL, v, ADV) used to express epistemic-type thoughts? Of Sarah’s epistemic modals, 70% (25/36) are the adverb maybe (19a-e). The remaining 11 epistemic modal uses are comprised of 10 auxiliary modals and 1 little-v modal (20). Sarah’s mother also uses mostly adverbs, but the relative frequencies of ADV, INFL and v epistemic modals is more balanced. This information is summarized in Table 3.3 and visualized in Figure 3.2 below.

(19)  a. He’s maybe (.). see two          (3;02)
    b. I maybe lost it                  (3;03)
    c. Maybe Uncle Buster              (4;00)
    d. MOT: probably left em xxx.
       CHI: maybe he left em up the sky
       and he didn't come down no more   (4;02)
    e. Put a little more on, maybe      (4;07)

(20)  It's got to be a bubble gum       (4;00)
      (father enters with groceries, including atypical gum)
In order to test whether Sarah is using input-matching strategies for expressing epistemic meanings, I ran a ChiSq test comparing the frequencies of modal adverbs, auxiliaries, and little-v modals between Sarah and her Mother. The results show that the distribution is significantly different (χ² = 6.9236, df = 2, p = 0.031), but an examination of the residuals shows that no one cell is providing a significant contribution; the cell which approaches significance is the child’s use of little-v modals, which is lower than expected (R=3.93846154).

3.3.4. Discussion

This study has shown that epistemic meanings are delayed beyond what is expected given usage frequencies; the Epistemic Gap does not appear to be explained by frequency effects. For Sarah, all epistemic uses follow resolution of the epistemic gap. If the results here are taken together with the results from Study 1, it is likely that most (if not all) children use modal adverbs at low frequencies during the epistemic gap (n=3, for Eve), which resolves when

<table>
<thead>
<tr>
<th>Category</th>
<th>Child</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverb</td>
<td>25 (maybe)</td>
<td>7 (probably, maybe, certainly)</td>
</tr>
<tr>
<td>must, should, could, might, can</td>
<td>10</td>
<td>5 (should, may, might, must)</td>
</tr>
<tr>
<td>(got to)</td>
<td>1</td>
<td>4 (have to, got to)</td>
</tr>
<tr>
<td>Total</td>
<td>36/1858</td>
<td>16/253</td>
</tr>
</tbody>
</table>

Figure 3.2: Epistemic counts by syntactic category by group

In order to test whether Sarah is using input-matching strategies for expressing epistemic meanings, I ran a ChiSq test comparing the frequencies of modal adverbs, auxiliaries, and little-v modals between Sarah and her Mother. The results show that the distribution is significantly different (χ² = 6.9236, df = 2, p = 0.031), but an examination of the residuals shows that no one cell is providing a significant contribution; the cell which approaches significance is the child’s use of little-v modals, which is lower than expected (R=3.93846154).

3.3.4. Discussion

This study has shown that epistemic meanings are delayed beyond what is expected given usage frequencies; the Epistemic Gap does not appear to be explained by frequency effects. For Sarah, all epistemic uses follow resolution of the epistemic gap. If the results here are taken together with the results from Study 1, it is likely that most (if not all) children use modal adverbs at low frequencies during the epistemic gap (n=3, for Eve), which resolves when
functional modals begin to be used in epistemic contexts. For other children, I expect that, like for Sarah, epistemic meanings remain infrequent and the first epistemic use of a functional modal is significantly later than first root uses. This should be tested on other children. Consistency across children, that is, repeatedly finding that despite the sample (=Child) the same root > epistemic trajectory applies for functional modal meanings also provides evidence against the hypothesis that frequency effects alone explain the pathway (i.e. with enough samples, a deviant sample should be found).

After Sarah uses her first epistemic functional modal (must at 3;00), demonstrating resolution of her individual EG, her epistemic modal uses remain lower than expected when compared to the maternal input frequencies. Sarah uses primarily the adverb maybe to express epistemic meanings, among the extant adverbial, little-v and INFL epistemic strategies. Her mother also uses mostly adverbs, but uses fairly equal counts of all three strategies. Mental state verbs also express epistemic meanings and should be considered in the future.

These results provide some evidence against the frequency hypothesis because for Sarah epistemic meanings for both lexical and functional modals are delayed relative to root modals and remain lower than expected when compared directly to the input.

3.4. Study 3: Addressing grammatical development
3.4.1. Questions and Hypotheses

Study 3 addresses grammatical development in a single child (“Sarah”, Brown, 1973); it is divided into two parts (Part A and Part B), addressing the following research questions:

**PART A:** Does naturalistic evidence show that the resolution of the functional epistemic gap is linked to the development of propositional embedding?

**PART B:** Do input-divergent form-to-meaning mappings show patterns of overextension or upwards re-categorization, as predicted by the CRP?

Part A explores whether naturalistic evidence shows that the resolution of the epistemic gap is linked to the development of propositional embedding. In Studies 1 and 2 we established that the conceptual approach to explaining the epistemic gap is problematic and that frequency effects do not account for the developmental pathways for root and epistemic meanings. The grammatical hypothesis remains to be directly tested. I have revised it, to read as in (21).
(21) The Grammatical Hypothesis:
The epistemic gap occurs for functional modals (INFL, \(v\)) because children lack the grammatical structure necessary to support their epistemic meanings, which scope above propositions.

Functional modals are grammatically complex. Their meanings are keyed to compositional semantics; functional modals have root meanings when computed above VP (the predicate; 22a) and epistemic meanings when computed above IP (the proposition; 22b). These compositional differences in LF scope are expected to interplay with the overt syntactic development of sentential embedding. When the child produces only simple clauses we can expect no epistemic functional modals because functional modals are interpreted as epistemic only when they scope over propositions (minimally IPs).

(22) *The baby must be fed.*

\[\begin{align*}
a. \text{The baby} & \quad \text{must}^{\text{Root}} [\text{be fed}]_{\text{VP}} & \quad \text{Root Deontic} \\
b. \text{must}^{\text{Epistemic}} [\text{the baby be fed}]_{\text{IP}} & \quad \text{Epistemic}
\end{align*}\]

I hypothesize that grammatical development (i.e. the ability to represent propositions within propositions) enables the linguistic representation of functional epistemic modality. Once we see evidence that the child can embed IPs, then we may infer that she can grammatically embed propositional content. In other words, a child who can embed sentences within sentences should be able to scope a functional modal like *must* above a proposition at LF.

Part B explores whether the child makes divergent Form ↔ Meaning mappings, as predicted by the CRP for semantics (overextensions: *Content > Root > Epistemic*) and/or for syntax (upwards re-categorizations: *\(V > v > \text{INFL}\)*). This is assessed by looking at (a) infelicitous or otherwise non-adult lexical choices suggestive of divergent meanings for particular forms (semantic overextensions), (b) developmental patterns of omissions which suggest innovative syntactic analyses (syntactic re-categorizations), and (c) frequency differences between child and input which suggest the child relies more (or less) heavily on various strategies to express her modal thoughts.

For semantic overextensions the child is expected to use premodal lexemes in root contexts that are not available in adult English, and root modals like *can* (which cover primarily root meanings) in epistemic-type contexts that are not available in adult English. These kinds of input-divergent meaning overextensions will only be noticeable in corpus data for cases which are plainly non-adult like, like the *behind* example from Bowerman (1985) (7, above).
For syntactic re-categorizations the syntactic frame in which modal lexemes appear, including functional morpheme omission patterns, will be informative for how the child is categorizing different modal lexemes. Consider the syntactic frame for INFL modals (23).

(23) Syntactic frame for INFL modals

```
[ He ]
/                     /
[ INFL ]              [ VP ]
/   must            /  go
```

Now consider the syntactic frame that little-v modals appear in (24). These modals are ungrammatical with a bare verb (the verbal complement must be infinitival). For those that require BE-support (*be going, be supposed*), it is ungrammatical to omit BE.

(24) Syntactic frame for little-v modals

```
[ He ]
/                     /
[ is ]              [ vP ]
/   v               /  VP
/     going       /   to go
```

Now consider the syntactic frames when the child omits infinitival marking and be-support for little-v modals (25). These syntactic frames are input-divergent, but they are exactly the same frames that INFL-modals appear in (26). The child’s omission patterns may show upwards recategorization of the modal class (v) to INFL, in the predicted direction. Thus omission patterns are examined to determine whether there is evidence for input-divergent re-
categorization of modal categories in the direction V > v > INFL. Note that I do not attempt to explain omissions, but re-categorization suggests that a target little v which patterns like INFL is analysed as INFL (27; and if this re-categorization survives and spreads it would be v > INFL reanalysis).

(25) Little-v modals with divergent bare complements
   a. I got [wash it] (Sarah, 3;00)
   b. I have [play now] (Sarah, 3;04)
   c. Hey, I got [watch TV] (Sarah, 3;11)

(26) INFL modals with grammatically bare complements
   a. You must [go to bed] (Sarah, 3;01)
   b. I could [hit her with my broom] (Sarah, 3;08)

(27) Upwards re-categorized analysis of input little-v modal

Finally, the child has many form options for expressing modality, at least premodals, v, INFL, ADV, and MSVs. Does the child use the same strategies as her input or do we see input-divergent frequencies of usage? This is a different kind of divergence from overextension or recategorization, because rather than showing evidence for biased innovative Form ↔ Meaning mappings, it shows usage frequency differences. These too may show directional biases in accordance with the CRP. We know that once innovative analyses occur there is a preference across speakers to use innovative structures (see Kroch, 1989; Yang, 2000; i.a.). The child may participate in usage shifts that prioritize renewing items.

This leads to the prediction that, relative to the input properties, the learner will use premodal verbs at higher frequencies with abstract root meanings, in contrast to the primarily
lexical meanings\textsuperscript{58} for premodals in the adult language. Likewise, the learner will use more little-\textit{v} modals, which are most readily associated with root meanings in the adult language, for higher-scope-taking epistemic meanings. Finally, I expect lower relative frequencies of auxiliary modals for learners (in line with Valian, 1991; Klecha et al., 2008), as this syntactic category is most readily associated with epistemic meanings that are lost (presumably due to competitive pressure from overextensions from below\textsuperscript{59}). Figure 3.3 shows this pattern of associations in the adult language (solid line) and known form-meaning mapping overextensions from historical linguistics (dotted arrows).

**Figure 3.3: Syntax-Semantics Alignments**

<table>
<thead>
<tr>
<th>Syntax</th>
<th>V</th>
<th>\textit{v}</th>
<th>INFL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantics</td>
<td>Content</td>
<td>Root</td>
<td>Epistemic</td>
</tr>
</tbody>
</table>

3.4.2. Methods

As with Study 2, this study centres on Sarah from the Brown corpus (Brown, 1973; on CHILDES, MacWhinney, 2000). Sarah’s corpus contains a total of 139 files, with 37,021 child utterances. I used the `freq` command to extract a list of all lexical items used by the child in the corpus. I examined the `freq` output and noted all modal lexemes, both lexical and functional, including all adverbs (*maybe*), little-\textit{v} modals (*have to*, *gotta*), INFL modals (*must*, *can*, *might*). I also identified a sample of premodals\textsuperscript{60} which were not studied for Sarah elsewhere (*want*, *try*, *know* (*how*), *need*) with respect to the properties of interest; these represent a small sample of premodals for direct comparison within this study. Mental state verbs (MSVs) like *think*, *hope*, and *know* (sometimes referred to epistemic attitude verbs or as cognitive verbs) were excluded from the search as they are examined elsewhere (Shatz et al., 1983; Diessel, 2004, i.a.), including for Sarah; I refer to findings of those studies where relevant.

\textsuperscript{58} Premodals (verbs that are known to become modal verbs or auxiliaries) typically denote relatively concrete mental states, or states of obligation, desire or potential acting on the subject (Lightfoot, 1979; Tollan, 2013:9).

\textsuperscript{59} The expected child distribution of modal meanings to modal forms may be under pressures of economy in acquisition (see van Gelderen, 2004, 2009, 2011), whereby the child prefers a straightforwardly compositional syntax-semantics (see Tollan & Cournane, in preparation; Tollan, 2013).

\textsuperscript{60} Most premodals (verbs with meanings known to be reanalysed as functional modals; Lightfoot, 1979; Bybee et al., 1994) are Mental State Verbs, with meanings like to know, to think.
After identifying all of Sarah’s modals (28) and choosing the subset of premodals (want, try\textsuperscript{61}, know (how), need) in all of their forms (e.g., for want: wan, wanna, want), I used kwal to extract all utterances containing the chosen lexemes from all of Sarah’s files with 5 lines of preceding and 5 lines of following discourse.

(28)   Modals identified in Sarah’s corpus
       better, can, could, may, might, must, shall, should, will, would, got to, have to, need to, ought to, be going to, be supposed to, maybe

All and only modals and premodals with verbal (including clear instances of elided VPs, e.g., MOT: Why don’t you get Pebbles and Bam_Bam? CHI: I can’t [VP get Pebbles and Bam_Bam]) or sentential complements were included in this study\textsuperscript{62}. Contextualizing discourse was used to exclude repetitions, imitations and routines (e.g., songs), and to exclude irrelevant items (e.g., nominal can, the month May).

Utterances were stored in a spreadsheet in chronological order, noting file number and line of discourse as identifying features. Sarah’s age (in months), MLU, and MLU\textsubscript{SD} were also extracted from each file. As a baseline measure to control for the variable length of each transcript file, Sarah’s # of modal expressions to total # number of utterances per file was also recorded.

Lexeme (HAVE, WANT, MUST, MAYBE, WILL, etc). The modal lexeme was coded as the bare lexical root (e.g., HAVE for hafta, have, hasta, had; WILL for won’t, will, and ’ll) allowing all forms of a lexeme to be grouped together.

Target Category (INFL, \textit{v}, V, ADV). The target category of the modal was coded as INFL, \textit{v}, ADV, or V. This is like for Study 2, except that the little-\textit{v} modals were further separated in those that must occur with to be in the adult language (be going to, be supposed to), like I *\textit{(am)} going to go, and those that do not require to be (got to, have to, ought to). These were coded separately because the target syntactic frames are distinct, thus potential input-divergence is likewise different. Furthermore, this study includes a sample of premodals. These modals are provided and divided by category in (29).

\textsuperscript{61}Try is known to be a non-MSV pre-modal that is the basis for a future marker in, for example, Inuktitut (Bybee et al., 1994).

\textsuperscript{62}Of note, exclusions included many want[NP X] which is very frequent from early on and throughout. Other modals or premodals with NP or PP complements were much rarer.
Sarah’s modal lexemes by category

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Lexemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. INFL</td>
<td>better, can, could, may, might, must, shall, should, will, would</td>
</tr>
<tr>
<td>b. Little v</td>
<td>Without BE: got to, have to, ought to With BE: be going to, be supposed to</td>
</tr>
<tr>
<td>c. Adverb</td>
<td>maybe</td>
</tr>
<tr>
<td>d. Premodal V</td>
<td>want, try, know+how, need to</td>
</tr>
</tbody>
</table>

**Modal Meaning** (Root, Future, Epistemic). This study expanded on the meaning coding system in Study 2, by dividing all Root modals into Root and Future meanings. Thus, modals were classified by flavour into: root, future, and epistemic. These three categories were chosen rather than the standard two-way split between root and epistemic because the historical Modal Cycle has shown that futures and epistemics both develop from root modality (Chapter 1). While root and future modals are all future-oriented and have circumstantial bases, future meanings (e.g., shall, gonna, will) frequently pattern later than other root meanings in the Modal Cycle (Bybee et al., 1994; Denison, 1993), often following other root meanings for the same lexeme (e.g. deontic shall → future shall). Further, future modals with inertial ordering sources (general properties of the world, like gravity, rather than bouletic; Copley, 2002) are conceptually similar to epistemic modals (see Chapter 1, §1.2.1). This may have relevance for semantic overextensions from root > future/epistemic, so it was taken into consideration.

Premodal meanings were also examined and proved to be almost exception-less. The exceptions are of interest for semantic overextensions. Premodals appear to have only one sub-flavour of root modality, unlike root modals which have multiple. For example, want is a root bouletic, try a root intention (with an “attempt” meaning as well), know how is a root ability, and need is a root obligation. On the other hand a (primarily) root modal like can has multiple root meanings (ability, circumstantial, permission).

**Semantic Confidence** (sure, unsure). To mitigate the indeterminacy of coding semantic interpretations, two precautions were taken. First, I coded for confidence level on a 2-level scale (sure/unsure). An example of an unclear epistemic is provided in (30a), and a clear one is provided in (30b). In the former the syntax (two modals, the first INFL and the second v but bare and pattern like a double-INFL modal construction), but not the context (unclear whether she is saying that it might be the case that she’s going to draw a spaceship next or whether she’s saying...
she’s able or allowed to) inform the meaning, so the epistemic code is a “best guess”. Rather, in
(30b), the syntax, the lexeme, and the context all converge on epistemic.

(30)  a.   *hey I could going make a spaceship*   (Sarah, 5;00, drawing)
b.   *might be a prize in here*   (Sarah, 5;00, looking in a cereal box)

Table 3.4 provides the rates of convergence of the linguistic evidence with the contextual
/discourse and/or setting) labelled as “sureness”. Other uses only had one thread of evidence or
required more guesswork.

<table>
<thead>
<tr>
<th>Flavour</th>
<th>% Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>80%</td>
</tr>
<tr>
<td>Future</td>
<td>85%</td>
</tr>
<tr>
<td>Epistemic</td>
<td>64%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Mean: 82%</strong></td>
</tr>
</tbody>
</table>

**Inter-coder reliability.** The second precaution, was that a sample of 100 items from random
intervals throughout the corpus were coded by a different coder to check for inter-coder
reliability; he was given the instructions I followed for myself and the resulting overlap was 93%
for main category (Root, Future, Epistemic); all 7 items which were inconsistent were
inconsistent between Root and Future (in both directions of error), which is less concerning than
if Epistemic meaning was involved because Root and Future are in the same broad category,
while epistemic is distinct (though see e.g., Rubinstein et al., 2013 for similarities between root
circumstants and epistemic).

Confidence rates are all higher than chance, even with the conservative nature in which
they were determined for each item. Uncertain items were rarely (if ever) completely impossible
to determine, they rather required more inference on the part of the coder because the context
was more opaque or the child’s utterance contained obscured or otherwise unclear components.
As such, the uncertain items (as 30a above) are included in the measures below.

I assume that markers of sentential embedding, such as infinitival-*to*, embedded subjects,
and obligatorily embedding matrix verbs, are overt, measurable evidence for the semantic ability
to embed propositions (represented by minimally IP in the syntax) below the matrix verb (c.f.,
Diessel & Tomasello, 2001). I coded for evidence of an IP projection above the second verb in a
multi-verb utterance.
Modal Complement. (BareV, V\textsubscript{INF\_REDUCED}, V\textsubscript{INF\_to}, CL). The complements to the (pre)modals extracted was coded as either a bare verb (BareV, e.g., go, eat, fall), as in (31a, 32a), infinitival reduced when the to marker is reduced to schwa (V\textsubscript{INF\_REDUCED}, as in 31b, 32b), when the to was transcribed in full (V\textsubscript{INF\_to}, as in 31c, 32c), or clausal (CL, as in 31d, 32d). A (pre)modal was considered to have a clausal complement when there was a nominal intervening between the (pre)modal and the second verb (31d).

(31)  
a. must _ go/ have _ go  
b. wanna go/ haveta go  
c. want to go/have to go  
d. want [mom to read]  

(32)  
a. BareV: I want [VP dance]  
b. V\textsubscript{INF\_REDUCED}: I wan [TP a dance] (= I wanna dance)  
c. V\textsubscript{INF\_to}: I want [TP to dance]  
d. CL: I want [TP you (to) dance]  

Many of the codes relevant to the Part B results have already been discussed: lexeme, target category, modal meaning, modal complement, and infinitival-to. One further code that is relevant for reporting input-divergent patterns: 

BE-omission (Present, Absent, DO). Two of the little v modals require the BE auxiliary, BE-going-to, and BE-supposed-to. These two modal lexemes were coded for the presence of the morpheme (33a), the absence (33b), and erroneous DO-auxiliary (33c). This code, like the modal complement code, measures rates of omissions of obligatory functional material.

(33)  
a. I’m sposta  
b. I sposta  
c. I do sposta  

3.4.3. PART A: Propositional Embedding Results

To test the grammatical hypothesis for the epistemic gap, I investigated Sarah’s development of complements to the main verb. For example, is the complement to the first (or main) verb a bare verb (want [go], want [eat]), an infinitival verb (want [to go], want [to eat]), a verb with a reduced (or cliticized) infinitival marker (wann[a go]), or a clause with a subject (want [my mom to come])? Are there significant milestones before or around age three, such as the development of IP (or CP) complements, which could trigger the epistemic representations we begin to see around age three? Evidence for IP complements to the main verb includes overt
tense marking on the embedded verb (including infinitival-to), disjoint subjects across matrix and embedded verbs. Evidence for a CP complement to the main verb includes embedded that and wh-elements. I also discuss the findings of Diessel and Tomasello (2001), and Diessel (2004) for the valuable information they provide concerning the development of MSVs and complex complementation more generally.

### 3.4.3.1 Complement development and sentential embedding

Overall Sarah uses 2496 multiple-clause utterances (e.g., with two or more verbs) including 1504 with two finite clauses, and a further 992 with a finite and a non-finite clause (Diessel, 2004:11). Diessel (2004:11) found that for the children he studied non-finite subordinate clauses occurred around 2;00 (e.g., want go). Sarah’s usage of subordinate clauses steadily climbs to approximately 5% of utterances at age four, and approximately 10% of utterances by age five.\(^{63}\)

Sarah’s first apparent embedded subjects occur at 2;10 and are somewhat ungrammatical (34a,b), but that appears to be the subject of write/came.out. Previously Sarah uses exclusively bare verbs (e.g., wan(t), goin(g)) and reduced, possibly unanalyzed, forms (e.g., wanna, gonna). The that in these sentences is also possibly related to complementizer-that, but since Sarah doesn’t use a clear complementizer-that until 3;06, it is more likely a subject. These are soon followed by a clearer example with a pronominal subject me at 2;11; this embedded subject also has a distinct reference from the matrix subject (2\(^{nd}\) person, as in an imperative).

