A Dynamic Systems Approach to Interpersonal Behavior as a Function of Interpersonal Values

by

Mengxi Dong

A thesis submitted in conformity with the requirements for the degree of Master of Arts
Department of Psychology
University of Toronto

© Copyright by Mengxi Dong 2015
A Dynamic Systems Approach to Interpersonal Behavior as a Function of Interpersonal Values

Mengxi Dong
Master of Arts
Department of Psychology
University of Toronto
2015

Abstract

According to the cybernetic theory of self-regulation proposed by Carver and Scheier (1998), a value serves as a reference point toward which an individual’s behavior will gravitate. The current study examined this hypothesis through the recruitment of 140 undergraduate students at a southern Ontario university. Participants self-reported their interpersonal values and were then divided into four-person groups that cooperated to solve the “Lost on the Moon” puzzle. The behaviour of each participant during interaction was videotaped and coded using the joystick technique (Sadler, Ethier, Gunn, Duong, & Woody, 2009) and then subjected to attractor analyses using GridWare (Lamey, Hollenstein, Lewis, & Granic, 2004). Contrary to our hypothesis, no attractors were identified, although average agentic behavior was significantly associated with agentic values. The failure to identify attractors was perhaps due to a lack of within person variability, as the participants were more strongly influenced by individual differences and group characteristics.
# Table of Contents

Table of Contents......................................................................................................................... iii

List of Tables ................................................................................................................................. iv

Chapter 1 Introduction..................................................................................................................... 1

Chapter 2 Methods.......................................................................................................................... 7

1 Participants and procedure.......................................................................................................... 7

2 Materials and measures.............................................................................................................. 7
   2.1 Circumplex Scales of Interpersonal Values (CSIV; Locke, 2000).......................................... 7
   2.2 Joystick Coding (Sadler, Ethier, Gunn, Duong, & Woody, 2009)........................................... 8
   2.3 Social Behavior Inventory (SBI; Moskowitz, 1994)............................................................... 9

3 Analytic approach ....................................................................................................................... 9
   3.1 The reliability and validity of the joystick data ................................................................. 9
   3.2 Density distribution analyses ........................................................................................... 10
   3.3 Averaged interpersonal behavior and interpersonal values ............................................. 10
   3.4 Assessment of attractors in the interpersonal state space ................................................. 11

Chapter 3 Results .......................................................................................................................... 13

1 Inter-rater reliabilities............................................................................................................... 13
   1.1 SBI ...................................................................................................................................... 13
   1.2 Joystick coding .................................................................................................................. 13

2 The validity of the joystick technique in four-person interactions........................................ 13

3 Density distribution analyses ................................................................................................... 14

4 Averaged interpersonal behavior and interpersonal values ................................................. 15

5 Attractor analyses .................................................................................................................... 16

Chapter 4 Discussion .................................................................................................................... 18

References ....................................................................................................................................... 23
## List of Tables

**Table 1.** Multitrait-multimethod matrix for joystick coding and SBI coding.

<table>
<thead>
<tr>
<th></th>
<th>Joystick</th>
<th></th>
<th>SBI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agency</td>
<td>Communion</td>
<td>Agency</td>
</tr>
<tr>
<td>Joystick</td>
<td>.658*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communion</td>
<td>.366**</td>
<td>.527*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[.213, .502]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Agency</th>
<th>Communion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SBI</td>
<td>.918**</td>
<td>.310*</td>
<td>.96</td>
</tr>
<tr>
<td></td>
<td>[.887, .941]</td>
<td>[.152, .453]</td>
<td>[0.96, 0.99]</td>
</tr>
<tr>
<td>Communion</td>
<td>-.041</td>
<td>.331**</td>
<td>-.123</td>
</tr>
<tr>
<td></td>
<td>[-.206, .125]</td>
<td>[.175, .471]</td>
<td>[-0.283, .044]</td>
</tr>
</tbody>
</table>