(34)  First subjects in embedded Spec,TP  
   a.  *I want that* write on; *I want that* came out  \(\text{(Sarah 2;10)}\)  
   b.  *Watch me* do horsie  \(\text{(Sarah 2;11)}\)

Also at 2;10 Sarah begins to use infinitive-to on the second verb in utterances with two verbs (35) and infinitival-to occurs regularly (albeit optionally; see 3.4.4.3 in Part B below for graph) thereafter (see e.g., Dye, 2011 for discussion of sub-perceptual articulations of grammatical morphemes).

(35)  First infinitival-to in embedded T\(_{\text{INFINITIVE}}\)  
   *I want to see him; I have to go my wee wee*  \(\text{(Sarah 2;10)}\)

\(^{63}\) This is lower than other children in the study, she is about a year behind; others are >10% at age 4 (Diessel, 2004).
To further assess evidence for embedding, I looked for obligatorily-embedding verbs from Sarah in Diessel (2004). A few months after first embedded subjects and clear infinitivally marked embedded verbs, and less than a month after her first epistemic use of a functional modal (36), Sarah begins to use obligatory embedding verbs like think (c.f. Diessel & Tomasello, 2001, who argue that these early uses are all parenthetical) which provide further evidence for multi-clause sentences with embedded IP (minimally, no overt evidence for C as yet). In (37a) the mental state verb think (which is an epistemic lexical modal) qualifies the proposition I’m go in there, and (37b) shows the MSV know followed by he sit right here.

(36)  
*FAT: find them? [them=play dish set]  
*CHI: no. [returns without the dishes]  
*CHI: where my dishes?  
*FAT: I don’t xxx  
*CHI: must be gone  
(Sarah, 3;00)

(37)  
First obligatory embedding verbs  
a. I think I’m go in there  
(Sarah, 3;01)  
b. I know he sit right here  
(Sarah, 3;02)

To summarize thus far, the first evidence of embedded verbs taking subjects occurs at 2;10 and 2;11, at the same time that transcripts start to regularly include infinitival to marking the second verb providing evidence for I_{INF}. These developments occur in the two months prior to the first functional epistemic, at 3;00. Around the same time as the first functional epistemic, Sarah starts to use obligatorily embedding MSVs like think (3;01) and know (3;02).

Sarah uses her first wh-subject complement at 3;02 as well (38), potentially showing that she has a CP-layer in her embedded clause, though note that overt C-head elements (that, if, etc.) do not occur until later (3;06) and so this may be a wh-subject in Spec TP.

(38)  
Oh look what I did.  
(Sarah, 3;02; Diessel, 2004)

Sarah’s first overt complementizer that occurs at 3;06 (39), at a similar age to other children studied (Diessel & Tomasello, 2001). At 3;06 and 3;08 Sarah uses conditional clauses with if, presumably also representing an embedded CP (40a,b). By 3½ Sarah appears to be embedding full CP structures.

(39)  
I think that your hands are dirty  
(Sarah, 3;06)

(40)  
a. you hang it on your wall if you want to  
(Sarah, 3;06)  
b. I’m afraid he will bite me if I take him out  
(Sarah, 3;08)
Many dialects of English allow double-modal constructions with two auxiliary modals (see §1.2.3), and all dialects of English exhibit modal stacking with INFL+ and with +. Further, premodal verbs may also combine with modals (*But I want to have to*). Sarah uses 13 multi-(pre)modal sentences in the corpus (41a-m). These also begin to occur around age three (though the utterance in (42a) may contain don’t rather than won’t), and persist at a low rate throughout. Most are grammatical (especially if we ignore minor functional omissions) or marginal, but some are plainly erroneous (33j,l,m). Sarah’s functional structure is able to support three verbal elements, and also negation, by 2;10 (even if we allow that (42a) may include don’t rather than won’t).

(42) Sarah’s utterances with more than one modal

a. *I won’t [*?]* have (t)a go.* (2;10)
b. *I going ta get ta () come here xxx* (3;02)
c. *we’re go(ing) have ta put that top* (3;03)
d. *I’m going have eat it?* (3;09)
e. *I want get go out* (3;09)
f. *we’ll have to call Daddy up* (4;05)
g. *yeah, I could wish it could fly* (4;08)
h. *oh I will have to do it again* (4;09)
i. *Mama I have to need +* (4;10)
j. *I’ll better make the arms* (4;11)
k. *now I won’t have to take your thing* (4;11)
l. *but I wanna gonna take this two* (5;00)
m. *hey I could going make a spaceship* (5;00)

Mental state verbs, which are, at least in the adult language, verbs that embed clauses, begin to appear in Sarah’s corpus at 3;01 (43a). These verbs are epistemic lexical modals, and as such are dedicated epistemic markers. They occur at approximately the same time as all other epistemic strategies for Sarah (INFL, ADV, V).

(43) A selection of Sarah’s early MSV premods (data from Diessel, 2004)

a. *I think* I’m go in here (3;01)
b. *I know* he sit right here (3;02)
c. *And I think* (pause) we need dishes (3;02)
d. *Think* some toys over here too (3;03)
e. *Bet* can’t…it. (3;04)
f. *I bet* I can’t do that. (3;04)
g. *I guess* I better come… (3;05)
h. *I think* I play Jingle Bells…with the record player. (3;05)
i. *That will be me bet* you… (3;06)
j. *I wish* it’s Valentines (3;06)
In addition, recall the inertial future (Copley, 2002; Dahl, 1985) that has an inertial ordering source (44b, general properties of the world, “prediction”) as opposed to a bouletic future which has a bouletic ordering source (linked to the speaker’s wishes, 44a). The inertial future is predictive and may involve knowledge states of the speaker. Consider predicting that a cup will fall (That cup might fall!), in these cases we use epistemic markers (think (as in 44), maybe, might) and we use world knowledge (e.g., how gravity works on precariously placed objects) to predict future events. These uses collapse future prediction with epistemic reasoning. Sarah also uses her first predictive, rather than bouletic, future modal around age three, at 3;02 (45).

(44)  
I think that I will go to Harvard Square tomorrow…
  a. … I've been meaning to get some shopping done.
  b. … that's just the kind of thing I might do.  
(Copley, 2002: 81)

(45)  
so it won't fall off  
(Sarah, 3;02)

In Figure 3.4, I provide a graph of Sarah’s modal development, including all INFL, v and ADV modals divided between root meanings (the dashed line) and epistemic meanings (the solid line). The rate of modals per utterance is plotted on the y-axis and age-in-months on the x-axis. We see that root meanings occur from the beginning of the corpus and steadily rise in usage rates while epistemic meanings emerge at 3;00 (or 36 months) and remain low in frequency. Sarah’s epistemic gap is indicated, from 2;03 to 3;00. Her first occurrences of indicators of an IP layer on the second verb (sentential and thus, propositional) embedding are indicated on the graph, clustering before and approximately concurrent with her first epistemic use of a functional modal.
3.4.3.2. Discussion

Sarah’s first epistemic use of a functional modal occurs at 3;00. This use follows indications that she has developed the ability to embed sentences, and by extension propositions. In the months prior to 3;00 Sarah demonstrates the ability to represent linguistic material above an IP, and thus the ability to grammatically present scope-bearing elements above a proposition. The grammatical hypothesis predicted that this would be the case: epistemic uses of functional modals like *must* should become available as soon as the child is able to scope these modals above propositions. With similar conclusions from an experimental study, Sowalsky et. al (2009) found that two and three-year-old children were better able to attribute belief states to subjects when those states were encoded with a PP-adjunct (*according to John, X*) than when belief states were encoded with the attitude verb *think* (*John thinks that X*). It appears that grammatical complexity, namely sentential recursion, impedes the ability to represent functional epistemic modals (and related attitude verbs like *think*).

These findings are compatible with formal semantic approaches to functional modals (Hacquard, 2006). In addition, these results are generalizable as many previous studies have
demonstrated that epistemic uses of functional modals appear consistently soon after age three, and others have demonstrated that first evidence of sentential embedding (if you allow that these are true instances of embedding) occur just prior to age three (e.g., Kirjavainen et al., 2009 for infinitival-to; Diessel 2004 for subjects). The ability to embed sentences appears to be a necessary condition for epistemic representations of functional modals, like must.

The disjoint subject references, with a distinct subject for matrix and embedded clause may be particularly important for epistemic development. In (46) the imperative nature of the matrix verb shows disjoint subjects for the matrix and embedded clauses: (you) watch me do horsie. Disjoint subjects provide evidence for the child’s understanding of the semantics of embedding since the child must ascribe the two verbal events to two different agents, and to two different sentential structures (each with a distinct subject). Speculatively, when the child is presented with matrix-disjoint subjects, her understanding of perspective and intention forces her to attribute a distinctive (view-point correlated) truth-value to the embedded complement. This ability is likely critical in understanding epistemic modality, where the force of the modal is not on the subject, but rather must be linked to the speaker.

(46)  Watch me do horsie  (2;11) (VP-NP-VP)

Diessel and Tomasello (1999) and Diessel (2004) argue, contra Pinker (1984) and subsequent, that early MSVs (and other embedding verbs) do not provide evidence for sentential embedding, but are rather parenthetical. They argue that invariability of the subject (1st person or dropped) and lack of tense (always think, never thinks), as well as a lack of overt that (or other complementizers) until around 3;06, and occurrences both pre- and post- sententially (maybe he’s eating, he’s eating maybe) are all evidence that these are not cases of embedding.

(47) Parenthetical and embedding MSVs
   a. Parenthetical
      TP
      I
      Parenthetical
      CP
      I know John is happy
   b. Embedding
      TP
      I
      VP
      know
      CP
      [(that) John is happy]
While these early MSVs (and other embedding verbs) lack overt *that* until several months later (3;6, example 39 above for Sarah) they may not lack CP (or at least IP) embedded structures. Notably, the complementizer *that* is very infrequent in the input and Diessel and Tomasello (1999) do not run any statistical analysis to ascertain whether or not the early lack of *that* is an input effect (e.g., the Binomial Test for Concurrent Acquisition); adults rarely use overt *that* (Thompson & Mulac, 1991) in spoken embedded clauses, but no one would argue that adults do not have the ability to embed sentences. The finding that children develop epistemic functional modals (independently thought to require propositional embedding) soon after resolution of the epistemic gap suggests that children are actually embedding IP-sentences. Scope-bearing elements like modals are clear evidence for asymmetrical hierarchical relationships, like true subordination of clauses within clauses. The grammatical hypothesis is supported. Sarah begins using the predicted indicators of sentential embedding in the months leading up to the resolution of her epistemic gap.

### 3.4.4. PART B: Input Divergence Results

First, I provide a detailed report of Sarah’s modal uses by target category and lexeme, including frequencies for the child and the maternal input sample. This section assesses whether there are more fine-grained differences between the child and her input (e.g., certain lexemes are favoured over others), and whether the child is using the same modal strategies as her input. In other words, does the child rely on the same categories and/or lexemes to express the same modal meanings as her mother? If not, are her deviations CRP-consistent? Note that variable usage rates across lexemes does not constitute innovation (though it may be reflective of innovative analyses) but rather shifts of the socio-linguistic type.

As innovation is intimately linked to diffusion, it is of interest whether children are more reliant on newer (=lower) forms. For example, the little-*v* modals are newer in the history of English, which the child cannot know, but the child can have an internal metric whereby little-*v* modals are lower and more contentful than INFL-modals. Does the child then participate in favouring newer (lower) items? Newer items generally fare better than older items in diachronic grammar competitions (Kroch, 1989; Yang, 2000, i.a.).

To test for input-divergent child analyses I explored meanings which are deviant to assess whether they were overextended in the direction predicted by the CRP. These items were
identified as atypical during Modal Meaning coding. These items are necessarily a little subjective, as it is difficult to assess convergent adult-like meaning, let alone divergent meaning, from corpus data with impoverished context.

Finally, I also assessed omissions to determine whether the child makes input-divergent syntactic analyses. In syntactic pathways, it appears that the child needs to re-categorize a lexeme as higher in the syntactic structure (Roberts, 2010; see also Roberts & Roussou, 2003; van Gelderen, 2004, 2011). Omissions provide preliminary evidence for upwards recategorization because, for example, the syntactic frames that INFL modals appear in are more minimal than the syntactic frames that little-\(v\) modals appear in. Thus if modals which are little-\(v\) in the input are appearing in INFL frames this is evidence for an upwards re-categorization bias.

### 3.4.4.1. Input-divergent Usage Frequencies

Sarah uses (a) 1214 INFL modals, (b) 621 little-\(v\) modals, (c) 25 modal adverbs, and (d) 604 premodals, for a total of 2464 items. Her mother’s sample includes (a) 143 INFL modals, (b) 103 little-\(v\) modals, (c) 7 adverbs, and (d) 47 premodals, for a total of 300 items. I’ll discuss these target categories in turn.

**INFL.** INFL modals first appear in the corpus at 2;03 (can’\(t\)), a few weeks later than little-\(v\) modals (future going) and bouletic premodals (wanna). Excluding the premodals, INFL modals make up 1214/1860, or 65% of Sarah’s modal uses. This is in line with previous experimental research (Cournane, 2014), which also showed a prominence of INFL responses when children were prompted to use a modal.

Table 5 presents all the INFL modals used by Sarah, with the age of first occurrences in chronological order. Further, the raw counts and percentage out of all INFL modals (i.e., how many of the INFL modals are must?) are provided for both the child data and the input. For example, Sarah first uses can at 2;03 (I yyy can’t get down) and in her corpus there are 717 uses of can. Can makes up 68% of Sarah’s INFL modal uses. Her mother uses 55 instances of can in her sample of 300 INFL, \(v\), ADV, and premodals. The lexeme can represents 38% of Sarah’s mother’s INFL modals.
Table 3.5: INFL counts and percentages in child and mother

<table>
<thead>
<tr>
<th>INFL</th>
<th>First occurrence</th>
<th>Child</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td>can</td>
<td>2;03 I yyy can’t get down</td>
<td>717 (68%)</td>
<td>55 (38.46%)</td>
</tr>
<tr>
<td>will</td>
<td>2;05 won’t talk</td>
<td>369 (30%)</td>
<td>62 (43.36%)</td>
</tr>
<tr>
<td>must</td>
<td>2;09 he must talk</td>
<td>6 (0.5%)</td>
<td>1 (0.7%)</td>
</tr>
<tr>
<td>could</td>
<td>3;00 you could find em too</td>
<td>52 (4%)</td>
<td>5 (3.5%)</td>
</tr>
<tr>
<td>should</td>
<td>3;01 dem should be in dere</td>
<td>27 (2%)</td>
<td>3 (2.1%)</td>
</tr>
<tr>
<td>may</td>
<td>3;03 may look it</td>
<td>2 (0.2%)</td>
<td>1 (0.7%)</td>
</tr>
<tr>
<td>better</td>
<td>3;04 and better put this in the hand</td>
<td>27 (2%)</td>
<td>3 (2.1%)</td>
</tr>
<tr>
<td>shall</td>
<td>3;04 shall I go get him?</td>
<td>2 (0.2%)</td>
<td>1 (0.7%)</td>
</tr>
<tr>
<td>would</td>
<td>3;05 that would hurt</td>
<td>12 (1%)</td>
<td>11 (7.7%)</td>
</tr>
<tr>
<td>might</td>
<td>5;00 might be a prize in here</td>
<td>1 (0.1%)</td>
<td>1 (0.7%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1215</td>
<td>143</td>
</tr>
</tbody>
</table>

Can and will comprise 68% and 30% of all INFL uses, respectively. Together these two modals, make up nearly 90% of all the INFL modals in Sarah’s corpus. They are frequent throughout the entire corpus from the very beginning to the very end. The mother uses more will than Sarah, and rather less can, while all other INFL modals are at similar frequencies. Lower usage of will is expected given previous findings that children use significantly less will than gonna, despite exactly the opposite pattern in the input (Klecha et al., 2008; and §2.3.1). Can is typically English-learning children’s first modal, and is multi-purpose in meaning-coverage (ability, permission, possibility), perhaps helping explain its early high frequency.

On the other extreme, may, might and shall occur only once or twice each and together make up less than 1% of the whole child corpus. The two instances of may occur at 3;03 and 4;03 and both appear to have root deontic permission meanings (48). The two instances of shall (3;04 and 4;00) also both appear to have root deontic meanings, and are both questions (49). Both questions contain adult-like subject inversion. All of these four utterances were child-initiated. The final rarely-used modal auxiliary is might, which occurs only once and very late in the corpus (5;00) (50). This use follows a parental usage of would, and is very well supported by the context as a likely epistemic usage.

(48) a. CHI: may look it  
     b. CHI: ask you may I have a party?

(49) a. CHI: shall I go get him?
     b. CHI: shall I sit?

(50) CHI: might be a prize in here
While infrequent, *must* is a noteworthy case because it has clear root and epistemic uses and occurs in the corpus above overt aspect marking (Chapter 1; Chapter 4). The first occurrence of *must* (2;09) seems to be a root deontic (51a), though it is unclear from the context. The next occurrence is a near repetition (51b) and it is unclear whether Sarah is using it in an epistemic context (as her mother likely is). Finally, the third occurrence, at 3;00 is a spontaneous and epistemic-compatible use (51c). The final three uses include one possible root deontic, and two more that are adult-like epistemics both because of the context and the use of *must* above a perfect marker (′ve) (50 e,f) (Hacquard, 2006 i.a.).

(51) All instances of *must*:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>CHI: he mus(t) [?] talk.</td>
<td>(2;09)</td>
</tr>
<tr>
<td>b.</td>
<td>CHI: <em>must</em> be plane?</td>
<td>(2;11)</td>
</tr>
<tr>
<td>c.</td>
<td>CHI: <em>must</em> be gone</td>
<td>(3;00)</td>
</tr>
<tr>
<td>d.</td>
<td>CHI: yyy you mus(t) go to bed</td>
<td>(3;01)</td>
</tr>
<tr>
<td>e.</td>
<td>CHI: I <em>must've</em> lost it in the bed</td>
<td>(3;05)</td>
</tr>
<tr>
<td>f.</td>
<td>CHI: you <em>must've</em> break it and I can't fix it too good</td>
<td>(3;06)</td>
</tr>
</tbody>
</table>

In Table 3.6 I show the counts by semantic flavour within the set of INFL modals for Sarah and her maternal input sample (i.e., how many of the INFL modals express root meanings?). Sarah uses INFL modals primarily to cover root meanings, while her mother uses equal frequencies of INFL modals for root and future meanings. Both Sarah and her mother have very low frequencies of epistemic uses for INFL modals. This distribution of meanings across the set of INFL modals is represented in the Figure 3.5.

**Table 3.6: Flavour breakdown for INFL modals for child and mother**

<table>
<thead>
<tr>
<th></th>
<th>Root</th>
<th>Future</th>
<th>Epistemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child</td>
<td>885/1214 (72.9%)</td>
<td>319/1214 (26.3%)</td>
<td>10/1214 (0.8%)</td>
</tr>
<tr>
<td>Mother</td>
<td>69/143 (48.3%)</td>
<td>69/143 (48.3%)</td>
<td>5/143 (3.5%)</td>
</tr>
</tbody>
</table>

**Figure 3.5: Flavours within INFL category**
The distribution of meanings in the INFL set is significantly different between Sarah and her mother ($\chi^2 = 40.9291$, $df = 2$, $p << .001$); an examination of the residuals (Table 3.7) shows that all of the input/child contrasts have a significant contribution. The child is using auxiliaries for root meanings significantly more than the mother, likewise for epistemic meanings, and, in the opposite direction, she is using much fewer auxiliaries for future meanings. The highly significant difference in the future coverage appears to be largely due to adults using more will and children using more going to cover future meanings (Klecha et al. 2008).

**Table 3.7: Pearson residuals squared**

<table>
<thead>
<tr>
<th></th>
<th>ROOT</th>
<th>FUTURE</th>
<th>EPISTEMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHILD</td>
<td>1.164977</td>
<td>2.276859</td>
<td>0.8712568</td>
</tr>
<tr>
<td>MOTHER</td>
<td><strong>9.890085</strong></td>
<td>*<strong>19.329415</strong></td>
<td><em>7.3965435</em>*</td>
</tr>
</tbody>
</table>

Figure 3.6 shows Sarah’s development of the future markers will and gonna, which divide according to INFL (will) and little-v (gonna) category. Sarah begins with more little-v gonna and gradually uses more and more INFL will to express future meanings. Comparisons to other children learning English and the adult input (from Klecha et al., 2008), show that all children use more gonna than will, in direct opposition to adults, including Sarah’s mother (see Klecha et al., 2008), who all use more will than gonna. This represents a strong area of Form ↔ Meaning mapping divergence. Child rely more heavily on little-v gonna and adults rely more on INFL will.
Little-\(v\). Little-\(v\) modals (e.g., have to, be supposed to, be going to) first appear in the corpus at 2;03 in the second file (future going). Excluding the premodals, little-\(v\) modals make up 621/1860, or 33% of Sarah’s modal expressions (among INFL, little-\(v\), and ADV). Little-\(v\) modals are syntactically lower than the set of auxiliary modals (e.g., must, can) in the adult analysis, as evidenced by the fact that they can take tense and agreement marking (he has to go, he had to go), occur with infinitival verb complements, with to (Sally has to be able to figure-skate), and occur below INFL and ASP (Sam has been having to tidy up a lot lately). The little-\(v\) modals arose as functional modals later in the history of English than the INFL modals (see 1.2.3).

Table 3.8 presents examples of all the different little-\(v\) lexemes in the corpus including the age of first occurrences. Frequencies and percentages within the class (e.g., how many of the \(v\) modals are going?) are provided for both the child data and the input. The child data is similar to the input, except with somewhat higher counts of going and lower of have.
Table 3.8: Little-v modal counts and percentages in child and mother

<table>
<thead>
<tr>
<th>Little-v</th>
<th>First occurrence</th>
<th>Child</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td>going</td>
<td>2;03 I’m going</td>
<td>427 (69%)</td>
<td>52 (50.49%)</td>
</tr>
<tr>
<td>have</td>
<td>2;10 I have to go</td>
<td>88 (14%)</td>
<td>31 (30.1%)</td>
</tr>
<tr>
<td>get</td>
<td>3:00 I get play</td>
<td>69 (11%)</td>
<td>11 (10.68%)</td>
</tr>
<tr>
<td>supposed</td>
<td>3;05 you’re supposed</td>
<td>35 (6%)</td>
<td>9 (8.74%)</td>
</tr>
<tr>
<td>ought</td>
<td>3:08 I ought to freeze</td>
<td>1 (0.2%)</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>621</td>
<td>103</td>
</tr>
</tbody>
</table>

The future marker going is by far the most frequent little-v modal, accounting for 69% of child little-v modal utterances. Going (and variants) are more frequent than will (and variants) at 427 and 369 uses, respectively (in line with the findings of Klecha et. al 2008). The majority of uses of going appear to have a future-intentional meaning (Copley’s bouletic future). A small proportion appear to be more future-inertial (approximately 50/427, with 11 unsure (52)).

(52)  
  a. I’m gon(na) pull my back  possibly a inertial future [unsure]  
  b. wow. It gonna slip  likely a inertial future [sure]

Premodals. The pre-modal verbs selected (want, know+how, need and try) first appear in the corpus at 2;03 in the second file (wanna), at the same time as little-v modals (going), and just before modal auxiliaries (can’t). Premodals are defined as a class by being main verbs, which take a variety of complements, namely VPs, but also DPs (want, try) and/or CPs (know+how). The meaning of a premodal verb is relatively invariant, covering one type of root modality. For example, want consistently has a desire-bouletic reading when it has a DP complement (I want a cookie), a VP complement (I want to play), and a clausal complement (I want Daddy to read to me) (c.f., little-v modals which have distinct meanings with DP complements (I have a cookie) and VP complements (I have to go)). There are 605 instances of the selected premodals in Sarah’s corpus.

Sarah’s first premodal, want, occurs with a VP complement (53a), at 2;03 and, a year later at 3;03, want first occurs with a IP complement, as evidenced by an embedded subject (53b). Try first occurs at 3;02 with a VP complement (53c). A summary of Sarah’s premodals and those of her mother are provided in Table 3.9 below. Sarah’s first utterance with that premodal, and the age at which it occurred, are provided. Frequencies of the four premodals examined are consistent with the input. Want is the most frequent and is almost always

---

64 As there are many verbs which are potential premodals, notably MSVs and other Attitude verbs, the number for all premodals would be much higher (e.g., Shatz et al., 1983).
expressing a clear bouletic meaning (desire, wish); *know+how* is next most frequent and is always used to denote ability (see also Hackl, 1993); *try* is next most frequent and consistently has an intention (with some added semantics of the possibility of failure). *Need* only occurs once with a VP complement in the corpus (53d).

(53)  
a. *I wanna ride my horsie*  
b. *I want Daddy to help me*  
c. *I trying to get in back*  
d. *you need to draw?*

**Table 3.9: Premodal lexical counts for child and mother**

<table>
<thead>
<tr>
<th>Premodal</th>
<th>Age of first occurrence</th>
<th>Child</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td>want</td>
<td>2;03 <em>I wanna ride my horse</em></td>
<td>503/604 (83.28%)</td>
<td>37/47 (78.72%)</td>
</tr>
<tr>
<td>try</td>
<td>3;02 <em>I trying to get in back</em></td>
<td>30/604 (5%)</td>
<td>2/47 (4.26%)</td>
</tr>
<tr>
<td>know+how</td>
<td>3;06 <em>don’t know how open it</em></td>
<td>71/604 (11.75%)</td>
<td>8/47 (17.02%)</td>
</tr>
<tr>
<td>need</td>
<td>4;10 <em>you need to draw?</em></td>
<td>1 (0.2%)</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>605</td>
<td>47</td>
</tr>
</tbody>
</table>

When all syntactic categories are compared (Table 3.10), we see that the distribution of types for Sarah and her mother are significantly different ($\chi^2 = 21.5546$, $df = 3$, $p << .001$) between the child and the input. This is represented visually in Figure 3.7. An examination of the residuals reveals that the only cell with a significant contribution is the child’s use of premodal Vs, which is higher than expected given the input (R= 7.9215279). The little-\(v\) contribution approaches significance (R=7.5876403) and is lower than expected.

**Table 3.10: Counts by syntactic category for child and mother**

<table>
<thead>
<tr>
<th></th>
<th>INFL</th>
<th>v</th>
<th>V</th>
<th>ADV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child</td>
<td>1214</td>
<td>621</td>
<td>604</td>
<td>25</td>
</tr>
<tr>
<td>Mother</td>
<td>143</td>
<td>103</td>
<td>47</td>
<td>7</td>
</tr>
</tbody>
</table>

**Figure 3.7: Counts by syntactic category by group**
3.4.4.2. Overextensions

There were very few items in the corpus with clearly atypical, or divergent, meanings. Most items that were input-divergent involved omissions or grammatical errors of commission (Snyder, 2007). Meaning-divergent items were often impossible to parse because they included several errors, and at the same time, were one-off instances of a particular error; this suggests both performance issues for Sarah and unintelligible speech which is difficult to transcribe accurately.

The only consistent meaning-type divergent pattern was with *want*. (54) illustrates Sarah’s atypical uses of *want*. In the adult language *want* is a premodal with a consistent desire-bouletic meaning. In diachrony, bouletic modals are known to become reanalysed as general root modals (covering more root meanings, often future), for example Eng. *will*, Dutch *willan* (Bybee et al., 1994 for more examples).

(54) Sarah’s atypical uses of *want*
   a. *I want fit in there?* (2;08) Root Circumstantial?
   b. *I want hold dat?* (3;00) Root Deontic?
   c. *I’m wanna get some water* (3;02) Root/Future Intention?
   d. *want put that on there?* (3;06) Root Deontic?

It is possible that Sarah is using *want* in these utterances with a convergent adult bouletic meaning and the context of usage is just not as expected for an adult speaker. However, the question intonation is unexpected for bouletic meanings about the self (54a-c have first-person subjects), but is natural with ability/circumstantial (54a) and deontic permission uses (54b,d). These three uses (54a,b,d) are made more licit, to my mind, by swapping *can* for *want*, the meaning becomes adultlike if we use the adult means of expressing ability or permission (*can*). The remaining use (54c) is in a divergent syntactic frame and the context is more consistent with a future meaning, as covered by *gonna* in the adult language (it is possible this is a transcription error because *gonna* and *wanna* sound somewhat similar). These few anecdotal examples all show extensions of *want* into the semantic space covered by full-fledged modals.

3.4.4.3. Re-categorizations

This section reports input-divergent syntactic properties of Sarah’s modal utterances. I focus on premodals and little-ν modals, because these occur in divergent frames, while INFL modals only take bare verb complements in the input and likewise the child uses bare verbs from
earliest uses and remains target for INFL modals (with a few anecdotal exceptions discussed below).

As discussed above, the complement type for the premodals and little-\(v\) modals varies among the following types: bare (=a divergent Root Infinitive, e.g. want go, have go\)\(^{65}\), infinitival and reduced (e.g., wanna, gotta), infinitival and full (e.g., have to, want to), and clausal (e.g., want me do horsie?). Here I present the different rates of resolution of divergent bare complements between premodals (V) and little-\(v\) modals.

INFL modals are virtually always followed by bare complements, or elided complements (e.g., I can't) in Sarah’s data, in line with the input. Those that are not expected, include the only unusually tense/aspect-marked complements in the corpus: divergent present agreement (55a), divergent past tense (55b-e), divergent progressive (55f), and finally, an illicit instance of double modals (55g). All of these occur in the latter half of the corpus.

(55) \begin{align*}
a. & \quad \text{that will means} & (3;06) \\
b. & \quad \text{I can't pushed it} & (3;06) \\
c. & \quad \text{I can't found it} & (4;05) \\
d. & \quad \text{you should saw it!} & (4;08) \\
e. & \quad \text{he will wound it up} & (4;10) \\
f. & \quad \text{how come I can't putting on here?} & (5;00) \\
g. & \quad \text{hey I could going make a spaceship} & (5;00) \\
\end{align*}

The premodals studied are a sample of Sarah’s verbal development. The complements that they take begin almost exclusively bare (root infinitival), but over time bare complements gradually give way to reduced infinitives (tryna, wanna), infinitivals (to V), and finally clausal complements (overt subject for embedded verb). The development of each complement type for premodals is shown in Figure 3.8.

\(^{65}\) Compare with the convergently bare verbal complements to INFL modals (e.g. the verb that follows a modal auxiliary is obligatorily bare, He must run/be tired/fall often)
When we look at the complements of the premodals (Figure 3.8) we see a steady decline in root infinitives with concurrent rise in infinitival-marked and reduced infinitival (e.g., wanna), and clausal complements. In summary, the erroneous elements gradually gave way to the grammatical. The same measure, albeit without the clausal complement possibility, shows a different pattern for little-v modal complements. Little-v modals maintain bare complements, in fact showing a growing proportion of bare complements relative to total number of utterances, over the entire corpus (Figure 3.9). Infinitival – full and reduced – appear at the same time, soon before three years old, and also grow in frequency over time.
In Figures 3.8 and 3.9, the “Bare” graph shows the proportion of bare verbal complements, ungrammatical in the adult-language (=input-divergent) for both premodals and little-v modals. For premodals these bare verbs drop over time, giving way to grammatical complement types (e.g., wanna V, want to V, want IP/CP). For little-v modals, they actually grow, at a very similar slope to the reduced infinitivals (gonna, hafta). As premodal syntactic frames become gradually more convergent with the adult language, the little-v modals continue to pattern – at least some of the time – with the INFL modals in the following frame: [(Subj) modal V_{BARE}].

Further to the persistent presence of bare verb complements, little-v modals also show persistent omissions (and some errors of commission) of the functional material that precedes them, BE. The presence or absence of overt BE for those little-v modals which require BE (going, supposed) was recorded, including several divergent uses of do in the place of BE. Resolution of BE-omission for little-v modals is relatively late compared to other BE-omissions, e.g., simple progressives like *to be running* (Brown, 1973), copular contexts like *He is tall* (Becker, 2000, 2002). Be-going-to could be considered a progressive, as it comes from a progressive, but only those instances with future meaning (and not those with only a motion path meaning) were coded, and these are less clearly progressives in the current language (Klecha et
al., 2008; c.f. Copley, 2002). Further, be supposed to is not a progressive and never was, and it patterns similarly to be going to in Sarah’s corpus.

**Figure 3.10: BE-omissions for going and supposed by month**

In Figure 3.10, we see that Sarah shows development towards more overt BE (as required) (solid line) and less omissions (long dash line), but omissions remain more frequent than overt BE until after 3;06, and continue to occur through to the end of corpus.

*Supposed*, often pronounced more like *(s)posed*, is one of the little-ν modals which requires BE. It first occurs late (at 3;05), and all 35 uses appear to have root deontic meanings (5/35 unsure). *Suppose* occurs without a form of be in 19 utterances from 3;05-5;00 (e.g., 56a,b), not including a further seven examples which erroneously occur with do-support (rather than expected to be), across a time span of ten months (4;03-5;01). Erroneous do-for-be instances of be supposed to emerge at 4;03, very late in the corpus; all of these occur with supposed (57). In sum, 26 of the 35 instances (74%) occur without BE. *Going* shows similar development (58), at much higher rates except without any do-support errors.

(56) a. supposed to be there. You. (3;06)  
    b. I supposed to? (4;02)
(57)  a. does it (sup)posed to be like brown?  (4;03)
b. does a mouth (sup)osed to be right dere?  (4;05)
c. but I don’t (sup)osed be like that  (4;05)
d. does she (sup)osed to go home at +  (4;06)
e. I am going fly a kite but I don’t supposed to make a hole there do I?  (4;08)
f. do you supposed to put this around shoulders?  (5;00)
g. do they supposed to go down?  (5;01)

(58)  a. I goin touch it  (3;00)
b. he gonna break it  (3;10)
c. but I not going tell you now  (4;11)

It appears that Sarah remains unclear as to the light-v status of modals like gonna, gotta, and hafta, for longer than for the premodals (primarily wanna, but also tryna, know how, and need) (c.f. Diessel, 2004, following Bloom, Tackeff, & Lahey, 1984:297), who argues that wanna and hafta pattern together,\(^66\); and with Valian, 1991 who finds that subjects pattern differently with INFL and v showing distinct categories). Persistence of both bare verbal complements and BE-omission are promising findings for the CRP because they show the set of little-v modals patterning with the INFL modals for a protracted period of time, potentially showing the child as analyzing the little-v modals as higher up the tree than they are in the adult language. As the child appears to be in an optional-infinitive and optional-BE stage, one possibility is that she has both a gonna_\text{INFL} and a gonna_v in completion, as with grammars in competition in diachrony (Kroch, 1989; see Yang, 2000 for a related discussion).

3.4.4.4. Discussion.

In terms of usage frequencies by category, overall it appears that the child is relying more on INFL modals and premodals (within the set studied), while the mother is relying more on INFL modals and little-v modals. The mother is using the two highest syntactic categories to cover most of the modal space, while the child is using the highest (and most frequent, INFL)

\(^66\) Wanna and hafta, Diessel argues, in line with Bloom, Tackeff and Lahey (1984:297) ‘function to express the child’s mood of wish or intention’. He says, “the occurrence of bare infinitives is characteristic of modals such as can and must, with which wanna and hafta are semantically closely related.” (Diessel, 2004: 63). He notes that wanna and hafta cannot be fronted and require do-support when negated, and thus are matrix verbs. Like modal auxiliaries though, he says, they take bare infinitives. However, they only take bare infinitives if we analyse the second syllable as part of the verb, rather than contracted to. I’ve shown that if we differentiate between complement types, want behaves differently from have. It is likely that early uses of contracted to are unanalyzed. Further, while wanna and hafta pattern the same in some respects, they are distinct in others. Want is characterized as a verb, while have is a functional verb, or v (see §1.2.3 for details).
and the lowest (the renewing items, which are premodal). We have additional evidence, based on
delayed bare complement resolution in the little-v modals, that the child may be treating little-vs
as patternning with the INFL modals. This is further suggested by the heavy reliance on little-v
gonna over INFL will for future meanings. This may mean that the child is differentiating less
between the INFL modals and the little-v modals than the input; this is further suggested by
protracted BE-drop in those little-v elements that require BE.

Sarah uses INFL modals at high frequencies throughout the entire corpus. Her usage rates
are similar to the input, except for can which is higher and will which is lower. The meanings
that INFL modals cover in the input are significantly different from those they cover in the child
language: the mother uses INFL modals (primarily will) to cover future meanings and the child
uses INFL modals (primarily can) to cover root meanings (related to higher use of can and lower
of will in the lexical comparison above). Sarah uses gonna significantly more than the older
future marker INFL will, despite will being more frequent in the input. The child’s high use of
gonna (over will) for the semantic space of future may demonstrate “recruiting from below” in
the renewal cycle for the CRP (c.f. Klecha et al., 2008’s analysis of the low frequency of will,
where they argue that will is more complex due to contextual requirements67).

For overextensions, Sarah generally doesn’t show many meaning divergent uses, at least
not which are clear from a corpus with minimal context (see Cournane, 2014 for an experimental
approach; Chapter 2). Sarah does use premodal want with verbal complements at higher
frequencies than in the input (more verbal-selection for want), and with a handful of erroneous
uses that are in line with full-fledged modal overextensions from premodal > root modal. These
are consistent with the first semantic overextension from one root meaning (bouletic in this case)
to general root meanings.

In terms of evidence for syntactic recategorization, the most compelling findings concern
little-v modals. Sarah uses these with bare complements for longer than expected (as compared
to the premodal want and general expectations for gradual disappearance of root infinitives),
leading to little-v modals patterning with INFL modals and suggesting that the child treats little-v
modals as higher than they are in the input.

67 Both of these suggestions may be true, for example the child may recruit from below because lower elements are
(usually) more contentful and have more transparent meanings.
Why is it that the child resolves erroneous root infinitives for the verbal elements but not for the light-v elements? The set of INFL modals obligatorily take a bare verb complement, so when the child produces a bare verbal complement with a input little-v modal (59, left), it patterns with the higher INFL category (59, right).

(59) Re-categorization of little-v modals as INFL

\[
\begin{array}{c}
\text{He} \\
\text{is} \\
\text{vP} \\
\text{v} \\
\text{going} \\
\text{VP} \\
\text{to go} \\
\text{INFL} \\
\text{spose} \\
\text{go}
\end{array}
\]

In §3.1.1 I argued that in cases of syntactic recategorization the structure is also altered, reanalysis will only occur when the resultant modal-containing sentences (like the tree on the right) preserve the meaningful features present in the input (e.g., a modal possibility feature, a main verbal event, an agent). Sarah begins, like all children, with functional omissions.

### 3.5. Discussion & Conclusion

This chapter covered three studies, addressing the following research questions:

**Study 1:**

I. *Does the epistemic gap apply to all modals, or only to functional modals (e.g., must, could)?*

II. *Do children use epistemic adverbs (e.g., maybe, probably) in appropriate contexts during their epistemic gap?*

**Study 2:**

III. *Is the order of acquisition from root > epistemic explained by the relative frequencies of root and epistemic modal meanings?*

IV. *Are root and epistemic modals used at the same relative frequency as in the input?*
Study 3:

V. Does naturalistic evidence show that the resolution of the functional epistemic gap is linked to the development of propositional embedding?

VI. Do input-divergent form-to-meaning mappings show patterns of semantic overextension or syntactic upwards re-categorization, as predicted by the CRP?

In Study 1, we found that children use epistemic-type adverbs in epistemic compatible contexts during their epistemic gap (defined as in previous studies by using only canonical functional modals). These early epistemic-modals mostly qualify physical events rather than inner states. Conceptual development does not straightforwardly capture these facts, contra the Conceptual Hypothesis.

In Study 2, I addressed the role of relative usage frequencies (between root and epistemic meanings) and input frequency in the modal development pathway, showing that frequency effects do not explain the epistemic gap nor the lower than expected frequency of epistemic modals relative to the input. The child relies heavily on epistemic adverbs to express her epistemic meanings. The binomial test for concurrent acquisition shows that Sarah’s epistemic uses are delayed relative to root uses, and a $\chi^2$ comparing input meanings and child meanings shows that epistemic uses remain lower than expected post resolution of the EG. The frequency hypothesis does not explain the developmental differences between root and epistemic meanings, nor why epistemic meanings remain lower than expected.

In Study 3, I addressed grammatical development. First, I showed that the epistemic gap is best explained by grammatical development. Evidence for the grammatical ability to embed sentences within sentences appears in the months immediately preceding resolution of the epistemic gap. This ability is predicted to precede epistemic uses of functional modals because these uses (and not their root counterparts) scope over propositions (grammatical represented by minimally IPs) (Hacquard, 2006, i.a.). Furthermore, there is a lack of a clear corresponding ToM milestone for a major event at three years old (see de Villiers, 2007), but the development of IP embedding is generalizable across children to sometime after 2;08 (e.g., Bloom et al., 1984; Diessel, 2004, and citations therein).

With reference to the Epistemic Gap, I have argued that the Epistemic Gap reported in the literature is best explained by grammatical development, contra the dominant position that conceptual development in the area of ToM triggers epistemic meanings. The EG appears to only apply to functional modals like must or have (to), unsurprisingly as this set of modals has
received pride of place in the modality literature and previous L1A studies. The strongest conclusion is that children possess the ability to perform epistemic reasoning as early as two years. Dedicated epistemic markers, like the lexical modals *maybe* and *probably* do not need to be grammatically bound and thus allow children who are grammatical constrained to nonetheless express their (fledgling) epistemic thoughts. After sentential embedding develops, a functional modal like *must* can be bound in its epistemic position.

However, these strong claims must be tempered and further research is necessary to ascertain the semantic nature of early lexical modals like *maybe*. Whether early uses of *maybe* and *probably* are fully adultlike epistemic modals is impossible to ascertain satisfactorily from corpus data alone, especially for syntactically flexible elements like adverbs which are easy to use and very difficult to use erroneously. Studies on Mental State Verbs (*think, know, guess*) suggest children also rely on these for early epistemic-type thoughts (Shatz et al., 1983; Diessel & Tomasello, 2001; Diessel, 2004), albeit only after they can embed sentences (around age three for Sarah). Children may therefore prefer to use dedicated epistemic markers (=lexical is preferred to functional) early in development. Explicit mental state references increase and become productive after 3;06, several months after the resolutions of the EG.

The Epistemic Gap exists not as a line between no epistemic meanings and the onset of epistemic meanings, but rather as a line between dedicated epistemic modals (ADV, like *maybe*) and the onset of epistemic uses of polysemous modals (INFL, like *must*). We observe an asymmetrical development between root and epistemic meanings for functional modals, where root > epistemic. Grammatical development best explains the observed asymmetry between root uses of functional modals and epistemic uses of those same modals. The contributions of conceptual (ToM) development do not define the timespan of the epistemic gap for functional modals and appear unable to explain the lexical-functional developmental asymmetry seen for epistemic meanings. These findings are compatible with a formal distinction between lexical and functional modals (Hacquard, 2013), and with the general pattern of lexical > functional development in children. Sarah’s grammatical and modal meaning milestones are given in Table 3.11.
Study 3 also addressed grammatical development in another way. I looked for evidence for divergent Form ↔ Meaning mappings in the child language. This included meaning overextensions, syntactic re-categorizations and the distribution of the meanings relative to forms (category and lexemes that make up that category).

There were a few anecdotal examples for the premodal want patterning as though its meaning had overextended to root ability or permission. In terms of usage rates Sarah relies more heavily on want+VP than in the input, that is, on want with the same frame that the v modals (e.g., going, got, have) occur in. The largest difference in distributions of meanings by form between Sarah and her mother is in the domain of future meanings; Sarah, like other children, uses more going than will, while her mother, like other adults, uses more will than gonna.