*Note. SBI = Social Behavior Inventory (Moskowitz, 1994).*  
* p < 0.01, ** p < 0.001  
a. Instead of Cronbach’s alpha, the average reliabilities of the time-series calculated through the method recommended by Sadler et al., (2009) are displayed here.
Table 2. Variance estimated at each level in density distribution analyses.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Agency</th>
<th>Variance</th>
<th>ICC</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location (mean)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td>&lt; .001</td>
<td>&lt; .001</td>
<td>&lt; .01</td>
<td>374</td>
<td>1.00</td>
</tr>
<tr>
<td>Person</td>
<td></td>
<td>27733.040</td>
<td>.897</td>
<td>39.14</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>3200.545</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Size (standard deviation)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td>596.439</td>
<td>.449</td>
<td>9.706</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Person</td>
<td></td>
<td>296.071</td>
<td>.223</td>
<td>4.417</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>437.142</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shape (skew)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td>0.003</td>
<td>.010</td>
<td>.194</td>
<td>374</td>
<td>.846</td>
</tr>
<tr>
<td>Person</td>
<td></td>
<td>0.166</td>
<td>.624</td>
<td>15.439</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>0.098</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shape (kurtosis)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td>&lt; .001</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
<td>374</td>
<td>1.000</td>
</tr>
<tr>
<td>Person</td>
<td></td>
<td>1.157</td>
<td>.422</td>
<td>9.001</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>1.585</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| Parameter                  |        |            |       |      |    |     |
| <strong>Communion</strong>              |        |            |       |      |    |     |
| Location (mean)            |        |            |       |      |    |     |
| Group                      |        | 2141.946   | .420  | 8.956| 374| &lt; .001 |</p>
<table>
<thead>
<tr>
<th></th>
<th>Person</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1908.919</td>
<td>.374</td>
<td>7.811</td>
<td>374</td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Size (standard deviation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>637.700</td>
<td>.725</td>
<td>20.354</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Person</td>
<td>94.315</td>
<td>.107</td>
<td>2.086</td>
<td>374</td>
<td>.038</td>
</tr>
<tr>
<td>Residual</td>
<td>147.638</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape (skew)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>.147</td>
<td>.309</td>
<td>6.283</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Person</td>
<td>.108</td>
<td>.227</td>
<td>4.514</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Residual</td>
<td>.220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape (kurtosis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>3.447</td>
<td>.364</td>
<td>7.548</td>
<td>374</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Person</td>
<td>1.491</td>
<td>.157</td>
<td>3.079</td>
<td>374</td>
<td>.002</td>
</tr>
<tr>
<td>Residual</td>
<td>4.543</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 1
Introduction

To what extent and how do interpersonal values predict interpersonal behaviors? Interpersonal theory argues that interpersonal behaviors are motivated: A person does not merely act in other people’s presence; rather, through his or her behaviors, the person is trying to elicit valued reactions from the interaction partners (Leary, 1957). If a person values praise and admiration from others, the person is likely to boast of his or her talents and achievements. In other words, interpersonal behaviors are motivated by interpersonal values, where values are defined as the preference for certain outcomes or modes of conduct (Rokeach, 1973). Interpersonal values, then, are defined by contemporary researchers as the preferences for certain interpersonal outcomes or modes of conduct (Horowitz, 2004; Locke, 2000). In line with evidence showing the correlations between values of a wide range of contents and their corresponding behaviors (Bardi & Schwartz, 2003), it has been shown that interpersonal values predict interpersonal behaviors (Locke & Sadler, 2007). Contemporary researchers organize the contents of interpersonal values (sometimes also referred to as interpersonal motives) into two broad, abstract categories: agency and communion (Horowitz, 2004; Locke, 2000). Agentic values refer to the desire to control and dominate other people. Communal values refer to the desire to connect and affiliate with other people. These two broad categories of values are thought to reflect two evolutionary adaptations to the ancestral environment of humans, where other humans were likely to be the most important and salient feature (Simpson, Griskevicius, & Kim, 2011; Buss, 1991). Agentic and communal motives helped human ancestors to successfully survive and reproduce through promoting their positions in the social hierarchy (thus ensuring resources that could then be shared with friends and families) and through maintaining harmonious reciprocal relationships with other members of the society (Simpson, Griskevicius, & Kim, 2011). Reflecting the themes of agency and communion, the interpersonal circumplex model is prevalently used to measure interpersonal values, along with other interpersonal dispositions and behaviors.