The most compelling input divergent properties are the persistent omission of infinitival marking and be-support on little-v modals. These omissions cause the little-v modals to arguably occur in the same frames as the current set of INFL modals. One possibility is that the omitted functional categories are indeed not present, but rather the child analyses both target INFL and v as the same. This would be an early analysis of an immature grammar; if the interim analysis is convergent with the meaning of the input string, the evidence to complexify her analysis is weak – largely vacuous and largely phonologically reduced morphemes like BE and to. Granted Sarah does acquire these morphemes but continues to use Root Infinitive and omit-BE and high rates (rising for the latter). This may constitute competing analyses within the child’s grammar (c.f. competing grammars in diachrony, Kroch, 1989; Yang, 1999, 2000).
In conclusion, the naturalistic data has shown that modal development is best explained through the lens of grammatical development, the same lens we have established is the best way to view the diachronic modal cycle. Child learning biases can be viewed as products of the natural productivity creating processes of meaning extension and syntactic categorization. These learning processes readily produce input-divergent analyses which most of the time resolve, but under the right conditions will survive to become the innovations in the historical record.
Chapter 4: Exploring the role of aspect in cueing modal meanings

4.1. Introduction

This chapter presents two experimental studies investigating (a) whether children attend to grammatical cues from aspect marking to determine the meaning of the functional modal must, and (b) whether children attend to the evidential difference between a proposition p and the same proposition modalized must p (see Von Fintel & Gillies, 2010). The first study is labelled the Modal Flavour Task because it contrasts deontic interpretations with epistemic, and the second is labelled the Modal Detection Task because it contrasts modalized and plain sentences. This chapter reports ongoing work and as such the results and analyses presented are preliminary.

The motivation for the Modal Flavour task lies in the fact that the functional modal must has both root and epistemic meanings in the input language and the child must figure out how these meanings are distributed on the basis of the relevant grammatical cues and extra-grammatical contextual cues (see Chapter 1, §1.2.2). This task tests child interpretations of must-sentences with bare complements (1a) and with aspect-marked complements (1b,c) using a picture-choice task. I expect that the temporal-orientation shift triggered by aspect-marking provides children with evidence for epistemic interpretations of functional modals.

(1) a. Doggy must [eat his dogfood]bare (future-oriented: obligation)
   b. Doggy must [have eaten his dogfood]perfect (past-oriented: inference)
   c. Doggy must [be eating his dogfood]progressive (present-oriented: inference)

Recall that the basic kernel of meaning for modality is that which is necessary or possible, but not actual (or known to be actual). In future-oriented sentences (1a), the temporal unfolding of the event described by the proposition p has yet to occur (or complete) so there are both p worlds and ¬p worlds (Diversity Condition\(^{68}\), Condoravdi, 2002), so in the actual world the force of the modal may still apply and an obligation reading is strong. Bare verbs are used in English in non-actual sentences, for example imperatives (2a) and root modalities (2b; compare with Root Infinitives, e.g., Weverink, 1989; Wexler, 1994; Hoekstra & Hyams, 1998; Pratt & Grinstead, 2007). Modals, like must, select a state represented by a bare predicate. The bare

---

\(^{68}\) The Diversity Condition requires that modal operators applied to a prejacent p be interpreted against a diversity of modal bases, i.e. there must be both p and ¬p-worlds in the background (Condoravdi, 2002).
predicate is not temporally anchored, and so the event applies at a non-actual time and it is by default interpreted as a root modal (an epistemic reading is also possible in the future).

(2)  

a. *Go to bed! Eat your breakfast!*

b. *You must go to bed! You gotta eat your breakfast!*

On the other hand, epistemic meanings generally associate with past and present tenses, as in (1b,c), because epistemic reasoning is the only modal reasoning available in these otherwise actual temporal/aspectual eventualities; any ¬p worlds are relegated to mental states or depend on the availability of evidence (see Condoravdi, 2002). Perfects and progressives take non-stative verbal events (3a) and return states (3b). *Must* selects the state represented by the aspect marker, and the verbal predicate. As events with perfect and progressive marking are past or present oriented by default, when *must* selects an aspect-marked complement it is by default interpreted as an epistemic. Past and present orientation precludes the analysis of *must* as deontic because the actual world is settled; there are only p or ¬p worlds in the present or past, not both.

(3)  

a. \([\text{go to bed}]_{\text{NON-STATIVE}}\)

b. He [has \(\text{gone to bed}]_{\text{STATIVE}}\); He [is \(\text{going to bed}]_{\text{STATIVE}}\)

In sum, for the modal structures with *must* under investigation the bare complement is most compatible with future oriented root modalities like obligation, while the aspect-marked complements are most compatible with past- and present-oriented epistemic interpretations. *Must* interacts with tense and aspect to determine its flavour.

In this chapter, I present a study to test the development of functional modal interpretations with both bare complements and aspect-marked complements (progressive and perfect) in preschool English learners and adults. The goals are (a) to explore whether children attend to aspectual cues to determine the meaning of functional modals like *must*, and (b) to determine whether children differ from adults with respect to root or epistemic interpretations of *must*-sentences of each type (bare, perfect, progressive).

This study is situated within the approach to modality discussed in Chapter 1 (Hacquard, 2006, 2010; Ramchand, 2012). A central assumption is that the meanings of functional modals are primarily determined by grammatical factors, such as tense, aspect and the aktionsart of the main verb because these modals have an event variable which must be bound by either Aspect

---

69 Manipulating the sentence further, or providing the right kind of context, can shift the temporal orientation for any of the sentences in (1) to change the modal interpretations (i.e., adding the temporal adverbial clause by this evening to (1b) shifts the temporal orientation to the future and opens up a deontic reading).
(Asp^0) or the Speech-Act (C^0) event (see Percus, 2000). Root interpretations for must arise when the modal is bound by Asp^0 (4a) just above the VP, and epistemic interpretations arise when the modal is bound by C^0 (4b), above IP. The presence of aspect marking keys an epistemic interpretation because Asp^0 is below the modal, leaving the modal to be bound by the higher C^0.

(4)  
a.  must (eat his dogfood) = root, no embedded proposition  
    … [Asp_e1 must_e1 [eat his dogfood]_VP]_AspP

b.  must (Doggy eat his dogfood) = epistemic, embedded proposition  
    [C_e0 ... must_e0 [Doggy be eating his dogfood]_IP]_CP

The study in Chapter 3 shows that Hacquard (2006)’s predictions for the naturalistic development of modal meanings were borne out. Children develop the ability to syntactically embed propositions right before the epistemic interpretations of functional modals like must become available. Only functional modals exhibit the epistemic gap, not dedicated epistemic modal adverbs like maybe and probably, a finding which challenges the conceptual hypothesis for this gap (e.g., Papafragou, 1998) and supports a complexity based approach, following Hacquard’s theory of modal representation wherein epistemic interpretations of functional modals rely on more complex structural representations than root interpretations.

Resolution of the epistemic gap provides the representational possibility for epistemic uses/interpretations of functional modals, but it does not provide the child with evidence for when a functional modal is root and when it is epistemic (see §3.4.3. for a discussion on epistemic cueing from disjoint subjects). This study explores the nature of this evidence (see also Dudley et al., 2015 for an approach with attitude verbs think and know). Hacquard’s theory predicts that grammatical evidence should help children determine: (a) that certain modal expressions are functional while others are not (e.g., lexical modals), and (b) that the interpretations (root vs. epistemic) of these modals are grammatically principled (Hacquard, 2013). The experiments presented in this chapter speak to the latter prediction.

In the Modal Flavour task, participants hear sentences with the functional modal must followed by a bare verb complement (5a: Modal-only sentence) or by an aspect-marked complement, with perfect (5b: Modal-Aspect sentence (Perfect)) or progressive (5c; Modal-Aspect sentence (Progressive)). In short, this study contrasts sentences with a modal and no aspect marking [+Mod, -Asp] to sentences with both a modal and aspect marking [+Mod, +Asp]. The former are expected to elicit deontic interpretations while the latter are expected to elicit epistemic interpretations.
(5) a. Modal-only sentence: *Michelle must [swim]bare*
   b. Modal-Aspect sentence (Perfect): *Doggy must [have eaten his dogfood]perfect*
   c. Modal-Aspect sentence (Progressive): *Michelle must [be swimming]progressive*

The Modal Detection task was conducted to verify whether children understand that aspect marking alone (e.g., *is eating*) is different from modal and aspect marking together (e.g., *must be eating*). This is important for two reasons, first to verify that children are not only attending to the complement of *must* in the Modal Flavour task (e.g., relying only on *be eating* vs *eat*; or *have taken* vs. *take* without computing the modal). And second, to explore whether children understand that the difference between a proposition *p* and the same proposition modalized as *must p* is an evidential difference (§1.2.1). Epistemic *must* has an evidential component, and as such *must* signals that the speaker is making an indirect inference based on available evidence (Von Fintel & Gillies, 2010; see also Westmoreland, 1995).

Von Fintel and Gillies (2010) argue that *must* has a presupposition of indirect evidence[^70], but otherwise sentences with *must* have the same strength as unmodalized sentences. Consider the bare prejacent *is raining* (*φ*) and the modalized prejacent *must be raining* (*must φ*). The quantificational treatment of modals predicts that the latter is stronger than the former because *must φ* entails *φ*. This logical conclusion, however, goes against the intuition that speakers use *φ* when they are more confident, and *must φ* when they are somehow less confident (e.g., Karttunen, 1972; Groenendijk & Stokhof, 1975; Lyons, 1977; Kratzer, 1991). Von Fintel and Gillies (2010) argue that when speakers use *must φ* they are as strongly committed to the prejacent as when speakers use *φ*. The difference in interpretation is not due to strength, but to type of evidence. Epistemic modals express inferences based on evidence or reasoning (or both).

Von Fintel and Gillies (2010)'s proposal contrasts with other approaches which try to account for the tension between the logical prediction that *must φ* entails *φ*, and the intuition that *must φ* is weaker than *φ*. Under these approaches *must* does not contribute to the truth conditions of the sentence (Frege; Westmoreland, 1995)[^71], or additional machinery is necessary to truth-

[^70]: This is not strictly true, rather, *must* “comes with a presupposition that neither the prejacent nor its negation is known through direct evidence or trustworthy reports” (Von Fintel & Gillies, 2010:22). So if Jane sees people arriving wet into a windowless room, she can say “It must be raining” since she doesn’t have direct evidence that it is raining (e.g., a window showing the rain), nor direct evidence that it’s not raining (e.g., a window showing sunshine). This distinction becomes relevant when epistemic modals are embedded under negation.

[^71]: Papafragou (2006) and Von Fintel and Gillies (2010), among others, provide evidence that *must* contributes to the truth-conditions.
conditionally weaken *must* relative to the bare prejacent (Kratzer, 1991) or strengthen the prejacent relative to the modalized prejacent (Veltman, 1985).

The following scenarios lay the foundations for the Modal Detection task. In (6) the speaker looks out the window and sees direct visual evidence that it is raining. She can say (6a), but she cannot say (6b). The modalized sentence is illicit in this direct-evidence scenario because *must* carries the presupposition that the evidence for the prejacent is indirect evidence. In (7), the speaker cannot see outside. Instead she sees people with wet rain gear and knows that rain is the only possible cause. In this indirect-evidence scenario the speaker can say either (7a) or (7b), depending on whether she chooses to signal the indirect evidence source or not. Indirectness is not weakness, but rather a different evidence source.

(6) [Seeing the pouring rain]
   a. It’s raining.
   b. ?? It must be raining. (Von Fintel & Gillies, 2010)

(7) [Seeing wet rain gear and knowing rain is the only possible cause]
   a. It’s raining.
   b. It must be raining. (Von Fintel and Gillies, 2010)

*Must* is licensed if and only if it is presupposed that the evidence for the prejacent is indirect. Children are known to have difficulty with both presuppositional content and with indirect evidential markers (Aksu-Koç, 1988; de Villiers et al. 2009; Rett & Hyams, 2014), thus they are expected to have difficulty with *must*’s evidential component.

Participants assigned to the Modal Detection task heard sentences with both *must* and aspect-marking [+Mod, +Asp] (8,a,b), in contrast to sentences with no modal and overt aspect-marking [-Mod, +Asp] (8,c,d). The interpretational difference is that the presence of the modal requires that the picture context depict a scene where there is only indirect evidence for the proposition. For the epistemic/evidential interpretation, speakers may choose to either express that with *must* or to forego the evidential marker, but for the Actual interpretation speakers can only use the aspect-only sentences (Von Fintel & Gillies, 2010:3).

(8)   a. Modal-Aspect sentence (Perfect):  Doggy *must* [have eaten his dogfood] _perfect_
   b. Modal-Aspect sentence (Progressive): *Michelle* *must* [be swimming] _progressive_
   c. Aspect-only sentence (Perfect):  Doggy [has eaten his dogfood] _perfect_
   d. Aspect-only sentence (Progressive): *Michelle* [is swimming] _progressive_
Taken together, the studies in this chapter center on two dimensions of the [+Mod, +Asp] sentence (e.g., *Scott must be wearing his boots*) which gives rise to epistemic interpretations, in relation to sentences with both TAM markers separately: (a) just the modal marker [+Mod, -Asp] (e.g., *Scott must wear his boots*), or (b) just the aspect marker [-Mod, +Asp] (e.g., *Scott is wearing his boots*)\(^2\). The tasks and how they are related is summarised in Table 4.1.

### Table 4.1: Relationship between the two tasks of the study

<table>
<thead>
<tr>
<th>Sentence → Task</th>
<th>+Mod, -Asp</th>
<th>+Mod, +Asp</th>
<th>-Mod, +Asp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavour Task</td>
<td>Michelle must swim</td>
<td>Michelle must be swimming</td>
<td>Michelle must be swimming</td>
</tr>
<tr>
<td>Detection Task</td>
<td>Michelle must be swimming</td>
<td>Michelle is swimming</td>
<td></td>
</tr>
<tr>
<td>Target Pictures</td>
<td><img src="#" alt="Image 1" /></td>
<td><img src="#" alt="Image 2" /></td>
<td><img src="#" alt="Image 3" /></td>
</tr>
</tbody>
</table>

This chapter is organized as follows: first, I present a picture norming study that preceded the studies. Second, I present the first experiment, the Modal Flavour task. Third, I present the Modal Detection task. Finally, I conclude by discussing the results in light of modal theory and modal developmental pathways in acquisition and diachrony.

### 4.2. Preliminary Picture Norming

The two studies in this chapter require pictures which clearly disambiguate the two possible interpretations of a sentence. I conducted a preliminary picture norming study in order to measure how appropriate each picture was for the test sentences. Subsequently, results were used to improve the test pictures. This step was deemed necessary for two reasons, (a) *must* is a functional modal whose meaning is determined largely by its grammatical context, but context of utterance (in this case the story introduction and the evidence available in the pictures) is also a variable which must be controlled as much as possible, and (b) the epistemic interpretation of *must* is evidential in nature, meaning that it is licensed in normal usage only when there is evidence to make a strong indirect inference (e.g., *Scott must be wearing his boots*), but not so

\(^2\) The sentence with neither marker [-Mod, -Asp] could be the simple present (e.g., *Scott wears his boots*) or simple past (e.g., *Scott wore his boots*) in English and was not tested.
much evidence as to uniformly forego the modal altogether and produce a actual sentence (e.g., *Scott is wearing his boots*). For each picture intended to depict epistemic scenarios, it was critical to ensure that just enough visual evidence was available to license the use of *must*, but not so much evidence as to lead participants to prefer the competitor actual sentence.

### 4.2.1. Methods

I designed twenty-four stories, each with a triplet of test sentences, as in (9). For each story, the three test sentences all had the same subject (e.g., *Scott*) and basic predicate (e.g., *wear his boots*) that were modified to include *must* (9a,b) or aspect-marking (9b,c). Further, an introductory sentence or two was used to present each story (10). The stories were either progressive (ongoing) or perfect (past) stories. This introduction sought to provide context suitable for all of the three test sentences.

(9)  
| a. Modal-only sentence: | *Scott must* wear his boots. | [+Mod, -Asp] |
| b. Modal-Aspect sentence (Progressive): | *Scott must be* wearing his boots. | [+Mod, +Asp] |
| c. Aspect-only sentence (Progressive): | *Scott is* wearing his boots. | [-Mod, +Asp] |

All predicates included only activity or accomplishment verbs (*wash, wear, eat, get*, etc.) because these pattern with deontic readings in (9a)-type sentences and epistemic readings in (9b)-type sentences (see Ramchand, 2012). Stative verbs were avoided because they receive epistemic readings with bare complements (e.g., *John must like Mary*) and are awkward with the progressive (*?John must be liking Mary*).

(10) *This is Scott, he wants to play outside in the rain but he doesn’t want to wear any clothes!*  

Each story required four pictures, one for the introductory sentence and one for each of the three test sentences (Figure 4.1). Picture A illustrates the introductory sentence in (10). The three subsequent pictures depict the target interpretations for each test sentence: Picture B shows the deontic target interpretation for sentence (9a), Picture C shows the epistemic target interpretation for sentence (9b), and finally, Picture D depicts the Actual target interpretations for sentence (9c). In the Actual picture the modal-aspect sentence should be at least odd if not illicit.
Section 4.1: The four picture-types involved in each story

This formula was repeated for all 24 stories, yielding 96 pictures, of which 24 were introduction pictures and 72 were the test pictures under evaluation. All stories included a deontic “Picture B” as target for the [+MOD, -ASP] sentence, an epistemic “Picture C” as target for the [+MOD, +ASP] sentence, and a target actual “Picture D” for the [-MOD, +ASP] sentence.

For each test picture, adult participants were asked to rate all three test sentences on a Likert scale from 1-4, as shown in Figure 4.2. For example, if the participant saw the introductory picture and blurb for the story in Figure 4.1, followed by the deontic Picture B, he would then rate how well Picture B illustrated Scott must wear his boots (9a), Scott must be wearing his boots (9b), and Scott is wearing his boots (9c). This yielded a score for each picture for the sentence it was drawn to illustrate as well as for both competitor sentences. Ideally, a picture is rated as optimal (see “4” in Figure 4.2) for the target sentence, and both competitor sentences receive low ratings.

Section 4.2: The Likert scale given to the participant to judge each sentence

| 1 This picture doesn’t illustrate this sentence | 2 This picture is somewhat odd with this sentence | 3 This picture is almost good with this sentence | 4 This picture illustrates this sentence well |

Figure 4.2: The Likert scale given to the participant to judge each sentence
Pictures were counterbalanced across stories, so that each adult saw only one of the three test pictures for each of the 24 stories. There were three versions of the norming task all with the same order of stories. Each version had 8 deontic pictures, 8 epistemic pictures, and 8 actual pictures in a random order. Each version was compiled into full-colour booklets and participants scored the pictures by hand in scoring booklets.

A total of 72 pictures (3 pictures x 24 stories) were submitted to a norming study by 21 adult native speakers of English from the Greater Toronto Area. Each adult saw 24 test pictures and scored all three test sentences for each picture (72 sentences per participant). Each picture was scored 7 times.

4.2.2. Results

The deontic pictures were nearly all successful depictions of the target sentence with modal *must* followed by a bare complement (e.g., *Scott must wear his boots*). In 20/24 of the stories, the deontic pictures were scored on average with a 4 for the target sentence, and a 1 for both competitor sentences. This is the ideal scoring situation. Only one deontic picture was problematic; the target modal-only sentence elicited a lower average score than both the modal-aspect and aspect-only sentences. Despite *must* being usually epistemic in natural usage in Toronto English, where speakers prefer *have to* to express strong deontic claims (Tagliamonte & D’Arcy, 2007), speakers nonetheless prefer deontic interpretations of sentences where *must* precedes a bare complement.

For only 5/24 of the epistemic pictures was the target modal-aspect sentence (*Scott must be wearing his boots*) rated highest. In these 5 stories, the target sentence received a 4, but the aspect-only sentence (*Scott is wearing his boots*) was close behind, with a median rating of 3 (= “This picture is almost good with this sentence”). On the other hand, with the exception of only 3 stories, the epistemic pictures were successful at eliciting a higher score for the [+Mod, +Asp] sentence (e.g., *Scott must be wearing his boots*) than the modal-only sentence (*Scott must wear his boots*) that is target for deontic pictures. This is a good sign for the Modal Flavour task, which tests the Deontic vs. Epistemic contrast: adult speakers of Toronto English rate the modal-

---

73 Fond (2003) had the same root-biased results for English *must* and Spanish *deber* followed by non-aspect marked complements, with both child and adult speakers. Both *must* and *deber* are uncommon in natural usage with root readings; *have to* and *tener que* are used instead. I take this as further evidence that its primarily the grammatical properties of the sentence which determine the meaning of a polysemous modal, rather than frequency effects or extra-linguistic context.
aspect sentences consistently higher for epistemic over deontic interpretations. This is evidence that the pictures are successfully aligning with epistemic or deontic interpretations as needed.

However, for the Modal Detection task, the results show that distinguishing modal+aspect from aspect-only is difficult. For these epistemic pictures, the aspect-only progressive (Scott is wearing his boots) and perfect sentences (Doggy has eaten his dogfood) often received a higher score than the modal progressive (Scott must be wearing his boots) and modal perfect (Doggy must be eating his dogfood) target sentences. The aspect-only sentences received higher median ratings than the target modal-aspect sentences for 11/24 of the pictures and the same scores for 5/24 pictures. The participants in general, for both the epistemic and actual pictures, preferred the aspect-only sentences. The aspect-only sentence is licit with both direct and indirect evidence, so this is not surprising (Von Fintel & Gillies, 2010).

The actual pictures were overall successful in receiving the highest median ratings for the target aspect-only sentences (Scott is wearing his boots). Aspect-only sentences received the highest score (Med = 4) in 21/24 of the stories. In the majority of successful cases the target sentence received a 4 while the modal-aspect sentence (Scott must be wearing his boots) was not far behind with a 3 (“This sentence is almost good with this picture”); participants found these sentences only somewhat odd likely because while they use an indirect evidence marker (must) to make a claim for which there is direct evidence (i.e., saying Hansel and Gretel must be hiding behind the curtains when you can see them hiding), the claim is still the right claim. The contrast is present between epistemic and actual pictures, but the magnitude of this contrast is small.

Picture scores were used to select: (a) which stories should be discarded, and (b) which pictures required modifications before the experimental phase. When examined by story, only three stories received the highest scores for the respective target sentences of all three pictures. These pictures accompanied by their target sentences are shown in Table 4.2. These stories all have in common that in the epistemic picture there is no remaining visual presence of the subject of the story. For example, when one of my pre-norming consultants saw the earliest version of the epistemic “Swimming Story” picture, the consultant rated the epistemic picture as a 2 for the target sentence. He said that because a small piece of Michelle’s foot was visible, he knew she was swimming and must was therefore unlicensed. In other words the foot counted as direct visual evidence. Her foot was removed from the visual evidence for the norming study, and the
result was the ideal median rating of 4. This shows how a small amount of evidence can dramatically shift speaker judgements.

**Table 4.2: The three stories which elicited the most distinct ratings for target sentences**

<table>
<thead>
<tr>
<th>Story</th>
<th>Introduction</th>
<th>Deontic</th>
<th>Epistemic</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Fox Story”</td>
<td><em>The fox sees a rabbit!</em></td>
<td><em>The rabbit must jump the fence.</em></td>
<td><em>The rabbit must have jumped the fence.</em></td>
<td><em>The rabbit has jumped the fence.</em></td>
</tr>
<tr>
<td>“Swimming Story”</td>
<td><em>This is Michelle and her mom. Michelle doesn’t know how to swim yet.</em></td>
<td><em>Michelle must swim.</em></td>
<td><em>Michelle must be swimming.</em></td>
<td><em>Michelle is swimming.</em></td>
</tr>
<tr>
<td>“Boots Story”</td>
<td><em>This is Scott, he wants to play outside in the rain but he doesn’t want to wear any clothes!</em></td>
<td><em>Scott must wear his boots.</em></td>
<td><em>Scott must be wearing his boots.</em></td>
<td><em>Scott is wearing his boots.</em></td>
</tr>
</tbody>
</table>

In the majority of cases, only the epistemic picture was problematic. In these stories, the epistemic picture elicited acceptances for both modal-aspect sentences (*Scott must be wearing his boots*) and the aspect-only sentences (*Scott is wearing his boots*). Epistemic pictures were adjusted for those items in which both modal-aspect and aspect-only sentences elicited equal ratings, or the epistemic picture was scored lower by only 1 for the target modal-aspect sentence. Eight items did not fit these criteria and were discarded from the study.

---

74 This sentence only received a 3, although both competitors received a 1. It appears to have lacked drama, so following norming it was altered slightly, to include a dynamic looking fox and more action lines.
4.2.3. Post-norming adjustments

A total of 18/72 (25%) pictures were modified following the norming phase. Picture adjustments were conducted to improve scores for their target sentences. Adjustments took one of four forms, (a) removal of visual evidence from the epistemic picture to make the inference from visual evidence more indirect and improve the epistemic–actual contrast (12/72 pictures), (b) improving the actual picture to include more direct visual evidence and increase the epistemic–actual contrast (4/72 pictures), (c) improving the deontic picture to increase the visual sense of imperative/obligation (2/72 pictures), and (d) switching a picture from one aspectual condition to the other (e.g., from progressive to perfect) because this was deemed post-norming to fit better with the story (2/72 pictures).

4.3. Experiment 1: Modal flavour task
4.3.1. Questions and Hypothesis

The Modal Flavour task tests the development of sentences with must followed by a bare complement (*The rabbit must [jump the fence]*) in comparison to sentences with must followed by an aspect-marked complement (*The rabbit must [have jumped the fence]*)). The former are default deontic and the latter are default epistemic. The goal was to contrast deontic flavour interpretations with epistemic flavour interpretations of the functional modal must.

The research questions are:

- Do children use aspectual cues to determine the meaning of functional modals like must?
- Do children differ from adults with respect to root or epistemic interpretations of must-sentences of each type (bare, perfect, progressive)?

Hypotheses for the Modal Flavour task are the following,

I. **Aspect-Detection and Deontic-Bias Hypothesis:** *Three-year-old children will detect aspect as an epistemic trigger, but will exhibit an overall deontic bias.*

From soon after three years old, children will exhibit clear sensitivity to aspect marking because these children have (at least the beginning of) propositional embedding and thus epistemic interpretations of functional modals (see Chapters 2 and 3). However, we expect that children at age three will prefer deontic readings for all sentences with must, regardless of the

---

75 These also involved altering the epistemic picture to include minimal evidence, so these 2 pictures are also listed under modification type (a).
presence or absence of aspect marking. Young children have been shown to exhibit a root-bias both for usage (e.g., “Sarah” in Chapter 3) and comprehension (e.g., Fond, 2003; Heizmann, 2006), preferring root interpretations of functional modals whenever both interpretations are available in the context. In short, three-year-olds are expected to access epistemic meanings for must but to nonetheless prefer deontic readings more than adults, exhibiting a root-bias.

For younger three-year-olds this may be because they have not yet acquired the epistemic position for functional modals and only a root interpretation is possible (see §3.4.3); for most three-year-olds however, a preference for deontic interpretations of must is expected because children exhibit a root bias even following the acquisition of the epistemic position for functional modals (e.g, the resolution of the epistemic gap) (see §3.3; Fond, 2003; Heizmann, 2006). Three-year-olds rely more on dedicated epistemic markers (adverbs and mental state verbs) to express epistemic meanings, and use functional modals even more sparingly than adults (see Chapter 3). The post-epistemic-gap root bias may be because young children have not yet determined what grammatical and extra-grammatical conditions govern the interpretation of functional modals, so they are cautious with epistemic uses (c.f. Snyder, 2007). This is exacerbated by the lower frequency of epistemic uses in the input.

II. **Epistemic Bias Hypothesis:** *From four years old onward children will begin to treat must as primarily epistemic.*

Children will begin to pattern like adults, gradually selecting more and more epistemic contexts to illustrate the aspect-marked sentences, and deontic contexts to illustrate those sentences with must followed by a bare verb. Since children exhibit a root bias even following resolution of the epistemic gap, if it is correct that children drive the semantic modal cycle they need to do a full conversion to an epistemic bias in later development. In four-year-olds we expect the root bias to gradually resolve towards the adult-pattern, however, in five-year-olds we expect divergence from the input in the form of an intensified epistemic bias for must at rates higher than adults. The critical sentences are those with must followed by the bare complement (*Doggy must eat the dogfood*); in adults these elicit a root interpretation, even in a dialect like Toronto English which primarily uses have to express deontic obligation (Tagliamonte & D’Arcy, 2007).

As the child approaches age six, she is expected to show full polysemy for must including overextensions in the direction predicted by diachrony, such that the contribution of must is by
default computed as epistemic even with the bare complement (Doggy must eat the dogfood)\textsuperscript{76}. This prediction comes from the Child Reanalysis Proposal (CRP): if child modal overextensions drive the semantic modal cycle\textsuperscript{77}, then we expect that older children will choose epistemic interpretations for functional modals more readily than adults do, thus driving (a) root \textgreater epistemic meaning innovations (Modal\textsubscript{Root} \textgreater Modal\textsubscript{Epistemic}) and frequency shifts (|\textsubscript{root} and \textuparrow\textsuperscript{epistemic} uses, as seen with must in all dialects currently, according to sociolinguistic studies (Tagliamonte & D’Arcy, 2007, i.a.) and, (b) the ultimate loss of root interpretations for functional modals (as seen in the history of might, for example, which is currently overwhelmingly epistemic in usage; Hacquard & Wellwood, 2012). This finding would provide additional experimental evidence for biased modal acquisition in keeping with the Child Reanalysis Proposal (c.f. Cournane, 2014).

\textbf{III. Perfect Advantage Hypothesis:} Children will asymmetrically use aspectual cues from perfect and progressive marking to determine the meaning of must.

Finally, we expect that not all aspectual cues are equal. The Perfect Advantage Hypothesis predicts that young children will interpret perfect-marked sentences with must as epistemic earlier than progressive-marked counterparts. The perfect may reliably cue the temporal-shift for epistemic interpretations earlier than the progressive because of conflation with past tense (see Condoravdi, 2002 “modals for the past”, all those modals with modal+have). If children think perfect marking makes the modal prejacent [+PAST], then perfect is distinct from both present progressive marking and bare complements, which are both [-PAST]. For

\textsuperscript{76}This is technically grammatical for adult speakers, however examples which argue this is grammatical always illustrate the reading with a because-clause (or adverbial) to shift reference to a habitual reading, e.g., Doggy must eat his dogfood...because his coat is looking shiny. It is unclear whether the bare complement can license an epistemic interpretation as-is, without overt aspect-shifters in the sentence or salient in the context/discourse. However, considering might we know that this epistemic-only interpretation can arise diachronically.

\textsuperscript{77}The causal mechanism underlying this epistemic-bias is possibly a preference for surface scope (direct syntax-semantics alignment): once the child understands the role of aspect, she learns that must is always realized above aspect, facilitating the loss of root readings across all realizations of must, even when aspect is not overtly marked (the final stage of the modal cycle where functional modals become increasingly epistemic-restricted, like in the history of might; Bybee et al., 1994; Tagliamonte & D’Arcy, 2007; i.a.). The surface-scope isomorphism preference has been shown to be inaccurate for determining the relative scope between two scope-bearing elements (Gualmini et al., 2008). Children are capable of both scope-relationships from early on, and pragmatics factors explain the earlier observation that children lack inverse-scope. However, children do still exhibit a weak-bias (Gualmini et al., 2008). Further, functional modals have two possible scope positions, irrespective of other scope-bearing elements, thus the findings may differ from scope-interaction studies. I explore this relationship elsewhere by means of an examination of diachronic syntax-semantics (mis)alignments across the West Germanic family, Courane and Tollan (in preparation). Our goal is to determine whether the observed pathways for modal words could be explained by learner biases towards surface scope. This study takes a weak syntax-first view of diachronic change. That is, syntactic category reanalysis (i.e. V to INFL in English) accelerates the semantic Modal Cycle.
adults, the progressive aligns with a present-tense epistemic interpretation (e.g., Michelle must be swimming), however, young children might treat present progressive and future-oriented bare complements uniformly as propositions where the modal is still free to direct its force in the actual world (deontic) since they are [-PAST], as opposed to just mental domains (epistemic) (more unequivocally forced for [+PAST] prejacents). If this hypothesis is correct, we should see children first understanding the perfect as cueing epistemic interpretations. In other words, perfect aspect marking should be a superior trigger for epistemic interpretations of must.

Overall, three-year-olds will choose a higher proportion of deontic pictures for both modal sentences with and without aspect marking. All the children, except perhaps the youngest, are expected to accept epistemic readings as well, just at lower frequencies than for older children and adults. Epistemic-interpretation frequencies for aspect-marked sentences are expected to rise steadily. Children older than four years are expected to exhibit adult-like epistemic interpretations for aspect-marked sentences, in both aspect conditions. In addition, older children are also hypothesized to exhibit an increasing epistemic bias, choosing a higher proportion of epistemic interpretations for modal-only sentences than do adults; if these children show an epistemic bias it constitutes a divergence pattern in the direction of changes observed in the modal cycle.

I expect that even the youngest children will show a difference in epistemic-picture choice rates between modal-only sentences and modal-aspect sentences. This difference will be in the context of an overall root bias. Thus three-year-olds are expected to choose mostly deontic pictures, but to choose epistemic pictures more often when they hear the modal-aspect sentence. Four-year-olds are expected to show a transition from overall root-bias to overall epistemic-bias, and to continue to exhibit relatively higher epistemic picture choices for the modal-aspect sentences. Five-year-olds will show a pronounced epistemic bias, with both modal-only and modal-aspect sentences triggering primarily epistemic meanings. The modal-aspect sentences will continue to show relatively higher epistemic pictures choice rates, because the aspect-marking is an additional cue for epistemic meaning. Adults are expected to exhibit a clear difference between the rates of epistemic picture choice across sentence types. Adults will choose almost all epistemic pictures for modal-aspect sentences, and mostly deontic pictures for modal-only sentences, in line with the predictions for the role of bare complements versus aspect-marked complements in modal interpretations.
4.3.2 Methods

4.3.2.1. Participants

The participants for the Modal Flavour task were 21 monolingual-English, typically-developing children and 8 dialect-matched adults. The children were divided into three age groups, 3;01 to 3;11 (n = 8, M = 3;06), 4;00 to 4;10 (n = 7, M = 4;04) and 5;00 to 5;07 (n = 6, M = 5;04). Two children were excluded, one was bilingual and one failed to choose between the pictures after the first two training items. Children were recruited both by word of mouth and through daycares and kindergartens in downtown Toronto. Adults were recruited through posters at the University of Toronto. Adult controls were screened to ensure that they were from the same speech community as the target group, with no L2 learning until after age seven and with current English dominance. This was a between subjects design, so participants recruited either complete the Modal Flavour task or the Modal Detection task.

4.3.2.2. Materials

The Modal Flavour task is a picture preference task. Participants were invited to play a game with a character, “Penguin”, presented on a laptop using a program written in MatLab. Penguin holds a blue book (Figure 4.3), which she reads from. Penguin introduces herself and the book in the first slide, “Hi! I’m Penguin! My friend made me a book with lots of little stories – I’m going to show you some!”. Penguin speaks via pre-recorded audio files that are aligned with picture changes.

**Figure 4.3: Penguin and her book**

First the participant is presented with three training stories. For the first story the picture is presented at the same time as Penguin says, “Look! Bananas!” (Figure 4.4). The participant is
prompted by the experimenter to point to the page of the book (left or right) which “Penguin was looking at”. This training item begins to prime the participant to pay attention to visual evidence.

**Figure 4.4: First training item**

![Image](image.png)

The remaining two training items follow the format of the rest of the task (with simpler examples), which is as follows. The participant sees an introductory picture (Figure 4.5-1), and hears Penguin provide an introductory sentence or two (for this item, “This is Jada. She likes to play in the mud, but she also likes to be clean”). Then Penguin turns the book towards herself and turns the page (a page-turning noise plays) (Figure 4.5-2). With the book facing herself, Penguin says the test sentence, for example the modal-only target sentence, “Jada must take a bath”\(^78\). The sentences were pre-recorded using natural neutral prosody. Penguin then turns the book back towards the participant saying, “See look!” (Figure 4.5-3). The participant sees two pictures, and the experimenter prompts, “Penguin said, ‘Jada must take a bath’ – which picture was Penguin looking at?”. This format allows the participant to hear and process the test sentence prior to being presented with two images of which one is more likely to align with the interpretation the participant has already formed. The prompt encourages the participant to point to the picture that best fits his or her interpretation and the experimenter records this selection by either hitting the left or right arrow key.

**Figure 4.5: Sequence of pictures for a story**

![Image](image2.png)

\(^{78}\) The other half of the participants heard the epistemic target sentence, *Jada must have taken a bath.*
For the story presented in Figure 4.6, the participant is prompted to choose between the picture of Jada covered in mud (here, on the left) and the picture of Jada wearing her pyjamas with wet hair and a bathroom visible in the background. The target picture for the modal-only sentence is the deontic picture, while the target picture for the modal-aspect sentence is the epistemic picture, as shown in Figure 4.6.

**Figure 4.6: Target pictures for each test-sentence**

If the child interprets the sentence *Jada must take a bath* as an obligation, then she will select the picture where Jada has not yet taken a bath. If this sentence is interpreted as epistemic, she will select the picture where Jada is clean. If the child hears *Jada must have taken a bath* then she is expected to select the picture where Jada is clean and there is evidence that she took a bath (bathtub visible in background). The child may also interpret this sentence as deontic if she understands *must* as an obligation and either (a) ignores the aspect marking on the complement, or (b) attends to the aspect marking but cannot compute it in combination with the modal. After the child responded the experimenter sometimes asked, “How do you know it was that picture?” to add interest and naturalness to the task, as well as to potentially garner more insight into why the child made the selection she made. Child responses to these questions were noted.

Presentation of items was organized and randomized using MatLab. The recipe was as follows: each participant saw 3 training items, followed by 16 test items and 8 fillers. The first post-training item was always one of the filler items to give the children a little more practice with a more complex item prior to seeing the test items. The fillers consisted of recursive vs. flat structure PPs (e.g., *The woman [with the baby [with the hat]]* vs. *The woman [with the baby] [with the hat]*), and inverse vs. surface scope, respectively (e.g., *Every cat is not singing; ¬ >
Every vs. Every > –). These item types were considered of comparable complexity as the test sentences and gave rise to two possible imageable interpretations.

Of the 16 test items, 8 were from progressive aspect stories and 8 were from perfect aspect stories. Every participant saw the same 16 stories, however, (i) the order of presentation of stories and fillers was fully randomized (barring the first item which was always one of the fillers), (ii) whether the target picture was on the left or right of the book was also fully randomized, and finally, (iii) whether the participant heard the [+Mod, -Asp] sentence or the [+Mod, +Asp] sentence was also randomized with the constraint that overall the participant heard 4 [+Mod, -Asp] sentences and 4 [+Mod, +Asp] for each aspect-type. The design is summarized in Table 4.3.

**Table 4.3: Modal Flavour Task Design (2x2)**

<table>
<thead>
<tr>
<th>Test Sentence → Aspect Condition</th>
<th>Modal Only</th>
<th>Modal and Aspect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 Sentence</td>
<td>4 Sentences</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>“Jada must take a bath”</td>
<td>“Jada must have taken a bath”</td>
<td>8</td>
</tr>
<tr>
<td>Progressive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 Sentences</td>
<td>4 Sentences</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>“Scott must wear his boots”</td>
<td>“Scott must be wearing his boots”</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>

4.3.3. Results

Figure 4.7 shows average counts of epistemic picture choices by sentence condition for all groups (three-year-olds, four-year-olds, five-year-olds, adults), ordered from youngest to oldest. The dark grey bar shows the epistemic picture choices for the modal-aspect condition. The light grey bar shows the epistemic picture choices for the modal-only condition. Figure 4.8 shows epistemic picture choices for sentences in the perfect condition only (e.g., Jada must’ve taken a bath; half of the 8 modal-aspect sentences). In Figure 4.9, we see epistemic picture choices for all groups for only the progressive condition (e.g., Michelle must be swimming; the other half of the 8 modal-aspect sentences). Significance notation in Figures 4.7, 4.8 and 4.9 originate from the mixed-effects logistic regressions for the child and adult data, in Tables 4.4 and 4.5, respectively.
Figure 4.7: Epistemic picture choices by condition by group

![Bar chart showing epistemic picture choices by condition and group for different age groups (3yos, 4yos, 5yos, Adults). The chart compares Modal Aspect and Modal conditions. The x-axis represents the groups, and the y-axis represents the average of epistemic responses. Significant differences are indicated with stars (** and ***). (*) indicates a significant difference in the Perfect Condition.]

Figure 4.8: Epistemic picture choices by condition by group, Perfect Condition

![Bar chart showing epistemic picture choices for the Perfect Condition. The chart compares Modal Aspect and Modal conditions for 3yos, 4yos, 5yos, and Adults. Significant differences are indicated with stars (* and ***). (*) indicates a significant difference.]

---

155
The data in Figure 4.7 shows that adult participants (n=8) behaved as expected. We see that for the 8 modal-aspect sentences heard by each adult, they chose the epistemic picture on average 7/8 times. For the modal-only sentences, adults chose the epistemic picture on average 3/8 times. There was a highly significant main effect of sentence type for adults (Table 4.4). Of the adult participants, 7/8 showed the expected contrast; these 7 adults chose more epistemic pictures for the modal-aspect condition than for the modal-only condition. Of note, there was more variance in the modal-only condition, with a range between 0 and 8 epistemic picture choices. These numbers are in line with the semantics of the modal-only and the modal-aspect sentences, whereby the latter more strongly associates with an epistemic interpretation. Adults show no difference between perfect and progressive aspects with respect to picture choice in the modal-aspect condition (Figure 4.8, Figure 4.9).

Table 4.4 presents the mixed effect logistic regression results for the adult Modal Flavour Task data. We see from the output that there is a main effect of sentence condition (modal-only, modal-aspect), such that adults are much more likely to pick epistemic pictures when they hear the modal-aspect sentence. Further, the intercept shows that adults are overall more likely to
choose epistemic pictures. There is no significant effect of aspect type (perfect, progressive), nor any significant interaction.