The interpersonal circumplex is a two-dimensional model where all interpersonal dispositions (e.g., values) and behaviors can fall within the circular array defined by the orthogonal axes of agency and communion. The interpersonal circumplex model has circular properties. The
distance of a disposition or behavior from the origin of the circle indicates its extremeness (Kiesler, 1983). Dispositions and behaviors that are closer together on the circle are the most similar; likewise, dispositions and behaviors at two opposite poles of the circle (i.e., 180° away from each other) are opposite of each other (Kiesler, 1983). Correlations between dispositions and/or behaviors are strongest when they are along the same radius of the circle; correlations are weakest when dispositions and/or behaviors are along two radii at 90° angle with each other (Kiesler, 1983). Since its conception, the interpersonal circumplex has demonstrated its utility in describing the contents of a wide range of constructs (e.g., values, behaviors, problems) and has been applied to many fields of study (e.g., relationship, psychopathology, psychotherapy) (Horowitz & Strack, 2010). The interpersonal circumplex has also demonstrated agreement with the Five Factor Model of personality. The two interpersonal traits of the Five Factor Model, Extraversion and Agreeableness, have been found to be rotational variants of the agentic and communal axes (Costa & McCrae, 2011; Trapnell & Wiggins, 1990). Indeed, the interpersonal circumplex and the Five Factor Theory (McCrae & Costa, 2008) are thought to be two perspectives that are “so deeply intertwined that they are better seen as two different views of the same topic” (Costa & McCrae, 2011, p. 91) that converge with and complement each other. The interpersonal circumplex is thus an excellent model for conceptualizing interpersonal values and behaviors both because of its wide application and convergence with the well-established Five Factor Model.

Presently, most research utilizing the interpersonal circumplex to examine the relationship between interpersonal dispositions and behaviors embody a static, stable view of the relationship (e.g., Locke & Sadler, 2007). That is, the researchers mostly work with the mean levels of the interpersonal dispositions and the interpersonal behaviors of interest. Yet, interpersonal theory views interpersonal behaviors as the product of both intrapersonal dispositions (e.g., values) and interpersonal situations (i.e., the behaviors of the interaction partner(s)). This view emphasizes that interpersonal behaviors vary meaningfully across different situations. Under this view, then, relying on mean levels alone may not provide a comprehensive portrait of the individual’s behaviors. Since Walter Mischel’s *Personality and Assessment* (1968) and the person-situation debate, there has been recognition of the within-person variability of behaviors across situations. Recently, researchers have demonstrated that although the behaviors of individuals vary across situations, the pattern of within-person variability is stable (Fleeson, 2001; Shoda, Mischel, &
Wright, 1994). Similar findings of the stability of within-person variability have also been demonstrated within interpersonal theory and research (Fournier, Moskowitz, & Zuroff, 2008; Moskowitz & Zuroff, 2004). Given the principle of interpersonal theory, which highlights the interaction between disposition and situation in determining behavior, and given the general evidence of within-person variability in the expressions of dispositions across situations, the research on the relationship between interpersonal values and interpersonal behaviors should also embrace a more dynamic view, where within-person variability and situational influences are taken into account. Indeed, social-psychological research on the relationship between values and behaviors has already demonstrated the importance of situational influences on the behavioral expression of values. Bardi and Schwartz (2008) found that if a value is important for the group, the relation between the personal importance of that value and its corresponding behavior is weak. In other words, the dispositional influence on behaviors becomes weaker when the situational influence is stronger. Thus, for a comprehensive picture of the influence of values on behavior, it is not enough to just examine the static question of whether values are correlated with behaviors; a more dynamic question of how values are manifested in behaviors need to be addressed. To this end, the work of Carver and Scheier (1998) on the self-regulation of behavior may provide the theoretical and methodological grounds.