Table 4.4 (ADULTS): Mixed effects logistic regression testing the fixed effects of SENTENCE (modal_aspect, modal), ASPECT (perfect, progressive), and their interaction and the random intercepts of PARTICIPANT and ITEM, for the selection of epistemic pictures. Treatment sum coding. Coefficients reported in log odds.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.992</td>
<td>0.478</td>
<td>2.075</td>
<td>0.038*</td>
</tr>
<tr>
<td>SENTENCE (modal_aspect)</td>
<td>1.634</td>
<td>0.321</td>
<td>5.096</td>
<td>3.47e-07***</td>
</tr>
<tr>
<td>ASPECT (perfect)</td>
<td>0.128</td>
<td>0.300</td>
<td>0.427</td>
<td>0.670</td>
</tr>
<tr>
<td>SENTENCE:ASPECT</td>
<td>0.455</td>
<td>0.279</td>
<td>1.628</td>
<td>0.103</td>
</tr>
</tbody>
</table>

Random intercepts:

<table>
<thead>
<tr>
<th></th>
<th>Variance</th>
<th>N=</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARTICIPANT</td>
<td>=1.036</td>
<td>9</td>
</tr>
<tr>
<td>ITEM</td>
<td>=0.226</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 4.5 presents the mixed effect logistic regression results for the child Modal Flavour Task data. This data was modelled with three-year-olds as the comparison group, so the other child groups (AGEGROUP4, AGEGROUP5) show development contrasted with the three-year-olds. For three-year-olds there is a marginal effect of sentence condition, such that they are somewhat more likely to pick epistemic pictures in the modal-aspect condition. Likewise, there is a marginal effect for three-year-olds such that they are more likely to pick epistemic pictures in the perfect aspect condition (Figure 4.8 and 4.9 above). The five-year-old group are significantly more likely to pick epistemic pictures than the three-year-olds, showing a shift towards a significant epistemic bias. The other marginally significant finding is the interaction between aspect and AGEGROUP4. What we see is the four-year-olds show more epistemic choices for progressive sentences than three-year-olds (Figure 4.9). The last significant effect is the interaction between SENTENCE:ASPECT:AGEGROUP5. This interaction shows that five-year-olds reverse the trend from the three-year-olds: while three-year-olds pick the most epistemic pictures in the perfect condition of the modal-aspect sentences, five-year-olds pick the most epistemic pictures in the perfect condition of the modal-only sentences (compare Figures 4.8. and 4.9).
Table 4.5 (CHILDREN): Mixed effects logistic regression testing the fixed effects of SENTENCE (modal_aspect, modal), ASPECT (perfect, progressive), AGEGROUP (3, 4, 5; reference level = 3) and their interactions and the random intercepts of PARTICIPANT and ITEM, for the selection of epistemic pictures. Treatment sum coding (contrast coding for AGEGROUP). Coefficients reported in log odds.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.428</td>
<td>0.384</td>
<td>-1.114</td>
<td>0.265</td>
</tr>
<tr>
<td>SENTENCE (modal_aspect)</td>
<td>0.360</td>
<td>0.189</td>
<td>1.905</td>
<td>0.057</td>
</tr>
<tr>
<td>ASPECT (perfect)</td>
<td>0.362</td>
<td>0.188</td>
<td>1.932</td>
<td>0.053</td>
</tr>
<tr>
<td>AGEGROUP4</td>
<td>0.744</td>
<td>0.508</td>
<td>1.464</td>
<td>0.143</td>
</tr>
<tr>
<td>AGEGROUP5</td>
<td>1.922</td>
<td>0.612</td>
<td>3.141</td>
<td>0.002**</td>
</tr>
<tr>
<td>SENTENCE:AGEGROUP4</td>
<td>0.279</td>
<td>0.188</td>
<td>1.483</td>
<td>0.138</td>
</tr>
<tr>
<td>SENTENCE:AGEGROUP5</td>
<td>-0.352</td>
<td>0.359</td>
<td>-0.983</td>
<td>0.326</td>
</tr>
<tr>
<td>ASPECT:AGEGROUP4</td>
<td>-0.474</td>
<td>0.279</td>
<td>-1.699</td>
<td>0.089</td>
</tr>
<tr>
<td>ASPECT:AGEGROUP5</td>
<td>0.062</td>
<td>0.356</td>
<td>0.173</td>
<td>0.863</td>
</tr>
<tr>
<td>SENTENCE:ASPECT:AGEGROUP4</td>
<td>0.125</td>
<td>0.282</td>
<td>0.442</td>
<td>0.659</td>
</tr>
<tr>
<td>SENTENCE:ASPECT:AGEGROUP5</td>
<td>-0.821</td>
<td>0.362</td>
<td>-2.270</td>
<td>0.023*</td>
</tr>
</tbody>
</table>

Random intercepts:

<table>
<thead>
<tr>
<th></th>
<th>Variance =0.756, N= 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARTICIPANT</td>
<td>Variance =0.228, N= 16</td>
</tr>
</tbody>
</table>

Three-year-olds (n=9) chose significantly more deontic pictures with modal-only sentences. Three-year-old participants chose the epistemic picture on average 4/8 times when they heard the modal-aspect sentences, thus three-year-olds appear to be at chance for epistemic picture choices for modal-aspect sentences, but when compared to the modal-only sentences they are picking more epistemic pictures for modal-aspect sentences. For the modal-only sentences, three-year-olds chose the epistemic picture on average 2.6/8 times. Among the participants, 6/9 exhibited the expected contrast by choose more epistemic pictures for the modal-aspect sentences than the modal-only sentences. Of these 6 children, 5 chose 2+ more epistemic pictures for the perfect marked sentences than for the modal-only sentences. Of note, variance for three-year-olds participants is less than for adults in the modal-only condition, three-year-olds ranged between 1 and 4 epistemic picture choices when they heard modal-only sentences.

Four-year-olds (n=8) chose, on average, more epistemic pictures with modal-aspect sentences than with modal-only sentences. Overall they chose more epistemic pictures than three-year olds. Four-year-old participants chose the epistemic picture on average 5/8 times when they heard the modal-aspect sentences. For the modal-only sentences, four-year-olds chose the epistemic picture on average about 3.575/8 times. Of the four-year-old participants, 5/8
showed a stronger preference for epistemic pictures in the modal-aspect condition. Of note, variance for four-year-olds participants is more than for three-year-olds and for adults. In the modal-aspect condition, four-year-olds ranged between 3 and 8 epistemic picture choices. In the modal-only condition, they range between 0 and 7 epistemic picture choices. An example of a follow-up justification is given in (11). This child chose the epistemic picture for the modal-only sentence, and then pointed out the bootprints as his justification. All of the four-year-old participants pick more or equal number of epistemic pictures in the modal-aspect condition.

(11) Follow up question with 4-year-old, Boots Story (Progressive)
Test Sentence: Modal-only, “Scott must wear his boots”
[Child picked non-target Epistemic picture]
   a. Exp: How do you know Penguin was looking at that picture?
   b. Child: because there’s the boots [points to bootprints in mud]

Five-year-olds (n=5) chose, on average, more epistemic pictures with modal-aspect sentences than with modal-only sentences. Overall they chose significantly more epistemic pictures than both three and four-year-olds. Five-year-old participants chose the epistemic picture on average 6/8 times when they heard the modal-aspect sentences, approaching adult-like rates (7/8). For the modal-only sentences, five-year-olds chose the epistemic picture on average about 6/8 times, at almost the same rate as for modal-aspect pictures. The significant difference in epistemic picture choice counts between modal-aspect and modal-only sentences disappears with the five-year-olds.

Among five-year-old participants, only 2/5 chose more epistemic pictures in the modal-aspect condition than the modal-only condition. Variance for five-year-olds participants is low, as these children show an across-the-board epistemic bias. Epistemic picture choices rise for both conditions. In the modal-aspect condition, five-year-olds ranged between 5 and 8 epistemic picture choices; in the modal-only condition, between 4 and 8 epistemic picture choices. An example of a child’s justification when asked why they chose an epistemic picture for the test sentence “Iryna must wash herself” is provided in (12). There is no difference between aspect-conditions.

(12) Follow up question with a five-year-old, Washing Story (Progressive)
Test Sentence: Modal-only, “Iryna must wash herself”
[Child picked non-target Epistemic picture]
   a. Exp: How do you know Penguin was looking at that picture?
   b. Child: I can’t see her. She’s in the water and her clothes is on the floor.
Comparing groups, Figure 4.7 shows that epistemic picture choices for the modal-aspect sentences (*Scott must be wearing his boots*) show a steady increase from an average of 4/8 epistemic choices for three-year-olds, to 5/8 for four-year-olds, to 6/8 for five-year-olds to 7/8 epistemic picture choices for adults. There is clear development towards increasingly epistemic interpretations of modal-aspect sentences. In contrast, the epistemic picture choices for the modal-only sentences (*Scott must wear his boots*) shows development away from the adult rate rather than towards it. Children go from about 2.5/8 to 4/8 to 6/8, while adults average 3/8 epistemic picture selections for modal-only sentences. In both sentence-types children choose increasingly more epistemic pictures.

I hypothesized that for young children the association between aspect marking and epistemic interpretations of functional modals would be first available in the perfect (The Perfect Advantage). The perfect aligns with [+past] and thus differs from both the progressive and the bare verb, which align with [-past]. For the perfect modal-aspect sentences (Table 4.8), three- and four-year-olds show a clear contrast, in the adult direction, choosing more epistemic pictures for modal-perfect-aspect sentences than modal-only sentences. Five-year-olds show an overall epistemic bias. Of the three-year-olds, 6/9 chose more epistemic pictures for modal-aspect sentences in the perfect condition, than for modal-only sentences. An example of a follow-up question with a three-year-old child who chose the target epistemic picture after hearing the modal-aspect sentence in the Jada Bath story from the perfect condition is provided in (13). This follow-up response shows that the child is attending to the relevant indirect evidence.

(13) Follow up question with 3-year-old, Jada Bath Story (Perfect)
Test Sentence: Modal-aspect, “*Jada must’ve taken a bath*”
[Child picked target Epistemic picture]
   a. Exp: *How do you know Penguin was looking at that picture?*
   b. Child: *because there’s water drops* [points to Jada’s hair]

In the progressive (Figure 4.9), unlike in the perfect, three-year-olds show no significant difference between modal-aspect sentences and modal-only sentences, nor do four-year-olds. Three-year-olds show very similar rates when they hear the modal-aspect sentence in the progressive and when they hear the modal-only sentences associated with the progressive-condition stories (1.4/4 vs. 1.2/4). Only four three-year-olds (4/9) chose more epistemic pictures for the progressive modal-aspect sentences than of the modal-only sentences, and of these 4 children only one chose more epistemic pictures for the progressive modal-aspect sentences at a
magnitude of more than 1 (3 epistemic in the modal-aspect condition vs. 1 epistemic in the modal-only condition). Only the oldest children show a contrast in picture choices in the adult like direction, with more epistemic picture choices for the progressive marked modal-aspect sentences than for the modal-only sentences.

4.3.4. Discussion

The results for the Flavour Task, contrasting modal-aspect sentences with modal-only sentences are as expected for adults. Adults appear to form primarily epistemic interpretations for modal-aspect sentences, and significantly less epistemic interpretations for must in modal-only sentences (where a deontic interpretation is preferred). This is consistent with Condoravdi (2002)’s Diversity Condition, visualized in Figure 4.10. To evaluate a modal you must be able to compare both p worlds and ¬p world, in the past and present (where the facts of the actual world are settled), there are only both p worlds and ¬p world in epistemic bases. The progressive and the perfect align readily with present and past, respectively, so the most natural interpretation of the modal-aspect sentences is an epistemic one. On the other hand, the modal-only sentences are naturally future-oriented. In this case there are p worlds and ¬p worlds in the actual world and in mental worlds. The most readily available reading is the future-oriented root modal meaning and adult responses reflect that.

<table>
<thead>
<tr>
<th>Figure 4.10: The Diversity Condition</th>
<th>Non Actual</th>
<th>Epistemic</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both p &amp; ¬p in the Actual World</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Both p &amp; ¬p in Mental worlds</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

Children appear to show clear development towards adult-like patterns for modal-aspect sentences (e.g., Scott must be wearing his boots, Jada must’ve taken a bath). Even the youngest children choose more epistemic pictures in the modal-aspect condition, showing some sensitivity to the role of aspect marking in modal interpretation (see also Heizmann, 2006). Upon closer inspection, the three-year-olds show a contrast between the perfect-aspect sentences (Jada must’ve taken a bath) and the modal-only sentences, but not between the progressive-aspect sentences (Scott must be wearing his boots) and the modal-only sentences. Heizmann (2006) found that three-year-olds were able to interpret progressive sentences in English as epistemic; the methods were different which may explain this possible discrepancy in our results. Overall, the youngest children exhibit a deontic-bias, exhibiting the lowest rates of epistemic picture choice among the four groups (c.f., Fond, 2003; Chapter 3).
The four- and five-year-old groups show an increasingly strong association between modal-aspect sentences and epistemic interpretations. However, they also show an increasingly strong association between modal-only sentences (Scott must wear his boots) and epistemic interpretations. The pattern for four-year-olds is not significantly different from that of three-year-olds. However, the pattern for five-year-old children shows an overall epistemic-bias across both sentence conditions. Further, the modal-only sentences that are more compatible with deontic-interpretations for adults are primarily interpreted as epistemic for the five-year-old children. For the modal-only sentence, child development appears to not be towards the adult pattern. Rather the youngest children show the most adult-like rates of epistemic association for modal-only sentences and as children age they over-select the epistemic interpretations of modal-only sentences, compared to adults.

The pattern may suggest a protracted U-shaped development. The youngest children appear to show adult like patterns, showing a contrast between modal-only interpretations to modal-aspect interpretations (for perfect complements), albeit with an overall deontic preference. In the modal-only condition the children become increasingly divergent from the adult pattern rather than convergent, exhibiting overextension. Finally, we expect resolution towards the adult pattern sometime after age six (compare with evidential development which can be similarly protracted in complex evidential systems, see §2.2.3, de Villiers et al. 2009). If the resolution is not complete then the child’s overextension of epistemic interpretation would be of the right type to drive modal meaning change.

What explains the increasing rates of epistemic interpretation for modal-only sentences for four- and five-year-old children? In other words, why would a child begin with a root bias and subsequently overextend towards an epistemic bias, even in compositional structures that align strongly with root interpretations (i.e. modal-only sentences)?

It is possible that the five-year-olds divergence from adults is explained by differences in the interpretation of (a) must, (b) the bare complement (Scott must wear his boots), or (c) the combination. If (a), then older children treat must as lexically epistemic and that accounts for their increasing across-the-board epistemic bias. If (b), then older children treat the bare complement as habitual at a higher rate than adults. If (c), then older children’s responses may arise from a combination of (a) and (b).
Older children may re-interpret *must* as lexically epistemic from increased usage exposure to the adult language. *Must* is mostly epistemic in Toronto English (Tagliamonte & D’Arcy, 2007) and *have to* covers the deontic space (e.g., *You have to be home by 4*). After acquiring the grammatical representations necessary for epistemic uses of functional modals, the child may become increasingly aware of the epistemic-bias in *must* usage in Toronto English. Three-year-olds rely on logical relations (i.e., the logical effects of temporal-orientation of the prejacent on the interpretation of the modal) to determine the interpretation of the modal, but older children gradually assume that *must* is epistemic and largely abandon the deontic interpretations as logically possible, but inconsistent with the input. One way to test whether these lexical differences play a role would be to repeat this experiment with *have to* in place of *must*. If the lexical item, rather than the semantics (Diversity Condition, role of Aspect), determines the interpretation (at least for older children) then *have to*-sentences followed by bare complements should remain root-biased.

It is also possible that the issue lies with the bare complement (*Scott must wear his boots*). This may interact with a new and improving ability to assign epistemic interpretations to sentences with functional modals like *must*. For example, the three-year-old child is clearly still figuring out the meaning of *must* and still usually opts for the more familiar root-interpretations. However, it is reasonable to argue that once the child is aware of epistemic interpretations and has some sense of how they interact with the grammar (both three- and four-year-olds prefer epistemic interpretations for modal-aspect sentences over modal-only sentences, but four-year-olds show a slight epistemic bias) their grammar is “piqued” towards epistemic readings. If the child hears “He must….” she may already commit to an epistemic interpretation. If the sentence continues with “…wear his boots”, this complement can be interpreted as habitual without reanalyzing the initial commitment to epistemic *must*. This story interacts with the usage bias in Toronto English; increased lexical interpretations of *must* after age four (and not sooner) may be explained by an interaction between onset of epistemic meanings for functional modals and an increased understanding of what the input encodes.

Whatever explains the trend, this overextension trend towards increased epistemic interpretations is in line with the diachronic prediction, where a modal like *must* is predicted to become more frequently used with epistemic meaning (c.f. *might*). More generally, children are predicted to systematically overextend the coverage of functional modals from root uses to
epistemic. This means that the child begins with a root-only usage of functional modals (for grammatical reasons; see Chapter 3), and when she develops the ability to scope grammatical material above propositions she subsequently is able to use functional modals epistemically. At this stage of development the child may overextend the meaning coverage of modals that are root-only in the input language. This overextension parallels the diachronic innovations for modal verbs.

4.4. Experiment 2: Modal detection task
4.4.1. Questions and Hypothesis

The Modal Detection task examines the possibility that the child is only attending to the complement of the modal, as the aspect marker or lack thereof also keys tense interpretations (future-oriented when absent (14a), past or present-oriented when present (14b)). This temporal information allows the child to pick a picture where that rabbit has yet to jump for (14a) and one where the rabbit has already jumped for (14b). Thus we must investigate whether the child attends to the modal independently of the aspect marker.

(14) a. The rabbit must jump the fence. [Modal Only]
b. The rabbit must have jumped the fence. [Modal-Aspect]
c. The rabbit has jumped the fence. [Aspect Only]

This experiment also addresses the following question: do young children understand that the presence of a modal in addition to aspect marking indicates that evidential inference is required? A sentence with both an aspect marker and a modal has an epistemic interpretation (14b), which, in contrast to the same sentence without the modal (14c), requires that evidence supporting the proposition be present but indirect. The sentence in (14c) is felicitous when visual evidence is direct or indirect.

The Modal Flavour task tested the presence or absence of aspect marking [+Mod, ±Asp], contrasting target epistemic interpretations to deontic interpretations. The Modal Detection task contrasts the presence or absence of modal marking [±Mod, +Asp], contrasting target epistemic interpretations to target actual interpretations.

It is important to note that both adults and children are expected to exhibit weaker contrasts in this task than in the Modal Flavour task. The results of the norming study showed that the Deontic – Epistemic contrast is strong (4:1 ratio for target to non-target sentences) for
the pictures used in these studies, but the Epistemic – Actual contrast is less strong, even at its best (4:2 ratio for target to non-target sentences, more commonly 4:3).

Hypotheses for the Modal Detection task as follows,

I. *Children attend to the difference between Modal-Aspect and Aspect-only sentences, rather than attending only to the information in the complement.*

This experiment will show that children are not relying on the complement alone to make their picture (Modal Flavour Task) or sentence (Modal Detection Task) choices, but hear the whole sentence with all of its parts. This is not the same as having an adult-like interpretation of each of those parts, or their compositional meanings, but rather implies that children know that aspect marking contributes meaning differentially from no aspect marking, and a modal like *must* contributes meanings differentially from no modal. If children understand that the Modal-Aspect sentence is different from the Aspect-only sentence, then they will (a) choose those sentences at significantly different rates for the different picture types (Actual and Epistemic), and (b) make remarks about the “must” (or lack therein) when questioned about their sentence choices in follow-up questions.

II. *Younger children will be better at choosing Aspect-only sentences for Actual pictures than Modal-Aspect sentences for Epistemic pictures.*

Previous studies on evidential markers show that children acquire direct evidential markers earlier than indirect evidential markers (Aksu-Koç, 1988). Epistemic *must* marks an indirect evidence source, while the lack of *must* in an otherwise identical sentence is unmarked for evidence source. The Modal Detection Task contrasts sentences that are only licensed when the speaker has indirect evidence (*Scott must be wearing his boots*), and sentences which are licensed in a story so long as they are true, regardless of evidence source (*Scott is wearing his boots*). Children are expected to understand the meaning and usage conditions for the aspect-only sentences prior to the modal-aspect sentences; the aspect-only sentences have no evidential restriction and are likely more frequently encountered. The modal-aspect sentences are complex because *must* is a functional modal with both root and epistemic meanings, and further, the epistemic meaning of *must* is evidential which add another layer of conditions on the use of *must* (whether all epistemic modals are evidential is currently under debate). In other words, young children may understand that *must* is epistemic but not the nature of its evidential contribution.
III. By five years old children will behave adult-like in the Actual condition and begin to approach adults in the epistemic condition.

Older children are expected to be adult-like for direct evidence conditions. They should be adult-like for responses to Actual pictures and avoid selecting *must*-sentences for these pictures; the indirect evidence marker *must* is not licensed when evidence is direct. For epistemic pictures older children should be more adult-like, but will likely not yet reliably choose *must*-sentences at adult-like rates. This hypothesis is based on previous studies that have shown that polysemous evidential markers are acquired later than monosemous (Rett & Hyams, 2014), and similarly, more complex evidential systems are not adult-like until preteen years (see de Villiers et al., 2009). The English modal system with multiple functional and lexeme modals, some of which mark evidentiality, may indeed count as a complex system.

Overall, I expect the three-year-olds to select the modal-aspect *must*-sentence at chance for the epistemic pictures, but to show a preference for the aspect-only sentences when they see the Actual pictures. Four-year-olds are expected to also have trouble in the epistemic condition because of difficulty with both epistemic modality and indirect evidential marking, but will be better than three-year-olds in the Actual condition, avoiding the unlicensed *must*-sentence. I expect five-year-olds to be near adult-like for the Actual condition and to show an understanding that *must* is preferred in contexts of indirect reference. For adults, the expected pattern is no *must*-sentences in the Actual condition, where the indirect evidence presupposition of *must* is not satisfied. For the epistemic pictures I expect adults to usually prefer to mark the indirect nature of their evidence, but the aspect-only sentence is also licensed, and so expected.

4.4.2 Methods

4.4.2.1 Participants

The participants for the Modal Detection task were 17 monolingual-English, typically-developing children and 9 dialect-matched adults. As with the Modal Flavour task, the children were divided into 3 age groups, 3;03 to 3;08 (n=5, $M = 3;05$), 4;0 to 4;11 (n=7, $M = 4;06$), and 5;2 to 5;11 (n=5, $M = 5;06$). A further 6 children were excluded for failing the training items (n=3), or always choosing the shark puppet (n=3). Recruiting methods were the same as for the Modal Flavour task.
4.4.2.2. Materials

Participants were invited to listen to stories told by the experimenter from a handmade storybook. Two puppets, Frog and Shark, controlled by another experimenter, also listened to the stories. Participants were told that Frog and Shark would comment on the stories but they were silly puppets who didn’t always pay attention and were not always careful with their words. The participant was asked to reward the puppet who was paying attention and more careful about what he said. The children rewarded the puppets by feeding them a watermelon toy.

The Modal Detection task is a sentence preference task. First the participant is presented with three training stories. For example, the experimenter shows a picture of an apple and says, “Oh look, some fruit!” and then directs the question “What do you see guys?” to the puppets. The Frog speaks first and says “I see a banana!” and the Shark speaks second and says “I see an apple!” The participant is then prompted to choose a puppet with the prompt, “Which puppet is paying better attention?” The child was encouraged to feed that puppet the watermelon slice. After the child responded the experimenter sometimes asked, “How do you know it was [Shark/Frog]?” to add interest and naturalness to the task, as well as to potentially garner more insight into why the child made the selection she made.

The same stories and fillers were used as in the Modal Flavour task (albeit with one picture and two sentences). In a typical test item the child heard the introductory sentences (same as for the Modal Flavour task) and then the experimenter turned the page revealing a continuation picture, as in Figure 4.11. The experimenter prompted the puppets to talk about the picture, to which they would say an Aspect-only sentence (Scott is wearing his boots) and a Modal-Aspect sentence (Scott must be wearing his boots), using natural prosody. Frog always spoke first, but which puppet said which sentence was counterbalanced.
There were 16 test stories, 8 progressive and 8 perfect. Within each set of 8 stories, 4 had an epistemic picture and 4 had an actual picture (Table 4.6). There were 8 fillers. These filler items were of a similar length and complexity to the test items. Items were presented in the same order for all participants and the experimenter recorded responses on a score sheet.

<table>
<thead>
<tr>
<th>Test Picture → Aspect Condition</th>
<th>Actual</th>
<th>Epistemic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>4 Perfect (“Jada has taken a bath”)</td>
<td>4 Perfect (“Jada must have taken a bath”)</td>
<td>8</td>
</tr>
<tr>
<td>Progressive</td>
<td>“Scott is wearing his boots”</td>
<td>“Scott must be wearing his boots”</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>

4.4.3. Results

Figure 4.12 shows average counts of must-sentence choice by picture condition for all groups (three-year-olds, four-year-olds, five-year-olds, adults), ordered from youngest to oldest. The dark grey bar shows the must-sentence choices for the epistemic picture condition. The light grey bar shows the must-sentence choices for the actual picture condition.
Tables 4.7 and 4.8 provide the confidence intervals from mixed effects logistic regression models with priors for adult and children, respectively. The presence of zeros in the data (0 progressive must-responses for five-year-olds and for adults) made it impossible to run the logistic regression in the usual way. Rather, the prior gives a distribution of the most probable models to account for the data. When all the best regression models accounting for a particular factor fall far from what can be considered the null hypothesis (=0), in other words when they are all positive or all negative between 2.5% and 97.5% intervals, these factors are likely significant (but this is not a p-value).

Thus, for adult participants, we see that they appear to be overall more likely to pick aspect-only sentences (negative intercept for must-sentences). There also appears to be a significant effect of picture condition such that an epistemic picture increases the odds of picking a must-sentence. Likewise, being in the perfect condition increases the odds of picking a must-sentence for adults.
Table 4.7 (ADULTS): Confidence intervals from mixed-effects logistic regression with prior testing the fixed effects of PICTURE (epistemic, actual), ASPECT (perfect, progressive), and their interaction, for the selection of sentences with the modal must. Treatment sum coding. N = 9.

<table>
<thead>
<tr>
<th></th>
<th>2.5%</th>
<th>50%</th>
<th>97.5%</th>
<th>reject null hypothesis?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-11.781</td>
<td>-4.6223</td>
<td>-1.507</td>
<td>Y</td>
</tr>
<tr>
<td>PICTURE (epistemic)</td>
<td>2.028</td>
<td>5.132</td>
<td>12.280</td>
<td>Y</td>
</tr>
<tr>
<td>ASPECT (perfect)</td>
<td>0.196</td>
<td>3.283</td>
<td>10.345</td>
<td>Y</td>
</tr>
<tr>
<td>PICTURE:ASPECT</td>
<td>-10.438</td>
<td>-3.327</td>
<td>-0.280</td>
<td>Y</td>
</tr>
</tbody>
</table>

The confidence intervals for the child data show that three-year-olds (the reference group) are not above chance for any condition. Both four-year-olds and five-year-olds appear to be significantly less likely to pick must-sentences, with a stronger effect for the five-year-olds. Furthermore, there is an interaction for PICTURE:AGEGROUP5, whereby five-year-olds are more likely to pick the must-sentence in the progressive. Further testing is needed to verify this interaction, given present limitations in sample size.

Table 4.8 (CHILDREN): Confidence intervals from mixed-effects logistic regression with prior testing the fixed effects of PICTURE (epistemic, actual), ASPECT (perfect, progressive), AGEGROUP (3, 4, 5; reference level = 3) and their interactions for the selection of epistemic pictures. Treatment sum coding (contrast coding for AGEGROUP). N = 17.

<table>
<thead>
<tr>
<th></th>
<th>2.5%</th>
<th>50%</th>
<th>97.5%</th>
<th>reject null hypothesis?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.629</td>
<td>-0.164</td>
<td>0.308</td>
<td>N</td>
</tr>
<tr>
<td>PICTURE (epistemic)</td>
<td>-0.505</td>
<td>-0.043</td>
<td>0.413</td>
<td>N</td>
</tr>
<tr>
<td>ASPECT (perfect)</td>
<td>-0.638</td>
<td>-0.175</td>
<td>0.285</td>
<td>N</td>
</tr>
<tr>
<td>AGEGROUP4</td>
<td>-1.852</td>
<td>-1.179</td>
<td>-0.539</td>
<td>Y</td>
</tr>
<tr>
<td>AGEGROUP5</td>
<td>-13.790</td>
<td>-6.218</td>
<td>-2.813</td>
<td>Y</td>
</tr>
<tr>
<td>PICTURE:ASPECT</td>
<td>-0.515</td>
<td>-0.057</td>
<td>0.399</td>
<td>N</td>
</tr>
<tr>
<td>PICTURE:AGEGROUP4</td>
<td>-0.334</td>
<td>0.324</td>
<td>1.009</td>
<td>N</td>
</tr>
<tr>
<td>PICTURE:AGEGROUP5</td>
<td>0.017</td>
<td>3.426</td>
<td>10.867</td>
<td>Y</td>
</tr>
<tr>
<td>ASPECT:AGEGROUP4</td>
<td>-0.584</td>
<td>0.085</td>
<td>0.759</td>
<td>N</td>
</tr>
<tr>
<td>ASPECT:AGEGROUP5</td>
<td>-0.360</td>
<td>2.980</td>
<td>10.445</td>
<td>N</td>
</tr>
<tr>
<td>PICTURE:ASPECT:AGEGROUP4</td>
<td>-0.401</td>
<td>0.251</td>
<td>0.898</td>
<td>N</td>
</tr>
<tr>
<td>PICTURE:ASPECT:AGEGROUP5</td>
<td>-10.786</td>
<td>-3.301</td>
<td>0.106</td>
<td>N</td>
</tr>
</tbody>
</table>

Adults (n=9) behaved as expected in both the epistemic-picture condition and the actual-picture condition. When adults saw the epistemic pictures, they chose the modal-aspect sentence (Scott must be wearing his boots) on average 5/8 times. When adults saw the actual picture, they almost never chose the modal-aspect sentence (0.2222/8 times). This means that adults always choose the aspect-only assertion (Scott is wearing his boots) when presented with direct visual evidence. In contrast, when they see a picture with indirect evidence, they usually pick the modal-aspect sentence, but sometimes the aspect-only sentence. Adults varied between 2 and 8
must sentence choices for epistemic pictures, and between 0 and 1 must sentence choices for actual pictures; all 9/9 adult participants showed a preference for more must choices in the epistemic picture condition. Adults behaved as expected in both conditions.

Three-year-olds (n=5) behaved at chance in both the epistemic-picture condition and the actual-picture condition. For both picture-types three-year-olds choose the modal-aspect sentence about half the time. Only one of the three-year-olds chose more must-sentences in the epistemic picture condition than the actual picture condition. Three-year-olds were attentive and generally appeared thoughtful about their responses, but nonetheless appear to be at chance.

Four-year-olds (n=7) choose many fewer modal-aspect sentences for the epistemic picture than do adults, and more modal-aspect sentences for the actual pictures than do adults. For the epistemic pictures four-year-olds chose the modal-aspect sentence on average just over 2/8 times. For the actual picture, they choose the modal-aspect picture on average just under 1.5/8 times. Overall the numbers are lower than for three-year-olds, suggesting that four-year-olds, unlike the younger participants, detect the modal and then avoid choosing it. Individual responses show that 4/7 four-year-old participants choose more must-sentences in the epistemic condition than in the actual condition. However, most four-year-olds choose few modal-aspect sentences in either condition.79

Five-year-olds (n=5) show even fewer modal-aspect sentence choices across both picture conditions than four-year-olds. They choose many fewer modal-aspect sentences for the epistemic picture than do adults, and are adult-like for the actual pictures. For both picture conditions, the five-year-olds on average choose the modal-aspect sentence less than 1/8 time. Overall the numbers are lower than for four-year-olds, suggesting that five-year-olds, like most four-year-olds, detect the modal and avoid choosing it. Individual response counts, unlike for the four-year-olds, show little variation. Only 2/5 five-year-old participants chose more must-sentences in the epistemic picture condition than the actual picture condition.

One of the five-year-old participants who chose 100% aspect-only sentences was forthcoming about why she made the choices she did. She consistently told the experimenters that the puppet who used the modal-aspect sentence was wrong because “he said might” and sometimes would then point to the picture saying, “but it’s not might because look there’s his

---

79 One four-year-old participant actually showed an overall preference for must-sentences and is atypical in this sense.
boots” (actual picture) or “but the rabbit did jump over the fence. The rabbit is gone” (epistemic picture, where adults mostly chose the must-sentence). That the puppet said might remained her reason for not choosing the must-sentence, even after hearing many items, all with must. Other children were less forthcoming about why they chose particular sentences, and were more likely to point to the picture when asked why they chose the puppet they did. For example, one boy chose the aspect-only sentence for the epistemic Fox and Rabbit story, and when asked why, he pointed at the picture to show us, as if to say that that puppet was saying what was in the picture.

In the actual condition the adults chose almost no modal-aspect sentences. For the children we see a progression from chance rates for three-year-olds to near-adult rates for four-year-olds, to adult-like behaviour by five years old. The association of assertions with only aspect-marking (progressive or perfect) with images that present direct evidence may be adult-like sometime after age four. The developmental pattern progresses steadily from chance to adult-like behaviour.

In contrast, the epistemic condition shows that adults choose primarily modal-marked sentences when presented with pictures without direct evidence for the proposition under consideration. However, for epistemic pictures, children begin at chance and progress to less and less modal-aspect picture choices. By five years old children are choosing the modal-aspect sentences at rates much lower than adults do. Children at four and five years old overwhelmingly choose plain assertions regardless of whether they see a picture with direct or indirect evidence for the proposition under consideration.

4.4.4. Discussion

Adult responses in the Modal Detection task were as expected. Adults choose almost exclusively aspect-only sentences when presented with an Actual image with direct evidence. When direct evidence is available the presupposition of indirect evidence is not met and must is not possible. Adults chose both aspect-only and modal-aspect sentences for the epistemic pictures which show indirect evidence. Both sentence types are appropriate in this context and adults chose to mark the indirect evidence source with must more often than choosing to not mark it. These results are fully in-line with Von Fintel & Gillies (2010), as the usage of must is only compatible with indirect evidence (the epistemic pictures), but the sentence without must can be used for either direct or indirect evidence (actual or epistemic pictures) (c.f. Rett &
Hyams, 2014 for the evidential component of Copy-Raising constructions). Thus the contexts where one can say the must-sentence is a subset of the contexts where one can say the unmodalized sentence.

Children at all ages behaved quite differently from adults in the Modal Detection task. Three-year-old children showed no difference for sentence-choice across the two picture conditions; their responses appear to be at chance. This is contra to the hypothesis above, where I predicted that three-year-olds would attend to the difference between the two sentence types and behave differentially across conditions. Four and five-year-old children treat the two sentence types differently, showing that they attend to must and know that a modal-aspect sentence is somehow different in meaning from an aspect-only sentence.

Four-year-old children show clear development towards the adult pattern for the Actual pictures, choosing the unmodalized aspect-only sentence, and five-year-olds are adult-like for the Actual pictures. This suggests that as of about four years old children know that must is not licensed in scenarios with direct evidence. However, this conclusion is problematic because four- and five-year-old children also develop away from the adult pattern with epistemic pictures, also avoiding must-sentences for pictures with indirect-evidence. Children develop wholesale towards avoiding the must-sentences for both direct and indirect evidence pictures. Thus, the older children are definitely hearing the contrast between modal-aspect sentences (Scott must be wearing his boots) and aspect-only sentences (Scott is wearing his boots), because they are systematically avoiding the modal-aspect sentences. Children are not relying only on the complement to choose a sentence-type because the complements are the same (wearing his boots)\(^\text{80}\).

What pragmatic or semantic reasons might account for why four- and five-year-olds chose the aspect-only sentences across-the-board? There are three possibilities that come to mind, (a) the aspect-only sentence is appropriate in both contexts and is thus a safer choice (it cannot be wrong), (b) children may treat must as weak (∃), like might, rather than treating it as

\(^{80}\)This is not strictly true, the modal-aspect complements contain is and has with present and past marking on the auxiliary, respectively, while the aspect-only complements contain bare be and have. Take for example the item where the children see the rabbit being chased by a fox, and then see the picture with the rabbit missing and the fox looking around. They hear The rabbit must've jumped the fence and The rabbit has jumped the fence. If the children are not hearing (or ignoring) must and consider only have jumped the fence vs. has jumped the fence, then the modal-aspect sentence contains a subject-agreement error, and only the latter agrees correctly with the subject The rabbit. This is possible but unlikely because when prompted to elaborate on their puppet choices the children often pointed out something like, “He said “must””.
evidential as adults appear to do, (c) children may be more accommodating than adults for what counts as direct evidence (this may interact with possible explanation (a)).

The aspect-only sentence is licensed both with actual (direct evidence) pictures and epistemic (indirect evidence) pictures, perhaps making possibility (a) above the safer choice. Children might choose the aspect-only sentence at high rates for both picture types because it is applies in all test contexts. This behaviour may be reinforced by the task and the child will choose the aspect-only sentence because it always seems to work (excepting for the fillers where the options are different). This behaviour is consistent with Von Fintel and Gillies (2010)’s assessment of the differences between the modalized prejacent (must be raining) and the plain prejacent (be raining), but would also demonstrate avoidance of the more complex modalized term, even when it is more appropriate. This avoidance may result from a lack of understanding of the licensing conditions (which are that this presupposition must be true: both the prejacent and its negation must not be known through direct evidence, see Von Fintel and Gillies 2010 for details).

It is also possible that children are semantically different from adults (possible explanation (b)). Adults treat must as a strong (∀) epistemic evidential marker and choose the must-sentence only in the context of indirect evidence, over half the time. These results are suggestive of the indirect evidence presupposition analysis of epistemic must. What if children think that must is weaker than the unmodalized sentence (aspect-only, Scott is wearing his boots), akin to might? Children might assume from their (perhaps limited) evidence that a must sentence is weaker than the unmodalized equivalent (as many linguists have done, see Von Fintel & Gillies, 2010). If this is the case, then so long as the child thinks there is enough evidence to make a strong claim, then the modalized sentence will not be strong enough. For example, the child who regularly chose the aspect-only sentence and told the experimenters that she didn’t choose the other puppet, “because he said might, and it’s not might”. This may be anecdotal evidence that four and five year old children treat indirect evidence as weaker than direct evidence (in effect conflating indirectness with weakness), even though this is not the case for adults.

These results may thus be comparable to the Tibetan-children in de Villiers et al (2009)’s study (see §2.2). In their experimental studies, direct markers were found to vary according to the child’s knowledge certainty, rather than the certainty of their evidence-source. The English-
learning children may also be choosing sentences based on whether they were certain or not, and not on the distinct evidential nature of direct visual evidence and indirect visual evidence. Another finding from Tibetan children in de Villiers et al. (2009) was that children were found to judge scenarios based on their own evidence, rather than the evidence marker used in a prompt question directed at the children. This may mean that the children are not caring so much about what the puppets say, but rather choosing the aspect-only sentences because they are certain about the truth of the prejacent (e.g., *wearing his boots*).

It is also possible that children are different from adults in what they consider to count as direct evidence (possible explanation (c)). That is, perhaps children over 4 have an adult-like understanding of *must*, including that it marks indirect evidence, but they differ from adults in what counts as “direct evidence”. Perhaps children are more accommodating or permissive about the kinds of visual cues or the nature of the evidence. For example, perhaps the many 4 and 5-year-olds who pointed to the pictures to explain why they chose the aspect-only sentence, even when the picture illustrated indirect evidence (Epistemic picture) were indicating that they chose the aspect-only sentence because the picture didn’t license the use of *must*. Children may consider bootprints, for example, as direct-evidence while adults consider them indirect-evidence.

Finally, it is possible that a task-effect interferes with children’s sentence choices because of immaturity in some non-linguistic capacity to accommodate. For example, perhaps children understand that *must* is an indirect evidence marker (other studies have shown that indirect evidential markers are acquired by age three; see §2.3.3.). Thus, the puppet saying the modal-aspect sentence will always be the puppet signalling “I have indirect evidence”, while the puppet using the aspect-only sentence may seem to have better information, signalling “I have direct evidence”. This may have contributed to the children picking the puppet saying the aspect-only sentence, regardless of what the picture represented. Perhaps the children relied on trusting the puppet. This may have been linked to the prompt to feed the watermelon to the puppet paying “better attention”. However, follow-up questions with children, such as “Oh! How do you know it was Shark?” indicated anecdotally that children were attending to the modal/no-modal difference and evaluating the pictures as having enough evidence for the aspect-only sentence.
4.5. Conclusion

This chapter presented two experimental studies. The Modal Flavour task investigated whether children attend to grammatical cues from aspect marking to determine the meaning of the functional modal *must*, while the Modal Detection task investigated whether children attend to the modal independently of the complement and, if they do, whether they attend to the evidential difference between a proposition $p$ and the same proposition modalized $must p$ (see Von Fintel & Gillies, 2010).

The main findings for the Modal Flavour task were that adults behaved as expected, choosing almost all epistemic pictures for modal-aspect sentences and primarily deontic pictures for the modal-only sentences. The children began with an overall deontic-bias at age three and progressed to an overall epistemic-bias by age five. The children became more adult-like for modal-aspect sentences, choosing an increasing number of epistemic pictures; there was a perfect advantage, whereby perfect marked sentences were understood as cuing epistemic meanings earlier than progressive marked sentences. Interestingly, the children became less adult-like for interpretations of the modal-only sentences, like *Scott must wear his boots*. These sentences elicited primarily deontic responses for adults and three-year-olds, but mostly epistemic responses for four-year-olds and overwhelmingly epistemic responses for five-year-olds. Children show a shift to an epistemic-bias for modal-only sentences, and at five years old behave quite differently from adults.

The main findings for the Modal Detection Task were that adults behaved as expected, assuming Von Fintel and Gillies (2010)’s analysis of *must* as a marker of indirect evidence which is otherwise just as strong as its unmodalized counterparts (*must be raining vs. is raining*). Adults almost never selected the *must*-sentence in the Actual condition, as *must* is unlicensed when the speaker has direct evidence for the proposition. In the Epistemic condition, adults chose mostly *must*-sentences, but also several aspect-only sentences. Both of these sentence types are expected in indirect evidence contexts (Epistemic pictures). The youngest children were at chance for both conditions, perhaps due to processing overload or the complexity of the task. By four years old the children are distinguishing between modal-aspect sentences (*must*-sentences) and aspect-only sentences. Both four and five year old children choose overwhelmingly aspect-only sentences for both picture types, with five-year-olds at floor for *must*-sentence choices.
The children develop towards the adult-like pattern for the actual pictures, selecting few (four-year-olds) to almost no (five-year-olds) must-sentences. However, these children are also developing away from the adult-like pattern in the epistemic condition. Both four- and five-year-old children chose few to almost no must-sentences in the epistemic condition, where adults preferred must-sentences.

It is important to keep in mind that the methods are different for both experiments, the Modal Flavour task was a picture choice task while the Modal Detection task was a sentence-choice task. However we can speculate about the results taken together to some extent. Considering the results from both tasks together, children appear to be able to evaluate the contribution of perfect aspect marking to modal interpretation for functional modals from as early as age three (Modal Flavour Task), but at the same age they may be unable to compute the indirect evidential conditions on the usage of must (Modal Detection Task). Older children, four- and five-year-olds, show an increase towards as epistemic bias for must in the Modal Flavour task and a parallel increase away from marking the epistemic with must in the Modal Detection task.

Why were three-year-olds above chance in the Modal Flavour Task but not in the Modal Detection Task? It is not necessary to be aware of the presupposition on the epistemic use of must in order to successfully tease apart the deontic vs. epistemic interpretations of must (modal-only sentence vs. modal-aspect sentence), but the participant has to know the presupposition to successfully evaluate the licit use of a must-sentence vis-a-vis a plain assertion (modal-aspect sentence vs. aspect-only sentence). This difference might explain why three-year-olds appear able to evaluate the difference between root and epistemic must based on aspect marking (and related tense alignment), but are not able to evaluate the difference between a modalized prejacent and its plain counterpart.

Three-year-olds appear not to attend to the difference between modal-aspect and aspect-only sentences in the Modal Detection task. This may be because three-year-olds do no pay attention to must, relying on verbal marking alone to make judgement, and they therefore cannot perform the Modal Detection task where both sentences have the same verbal marking (e.g., Scott is wearing his boots vs. Scott must be wearing his boots). This suggests that three-year-olds may rely only on the complement of must to make their picture choices in the Modal Flavour task as well. However, this conclusion is problematic for several reasons. First, three-year-old
children use epistemic modals in naturalistic production in appropriate contexts (e.g., Wells, 1985; Papafragou, 1998). Second, three-year-olds’ responses for the Modal Flavour Task do not pattern with predictions for them only attending to the verb. Three-year-old show an overall deontic-bias, which means that when they heard “have jumped” or “jump”, in both cases there was ≥50% chance they would choose the future-oriented picture where the relevant event had not yet taken place. This picture choice is not consistent with “have jumped”. On the other hand, within the context of the overall deontic bias, the three-year-olds were more likely to choose epistemic interpretations for modal-aspect sentences in the Perfect stories. This means that between “have jumped” and” jump” three-year-olds chose more epistemic pictures for “have jumped”. At an age where children reliably understand past tense marking and progressive marking, this pattern seems unlikely if the young children are only attending to the verb. Finally, sometimes three-year-olds chose epistemic interpretations for modal-only sentences (15). In these cases, the child heard the bare verb but nonetheless interpreted must as epistemic; this is unexpected if the child is relying on “jump” to make his picture choice, but is expected if the child is progressing towards an overall epistemic bias at age four and five.