Carver and Scheier’s conceptualization of how behaviors are self-regulated is particularly relevant for the study of the relationship between behaviors and values because it outlines a mechanism through which internal standards are translated into behaviors. Drawing from Weiner’s (1948) cybernetics, a science of communication and control, the central idea in Carver and Scheier’s model is the negative feedback loop. A basic negative feedback loop is composed of four elements: a) an input function that reads the current status of the system, b) a reference value towards which the system tries to move, c) a comparator that detects whether a discrepancy exists between the input value and the reference value, and d) an output function that acts on the environment to reduce the discrepancy (Carver & Scheier, 1998). It has been argued that the hierarchical organization of negative feedback loops underlies the self-regulation of organisms (Powers, 1973). Outputs of a negative feedback loop at a higher level in the hierarchy provide the reference value of the negative feedback loop immediately below it in the hierarchy.

For humans, the feedback loop at the highest level of the hierarchy has reference values that are very general and abstract. Termed system concepts, examples of these reference values include
the idealized self-image (e.g., “be a good person”) or the idea of an ideal relationship. The output of the highest feedback loop provides the reference value for the next (lower) level of feedback loop; labeled as principles, these reference values include the guiding principles implied by the system concepts (e.g., “be a considerate person”). Principles, in turn, provide reference values for programs (e.g., “switch seats with another passenger on the plane, so that she can sit with her child”) underneath it in the hierarchy. Finally, programs elicit outputs (motor sequence; e.g., “unfasten the seat belt and stand up”) that serve as the reference value for the feedback loop beneath it, the output of which exerts on the environment. Under Carver and Scheier’s model, then, the broad, abstract values of agency and communion would serve as the reference values at the highest level of the hierarchy of nested negative feedback loops. The broad agentic and communal values would then lead to values of intermediate abstractions, like the ones that are typically used as items in measures of interpersonal values (e.g., “it is important that I not make them angry” from the Circumplex Scales of Interpersonal Values; Locke, 2000), which then lead to a more specific plan of action (Horowitz, 2004). The specific plan of action finally leads to overt behavior. It should be noted that rather than in a step-wise fashion, feedback processes occur simultaneously across all levels of hierarchy (Carver & Scheier, 1998). That is, when a behavior that reduces the discrepancy between the goal and the current state is carried out at the lowest level of hierarchy of negative feedback loops, discrepancy reduction also happens simultaneously across all levels of the hierarchy, instead of being delayed until the behavior is successfully completed at the lowest level of the hierarchy. This way, the model provides a mechanism through which abstract values can be linked to concrete behaviors. Through the hierarchical organization of negative feedback loops, therefore, a successfully self-regulating person should always resort to a certain range of behaviors that reflect his or her values. This idea of a system making returns to a certain range of states after deviations can be best described by dynamical systems theory.

In the broadest sense, a dynamical system is “simply a set of elements that undergo change over time by virtue of interactions among the elements” (Vallacher, Read, & Nowak, 2002, p. 266). Elements of a dynamical system are said to be interactive because the relationship between a predictor and an outcome is dependent on other predictors. Such interactions among the elements gives rise to the hallmark nonlinearity of dynamical systems. In nonlinear systems, changes in one variable are not related proportionally to changes in another; rather, small changes in one
variable could result in disproportionally large changes in another variable. Although dynamical systems theory has only recently been applied in psychological research (e.g., Butler, 2011; Nowak, Vallacher, & Zochowski, 2005; Johnson & Nowak, 2002; Shoda, LeeTiernan, & Mischel, 2002; Vallacher, Read, & Nowak, 2002), the idea of nonlinearity has been familiar to psychologists for a long time through ideas like threshold effects and interactions (Carver, 1997). Most of the phenomena studied by psychologists are determined by multiple variables that can affect each other. In the case of values and behaviors, the relationship between the two variables is clearly nonlinear, as it has been shown to be affected by situational factors (Bardi & Schwartz, 2008). As interpersonal theorists propose that interpersonal behaviors are jointly determined both by one’s behavioral dispositions and by the behavior of interaction partner (Kiesler, 1983), a dynamical systems theory perspective may better account for the relationship between interpersonal values and interpersonal behaviors.

In dynamical systems theory, the concepts of phase space and attractors (Carver & Scheier, 1998; Vallacher & Nowak, 1997) may be particularly useful in conceptualizing the relationship between interpersonal values and behaviors. A phase space is the array of all possible states, usually defined by two or three axes, that a system can occupy. A phase diagram is the trajectory in phase space through which the system travels over time. In a system’s phase diagram, there are sometimes certain regions that the system occupies for longer durations of time and returns to more often than other regions. These regions are called attractors. Metaphorically speaking, attractors exert a “gravitational pull” on the system, such that the system is always pulled back to its proximity whenever there is a deviation. Under Carver and Scheier’s model of self-regulation, values, through the hierarchy of negative feedback loops, exert pull on the trajectory of behaviors so that when self-regulation is successful, attractors in the trajectory reflect values. The advantage to this approach in portraying the relationship between values and behaviors lies in its ability to capture the dynamical qualities of the relationship. For example, the flexibility of a person’s behavior can be indicated by the extent to which his or her behavior trajectory deviates from the attractors. It is also possible for a person’s behavior trajectory to show multiple attractors, instead of one. In the case of multiple attractors, the contents and relative strengths (as indicated by the amount of time spent in and the number of returns to the attractors) of the attractors can potentially reveal a more nuanced and comprehensive picture of the roles that situations and values play in predicting behaviors.
The primary purpose of the present study, therefore, was to examine whether people’s interpersonal values can predict the locations of the attractors in their interpersonal behaviors. We predicted that the location of the attractors shown in the participants’ behavior over time would correlate with their self-reported interpersonal values. Given findings from previous research (Johnson & Nowak, 2002), it is possible for some people to show no attractors at all in their behavioral trajectories and for others to show multiple attractors. Although these possibilities would be examined in the present study, we made no a priori hypotheses regarding what factors might predict the presence and number of attractors. As attractor analyses require time-series data, we have chosen the joystick technique developed by Sadler, Ethier, Gunn, Duong, and Woody (2009) to measure behavior as a time-series of states. The joystick technique is particularly appropriate for our purposes because it measures the shifts of an individual’s behavior within a Cartesian plane defined by the axes of agency and communion. The current study measured the behavior of each participant in four-person interactions using the joystick technique. As the joystick technique had previously only been used on dyadic interactions, the current study would also explore the reliability and validity of the technique when applied to group interaction. The choice of group interactions as the setting of the current study also allowed us to delineate the contextual and dispositional influences on behavior; we would use the density distribution analyses developed by Fleeson (2001) to delineate these influences. Specifically, we would compute the location (mean), size (standard deviation), and shape (skew and kurtosis), distribution parameters that were found to be stable by Fleeson (2011), of the time-series. We would then examine the proportions of variance in each of the parameters that were accounted for by contextual and dispositional factors. Delineating the influence of contextual and dispositional factors on behavior would provide us with a more comprehensive understanding of the results from the attractor analyses, as it would allow us to put the intra-individual attractors against the backdrop of context and dispositions.
Chapter 2
Methods