(15) Follow up question with a three-year-old, Fox and Rabbit Story
Test Sentence: Modal-only, “Rabbit must jump the fence”
[Child picked non-target Epistemic picture]
   a. Exp: How do you know Penguin was looking at that picture?
   b. Child: because the rabbit is gone

I suggest rather that three-year-olds heard the contrast in the Modal Detection task but failed due to processing overload; three-year-olds are only barely able to evaluate the modal-aspect combination (as seen in the Modal Flavour task) and use epistemic modals at low rates (see Chapter 3), and in the Modal Detection Task they both have to evaluate the modal-aspect combination and evaluate the presuppositional contribution associated with must (modal-aspect sentence) but not with the aspect-only sentence. Further, in scenarios with weak evidence, there may be differences in the informativeness of using the nonmodalized sentence in contrast with an epistemic sentence. This may be too much and thus they are at chance in the Modal-Detection Task, but perform in a patterned way in the Modal-Flavour Task.

Why did five-year-old children exhibit a strong epistemic bias for all must-marked sentences in the Modal Flavour task, but near-categorically avoid selecting must-sentences in the Modal Detection task? In the Modal Flavour task, the epistemic reading is near-categorical for
the aspect-marked sentences, but is also OK in the modal-only sentences (about \( \frac{1}{4} \) of adult responses). It is possible that five-year-old children consider *must* as epistemic, and the bare complement of *must* as habitual to accommodate, explaining their strong epistemic bias in the Modal Flavour task. Despite a clear understanding of *must* as epistemic, these children may not yet have the adult-like understanding of the evidential component of *must*’s meaning. Rather they may consider *must* to be weaker than the bare prejacent (unlike adults), or they may evaluate evidence relative to how sure they are, rather than how sure the speaker is, or how the evidence is objectively.

The finding that four- and five-year-old children exhibit a strong epistemic bias inconsistent with adult behaviour in the Modal Flavour task is predicted by the diachronic hypothesis for meaning change led by child learners. This bias is not expected if children are solely and reliably using aspect cues to pick either future-oriented deontic interpretations, or past and present aligned epistemic interpretations.
Chapter 5: Conclusion

Modal expressions vary as to whether they are lexical or functional, and further vary in syntactic form. Within the set of functional modals, some languages have functional modals with fixed-force and variable-flavour (English, Spanish), while others have functional modals with variable-force and fixed-flavour (Salish, Gitksan). Further still, the constructions and contexts in which functional modals appear systematically determine their in-context meaning in principled – but cross-linguistically variable – ways. Further still, some fixed-force modals, like must, carry evidential presuppositional requirements. Altogether, the learning problems posed by modal expressions are rich and diverse. According to Hacquard:

“[t]he child has to figure out whether modals in her language are functional or not, and has to associate certain modal meanings with certain scope positions: modals with epistemic meanings scope high, modals with root meanings scope low. Such a mapping should be particularly difficult when the same words are used to express both epistemic and root modality. Hence, the hope is that the meaning/scope association is principled, if indirect, as I have argued here. If the association were arbitrary, we would expect incorrect meaning/scope mappings, and the ordering of modals and tense and aspect to flip over time. However, diachronic patterns show that this is not the case: modals develop in systematic ways.” (Hacquard 2013:7)

Hacquard suggests that because diachronic patterns (i.e., the Modal Cycle) are systematic, the child is mapping functional modals to meanings in principled, systematic ways. Our confidence that functional modals are learnable and systematically determined relative to Tense, Aspect and contextual cues rests primarily on the success of child acquirers at becoming linguistically mature speakers of human languages – all of which appear to exhibit the same principled relationships between Tense, Aspect and Modality. Child divergence from the input over the course of development is expected to be likewise systematic if L1 learners are the source of the diachronic patterns.

In this dissertation I have sought to investigate whether child input-divergent patterns align with the reanalyses we see in the historical record. I conducted a series of naturalistic and experimental studies (Chapters 3 and 4, respectively) focusing on modal expressions in English. Modals are well known to evolve in a unidirectional manner: (a) syntactically, from verbs to functional verbs to INFL-elements, and (b) semantically, from root meanings to epistemic meanings, along the Modal Cycle (§1.3). While theorists have argued for a causal link between acquisition and change for over a century (Paul 1920 [1880]; Meillet 1958 [1905-06], i.a.),
surprisingly little research has investigated whether predictions of the Child Reanalysis Proposal (CRP) make sense for child data (c.f. Baron, 1977; van Gelderen, 2011: 21-26; Cournane, 2014).

At the outset of this dissertation, I posed the following broad questions for child language research: (i) do child learners diverge from their input during development in such a way that, if sustained, their divergent analyses are compatible with the directional innovations of diachrony? And, (ii), if the answer to question (i) is affirmative, then what aspect of the language faculty or the acquisition process is responsible for the input-divergent biases seen in child language? This latter question gets to the heart of processes of change in the language system. The expected divergence patterns for child language, given the CRP, are in I and II, below.

I. For the syntactic cycle, child learners are expected to treat items that are lower (e.g., v) in the input as higher (e.g., INFL); for example, to treat main verbs as functional verbs or functional verbs as auxiliaries. These upwards mis-categorizations would drive the syntactic modal cycle if they were sustained.

II. For the semantic cycle, child learners are expected to overextend the meanings of content verbs to root meanings, and root modals to epistemic meanings; for example, to use premodal want to denote the future, or root modal can to denote epistemic possibility. These overextensions, if sustained, would drive the semantic modal cycle.

The studies presented in this thesis tested these hypotheses and moreover addressed fundamental questions about the development of modality. Chapter 3 addressed primarily Hypothesis I (the syntactic hypothesis), but also challenges the accepted conceptual development approach to the epistemic gap. The psychological approach to L1 modal acquisition argues in favour of Theory of Mind (ToM) development triggering epistemic meanings (e.g., Papafragou, 1998). According to various authors, epistemic modal uses lag behind root modal uses because more advanced ToM is required for epistemic meanings (and irrealis mood equivalents; Stephany, 1979, i.a.). Chapter 3 used evidence from a series of corpus studies to argue for a greater role of grammatical development (see de Villiers, 2007), namely propositional embedding, in explaining the Epistemic Gap and the timing of epistemic emergence. As the Modal Cycle is a record of grammatical changes, I have argued that child biases should also be grammatical in nature if they indeed underlie the diachronic re-categorizations and meaning overextensions. The studies in Chapter 3 achieve this broad goal.

81 The missing piece, which should ultimately be integrated into any complete model of language change, is the role of the community and external forces of change (i.e., Sociolinguistic variation and change).
First, I showed that the Epistemic Gap has been overstated as applying to modality in general, such that children use root modal expressions prior to epistemic modal expressions. The picture is less clear; lexical modal expressions that are dedicated epistemic markers in the adult language (e.g., *maybe, probably*) occur from earliest modal uses. The existence of the epistemic gap has been based entirely on functional modals that pose additional learning challenges since they are grammatically complex and polysemous. A broader assessment of modal expressions, including lexical modals, calls into question the presumed sharp divide between root modal uses and epistemic modal uses. Further, for both lexical and functional modals, early epistemic-like uses rarely explicitly relate to mental states, mental state reference increases after 3;6 (see; O’Neill & Atance, 2000). This evidence for more adult-like meanings for epistemic expressions appears several months later than the emergence of even the last appearing category of epistemic modal expressions (mental state verbs, see Shatz et al., 1983; Diessel, 2004, i.a.). Mental state reference is neither correlated with first lexical nor first functional epistemic uses.

I further showed that the Epistemic Gap likely exists independent of the lower frequency of epistemics in the input, and that use of epistemic expressions relative to the total number of modals produced by the child remains significantly lower than the input rates into the sixth year of life. Epistemic modals can thus be assumed to be more difficult than root modals on the basis of early delay and later avoidance, in line with current semantic theory that argues for more complex complement selection for epistemic modals (Hacquard, 2006, i.a.).

Lending further favour to a grammatical account are my findings that the emergence of epistemic meanings for functional modals in Sarah’s corpus (Brown, 1973) follow soon after or co-appear with: (a) the development of verbs taking sentential complements (*I want Daddy to help me* 3;3; see also Diessel, 2004), (b) the emergence of subject mismatch between matrix and embedded clauses (*I want that write on* 2;10), and (c) the development of overt infinitival *to* marking the change from Small Clause > IP in the embedded clause (*I want to see him* 2;10). I argue that this clustering of effects in the overt syntax of the child shows a growing ability to embed complex, propositional content. The ability to scope the modal operator over a proposition was predicted to precede epistemic uses of functional modals because these uses (and not their root counterparts) scope over propositions (grammatical represented by minimally IPs) (Hacquard, 2006, i.a.). Furthermore, there is a lack of a clear corresponding ToM milestone.
for a major event at three years old (see de Villiers, 2007), but the development of IP embedding is generalizable across children to sometime after 2;08 (e.g., Diessel, 2004).

Chapter 3 has shown that the Epistemic Gap only applies to functional modals like must or have (to), unsurprisingly as this set of modals has received pride of place in the modality literature and previous L1A studies. The Epistemic Gap exists not as a line between no epistemic meanings and the onset of epistemic meanings, but rather as a line between dedicated epistemic modals (ADV, like maybe) and the onset of epistemic uses of polysemous modals (INFL, like must). I argue that children prefer to use dedicated, monosemous, epistemic markers (=lexical is preferred to functional) early in development (see also Rett & Hyams, 2014). The contributions of conceptual (ToM) development do not define the timespan of the Epistemic Gap for functional modals and appear unable to explain the lexical > functional developmental asymmetry seen for epistemic meanings.

Chapter 3 also addressed grammatical development by providing explicit evidence for syntactic re-categorization biases (i.e., for treatment of expressions which belong to lower categories like v in the input, as higher categories, like INF, in the child grammar). I looked for corpus evidence for divergent Form ↔ Meaning mappings in all of Sarah’s modal and premodal expressions. This included meaning overextensions, syntactic re-categorizations and the distribution of the meanings relative to forms (categories and the lexemes that make up that category). The most compelling input divergent properties in Sarah’s data were the persistent omission of infinitival marking and be-support for those functional v modals that obligatorily occur with these morphemes (have to, got to, be going to, be supposed to). These omissions cause the functional v modals to occur in the same frames as the current set of INF modals. One possibility is that the omitted functional categories are indeed not present in the child grammatical representation, but rather the child analyses both target INF and target v as the same higher category (INF). The persistent omissions provide evidence that child learners show patterns of upwards miscategorization in line with the syntactic hypothesis (Hypothesis I).

The findings from Chapter 3 are limited by the fact that they have only explored English development and only with a handful of children. While the findings from the corpus studies are congruent with major milestones reported elsewhere in the literature (e.g., resolutions of the functional epistemic gap, onset of sentential embedding), it remains important to verify whether
other children show the tight correlation between onset of markers of sentential embedding and first epistemic uses of functional modals.

A logical extension of the current research would be to look at longitudinal development in languages that do not have INFL functional modals, but have functional \( \nu \) modals, like German or Dutch. These languages pattern like Old English and can speak directly to both the acquisition questions raised in Chapter 3, and the diachronic questions as they represent a living example of an earlier stage on the Modal Cycle. In these languages, do children go through a phase where they use functional \( \nu \) modals in INFL frames? Sarah showed this phase but her target grammar included INFL modals, thus the analogy between forms and meanings may have helped drive or sustain her input-divergent analyses. Further research looking at a language without INFL modals might be telling for whether grammar-internal child biases can create INFL modals from functional \( \nu \) modals in the learning process (Cournane & Tollan, in preparation).

Another important piece of the puzzle which deserves more attention is the earliest reanalysis on the Modal Cycle, that from premodal to modal (§1.3), both syntactically (typically, \( V > \nu \)) and semantically (typically, attitude verb > root modal). For Sarah’s data I treated a subset of premodals, and there were a few interesting uses of \textit{want} which suggested more abstract root modal uses (§3.4.4.2) which warrant further investigation. Further research should investigate whether children show input-divergent analyses of attitude verbs whereby these attitude verbs behave like root modals.

Chapter 4 presented two experimental studies, addressing primarily the semantic hypothesis (Hypothesis II), but also addressing the role of aspect marking in modal development, and the indirect evidential component of the modal \textit{must}. The Modal Flavour task was designed to investigate whether children attend to grammatical cues from aspect marking to determine the meaning of the functional modal \textit{must}, while the Modal Detection task investigated whether children attend to the modal \textit{must} independently of its complement and, if they do, whether they attend to the evidential difference between a proposition \( p \) and the same proposition modalized \textit{must} \( p \) (i.e., \textit{It is raining} vs. \textit{It must be raining}; Von Fintel & Gillies, 2010).

The Modal Flavour Task was a picture-preference task where participants heard either a modal-only sentence (e.g., \textit{Scott must wear his boots}) or a modal-aspect sentence (e.g., \textit{Scott must be wearing his boots}) and saw two pictures, one depicting a epistemic interpretation and
one depicting a deontic interpretation. The modal-aspect sentences were either Perfect (e.g., *Jada must’ve taken a bath*) or Progressive (e.g., *Michelle must be swimming*).

The results for the Modal Flavour task showed that adults behaved as expected with mostly epistemic interpretations for modal-aspect sentences and primarily deontic interpretations for the modal-only sentences. The three-year-old children exhibited an overall deontic-bias, choosing mostly deontic pictures for both sentence types; however, despite this overall deontic bias the three-year-old children still showed a contrast in the expected direction by choosing more epistemic pictures for the modal-aspect sentences than for the modal-only sentences. The three-year-old children also showed a Perfect advantage, choosing significantly more epistemic interpretations for the perfect modal-aspect sentences than for progressive modal-aspect sentences. I suggest that this is because Perfect aligns with the past and is more distinct from the present and future oriented aspects, which both align with [-PAST] tense.

In the two older child groups (four- and five-year-olds), we see the children became more adult-like for modal-aspect sentences, choosing an increasing number of epistemic pictures. However, for the modal-only sentences (e.g., *Jada must take a bath*) these same children become less adult-like. For these sentences adults chose primarily deontic pictures, as did the three-year-olds (at least in the Perfect condition). Both four-year-olds and five-year-olds chose mostly epistemic pictures. Thus, while the youngest children have an overall deontic bias, the oldest children do a full reversal to an overall epistemic bias. The five-year-olds further show no contrast between the sentence types, preferring epistemic interpretations for both.

The Modal Flavour Task revealed overextension in the direction predicted by the semantic component of the CRP (Hypothesis II). The older children showed more epistemic meanings than root for modal-only sentences than did adult controls. This construction is arguably the best measure of biased interpretations since both the root meaning and the epistemic meaning are available albeit with a strong bias towards the root reading for adults. The older children show an increasing epistemic bias in the predicted root > epistemic direction. This bias is not expected if children are solely and reliably using aspect cues to pick either future-oriented deontic interpretations, or past and present aligned epistemic interpretations. That younger children reliably use aspect cues to determine the flavour of *must*, but older children show an increasing treatment of the modal-only sentence as epistemic is compatible with the view that there is a grammar internal bias towards treating functional modals as epistemic.
The Modal Detection Task was a sentence-preference task where the participant saw either a picture with indirect evidence (=epistemic condition) or with direct evidence (=actual condition) and heard two sentences. One puppet would use an aspect-only sentence (i.e., Scott is wearing his boots) and the other puppet would use a modal-aspect sentence with *must* (i.e., Scott *must be wearing his boots*). The participant had to choose which puppet was paying the closest attention to the story and being the most careful with his words.

In the Modal Detection Task, adult controls virtually never selected the *must*-sentence in the actual (i.e. direct-evidence) condition, as *must* is unlicensed when the speaker has direct evidence for the proposition. In the epistemic (i.e. indirect-evidence) condition, adults chose mostly *must*-sentences, but also several aspect-only sentences. Both of these sentence types are expected in indirect evidence contexts. Assuming Von Fintel and Gillies (2010)’s analysis of *must* as a marker of indirect evidence which is otherwise just as strong as its unmodalized counterparts (*must be raining* vs. *is raining*), adults behaved as expected.

The child results showed that three-year-old children were at chance for both conditions, likely not understanding the task, but by four years old the children were clearly distinguishing between modal-aspect sentences (*must*-sentences) and the unmodalized aspect-only sentences. Both four- and five-year-old children chose overwhelmingly aspect-only sentences for both picture conditions, with five-year-olds at floor for *must*-sentence choices. In other words, children became more adult-like for Actual pictures but less adult-like for Epistemic pictures. Like in the Modal Flavour Task, the older children become increasingly input-convergent for one condition but increasingly input-divergent for the other. Overall, the child results suggest that children prefer unmodalized statements whether there is clear visual evidence or inferred evidence.

Taken together, the studies in Chapter 3 and Chapter 4 show that children have persistent input-divergent developmental biases in both the syntactic and semantic development of their modal expressions. In Chapter 3 we saw that Sarah’s omission patterns from two to five years old show persistent (indeed, increasingly input-divergent) syntactic re-categorizations in the expected upwards manner for functional v modals. Her functional v modals (*be going to, have to*) appear in INFL-appropriate frames (*I going go*; c.f. *I must go*) beyond the expected resolution of the relevant omitted functional morphemes (*BE, toINF*). In Chapter 4, we saw that children also show an increasingly input-divergent epistemic bias for the interpretation of the functional modal
must for modal-only sentences (e.g., Jada must take a bath) that adults interpret as deontic. These biases are compatible with the predictions of the CRP for the Modal Cycle, both for syntactic recategorization up the functional hierarchy and semantic overextensions from root to epistemic meanings.

This thesis has focused on functional modals, those modals with both root and epistemic interpretations. The corpus studies showed that these modals have a distinct developmental trajectory from lexical modal counterparts (adverbs, attitude/mental-state verbs), and that syntactic re-categorizations were most apparent for functional v modals (have to, be going to). These functional v modals are semantically polysemous and merge in an intermediate position in the verbal structure; syntactically, they can still be reanalysed upwards to become INFL functional modals and the child modal evidence suggests that children may indeed treat these modals in an upwards manner. Likewise, the experimental studies centred on the functional modal must, and manipulated the construction in which must appeared to determine whether children attend to cues from aspect or attend to indirect evidential requirements. Here too, in the Modal Flavour Task, children behaved in input-divergent ways compatible with the CRP rather than exhibiting a gradual progression towards adult-like behaviour.

Three important limitations of the experiments in Chapter 4 are (a) they directly test only one functional modal, must, (b) the number of children tested in each age group is relatively small (Min. n=5, Max. n=9), and (c) the three-year-old children in the Modal Detection Task are at chance, making it unclear whether they process must at all.

To address the first limitation, the same experimental methods in the Modal Flavour and Modal Detection Tasks should be extended to other functional modals, like have (to) or could, to determine whether the overextension patterns from root to epistemic occur for all categories (INFL, v) and across different lexemes (e.g., must, have). To address the second limitation more children need to be tested to increase the power of the statistical analysis. The significant findings from Chapter 4 appear to be robust, however, sampling effects are more likely to interfere with the signals from the data when the sample size is small.

This last limitation (c) is a problem because one goal of the Modal Detection Task was to test whether children attend to the modal at all. In the Modal Flavour Task the test sentences all have the same subject and modal and only the complement is manipulated (i.e., Scott must wear his boots vs. Scott must be wearing his boots). It was thus a concern that the children may rely
only on the complement properties to make their picture-preference choices. In the Modal Detection Task the test sentences either have *must* or do not, so we can assess whether the child is paying attention to the contribution of *must*. The three-year-old children were at chance in the Detection Task, so we cannot fully answer whether or not they attend to the contribution of *must*. To address this limitation, three-year-olds should be tested in a different task that does not also rely on complex evidential reasoning. For example, we can test whether they detect a deontic modal contribution (e.g., *The boys must wash with lots of soap*) compared to its unmodalized equivalent sentence (e.g., *The boys wash with lots of soap*); both sentences have the same complement but the modal shifts the orientation from present-habitual to future-obligation.

In this dissertation, I have laid-out the child-language predictions for the CRP generally and provided diverse methods for exploring child language data in relation to fundamental processes of change. This dissertation has provided proof of concept for the Child Reanalysis Proposal. It is my hope that this approach to the CRP, whereby researchers can investigate contemporary child data to address diachronic questions, is extended to other domains and linguistic cycles (e.g., the Agreement Cycle, the Copula Cycle, the Negation Cycle; see van Gelderen, 2009, 2011). This approach provides meaningful insights and methods for linking the dynamic fields of diachronic linguistics and language acquisition, both of which deal with development and change at their core. There remains much to explore, for modality and for other cycles of change, but future research will not have to start from scratch.

Do child learners analyse their input data in divergent ways, which, if they were to remain divergent and spread to other speakers, would become the innovations we see in the historical record? More simply, are child learner errors the source of diachronic innovations? These causal links have lacked empirical confirmation and have been mostly inferred from abstract analyses of historical data. This thesis shows that these questions can be systematically explored with actual child data, once we succeed at formulating the hypotheses at the right level of formal analysis.
References


Moore, C., Pure, K., & Furrow, D. (1990). Children’s understanding of the modal expression of
speaker certainty and uncertainty and its relation to the development of a representational
Experimental Investigation into the Acquisition of Quantifier-Negation Interaction in
English*. PhD Dissertation. University of Maryland, College Park, MD.
357–374.
Correlated with Linguistic Units. Paper presented at Society for Research in Child
Development, Kansas City, MO.
and M. D. Morrissey (Eds.), *Diachrony within Synchrony: Language History and
Press.
Noveck, I. A. (2001). When children are more logical than adults: Experimental investigations of
O’Neill, D. K., & Atance, C. M. (2000). “Maybe my daddy give me a big piano”: the
development of children’s use of modals to express uncertainty. *First Language, 20*(58),
29–52.
Elsevier.
Papafragou, A. (2001). Linking early linguistic and conceptual capacities: The role of theory of
mind. In A. J. Cienki, B. J. Luka, M. B. Smith (Eds.), *Conceptual and Discourse Factors in
Papafragou, A., Cassidy, K., & Gleitman, L. (2007). When we think about thinking: The
*Cognition, 103*, 253–299.
(Ed.), *Proceedings of ITRW on Experimental Linguistics in ExLing-2006* (pp. 201-204).
pragmatics of modal auxiliary verbs during the third year of life. In *Proceedings of the


Annotation of Modal Meanings in Natural Language (WAMM) (pp. 38–46). Potsdam, Germany.