1 Participants and procedure

Undergraduate UTSC students were recruited through on-campus advertisement (N=140; 64 males, 76 females). Participants were divided into 40 four-person groups. Participants in each group were of the same sex and were previously unacquainted with each other. Prior to the group interaction, participants completed a battery of questionnaires, including the Circumplex Scales of Interpersonal Values (CSIV; Locke, 2000) and were asked to independently solve the puzzle “Lost on the Moon” (Hall, 1971). Participants then engaged in a group interaction, during which they were asked to co-operate and solve the “Lost on the Moon” puzzle together. The participants had up to 45 minutes to complete the puzzle together (although some groups completed the task sooner). Each group interaction was video-recorded by four cameras, with each participant featured by one camera. Subsequent to the group interaction, the participants completed another battery of questionnaires. After the post-interaction questionnaire session, participants were debriefed, compensated, and dismissed.

To assess the interpersonal behaviors demonstrated by the participants during the group interaction, undergraduate research assistants were trained to code the video-recorded behavior of each participant using the joystick technique (Sadler, Ethier, Gunn, Duong, & Woody, 2009) and the Social Behavior Inventory (SBI; Moskowitz, 1994).

2 Materials and measures

2.1 Circumplex Scales of Interpersonal Values (CSIV; Locke, 2000)

The CSIV is a measure of self-reported interpersonal values based on the interpersonal circumplex model (Wiggins, 1991). The CSIV divided the interpersonal circumplex into octants. Each octant is measured by eight items, each of which presents the hypothetical outcome of an interpersonal situation. Participants were asked to rate the importance of each item on a scale from 0 (not important) to 4 (extremely important). The eight subscales are Agentic (e.g., “It is
important that they acknowledge when I am right”), Agentic and Separate (e.g., “It is important that I keep the upper hand”), Separate (e.g., “It is important that they not know what I am thinking or feeling”), Submissive and Separate (e.g., “It is important that I not say something stupid”), Submissive (e.g., “It is important that I not make them angry”), Submissive and Communal (e.g., “It is important that they like me”), Communal (e.g., “It is important that they show concern for how I am feeling”), and Agentic and Communal (e.g., “It is important that they respect what I have to say”). Subscale scores can be combined to generate overall scores for the agentic and communal axes.

2.2 Joystick Coding (Sadler, Ethier, Gunn, Duong, & Woody, 2009)

The joystick technique was used to assess the moment-to-moment levels of agency and communion in participants’ behavior during the interaction. This technique utilizes a computer joystick apparatus that consisted of a joystick connected to a Dell Inspiron 6000 computer running the Windows XP operating system. On the computer screen, a joystick-monitoring software program (Sadler, 2011) displays a Cartesian plane defined by two axes, each ranging from -1,000 to 1,000. The axes correspond to the agentic and communal axes of the interpersonal circle. For the vertical axis, the top and bottom endpoints are respectively labelled dominant and submissive. For the horizontal x-axis, the left and right endpoints are respectively labelled unfriendly and friendly. The cursor of the joystick is represented by a dot in the Cartesian plane.

Using the computer joystick apparatus and the joystick-monitoring program, four intensively trained undergraduate research assistants (who were unacquainted with the participants) coded the interpersonal behavior of each participant. Specifically, the video-recorded interaction of the group was played using VLC Player in a window adjacent to the joystick-monitoring program. A coder watched the behavior of one participant and moved the joystick cursor within the Cartesian plane in the joystick-monitoring program according to how agentic and communal he or she judged the participant to be at that moment. The program sampled the position of the joystick cursor at 0.5-second intervals, generating time-series data for each participant’s levels of agency and communion throughout the interaction. To avoid coder fatigue, the interaction videos were cut into and coded as 15-minute clips. The data from a participant could thus be divided into
from 1 (if the group interaction only lasted 15 minutes) to 3 clips (if the group interaction lasted for the full 45 minutes).

2.3 Social Behavior Inventory (SBI; Moskowitz, 1994)

Following Sadler and colleagues (2009), the SBI, a more traditional and well-validated observational scale of interpersonal behavior, was included to validate certain aspects of the joystick data. The SBI is a 46-item scale of interpersonal behavior based on the interpersonal circumplex model (Wiggins, 1991). The SBI consists of 12 items for Dominance (e.g., “set goal(s) for the other(s)”), 12 items for Submissiveness (e.g., “waited for other people to act or talk first”), 12 items for Agreeableness (e.g., “listened attentively to the others”), and 12 items for Quarrelsomeness (e.g., “made a sarcastic comment”). One item is scored for both Dominance and the Quarrelsomeness (i.e., “criticize others”); one item is scored for both Submissiveness and Agreeableness (i.e., “went along with others”). Using the SBI, two undergraduate research assistants (unacquainted with the participants and who did not participate in joystick coding) rated each participant’s behavior during the interaction at the level of each clip. The ratings for the clips were then combined to form one agency score and one communion score for each participant. The ratings were on a scale from 1 (almost never) to 6 (almost always). The SBI subscales were combined to generate overall scores for the agentic and the communal axes.

3 Analytic approach

Unless otherwise specified, the following analyses were conducted using R (R Core Team, 2014). All multilevel models were estimated using the nlme package (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2014).

3.1 The reliability and validity of the joystick data

The inter-rater reliabilities of the joystick time-series were computed using the approach specified by Sadler and colleagues (2009). In this approach, the true score (shared) variance is compared to the total variance. True score variance is estimated as the mean of the cross covariances of the individual raters’ time series, and total variance is estimated as the variance of the aggregated (across coders) time series. Having established the reliability of joystick coding, we aimed to establish the validity of joystick coding against the SBI scores. The time-series data
were collapsed such that each participant had one agency score and one communion score. A multitrait-multimethod matrix (MTMM; Campbell & Fiske, 1959) using Pearson product-moment correlation was computed to compare the joystick coding to the SBI.

### 3.2 Density distribution analyses

Although the main hypothesis of the current study utilized attractor analyses, which are intrapersonal analyses, each participant’s behavior actually occurred under group context. Therefore, it is desirable to also examine the effect of the group on individual behavior in order to augment our understanding of the results from the within-person analyses. To this purpose, density distribution analyses similar to those reported by Fleeson (2001) were conducted.

Density distribution analyses allow the estimation of the stability of participants’ agentic and communal behavior as well as the source of variance in their behavior. For density distribution analyses, the joystick-generated time series for each participant were analyzed by clip. Each clip was 15-minute long, with 1800 data points, while each participant had from 1 to 3 clips depending on the length of the group interaction. The mean, standard deviation, skew, and kurtosis were computed for each clip for each participant. Multilevel modeling was used to examine the amount of variance in mean, standard deviation, skew, and kurtosis accounted for by between-group differences, by between-people differences, and by residual variance, which included within-person variance. For each of the mean, standard deviation, skew, and kurtosis, a 3-level multilevel baseline model was used to account for clips nested within participants and participants nested within groups, by estimating a random intercept for each participant and a random intercept for each group. Unstructured covariance matrices and the between-within method of estimating degrees of freedom were used. Intraclass correlation coefficients (ICCs) for a particular level were calculated as the proportion of variance uniquely explained by that level relative to the total variance.

### 3.3 Averaged interpersonal behavior and interpersonal values

The averaged joystick scores for each participant were modeled as a function of their self-reported interpersonal values, as measured by the CSIV. The relationship between averaged joystick scores and interpersonal values was estimated, such that it could be compared to the relationship between the locations of the attractors and interpersonal values. This was done to assess whether attractors could capture unique aspects of the data that the means could not.
level multilevel models were used to account for participants nested within group by estimating a random intercept and a random slope for each group. Unstructured covariance matrices and the between-within method of estimating degrees of freedom were used.

3.4 Assessment of attractors in the interpersonal state space

Attractors were assessed using the state space grid method (Hollenstein, 2013; Hollenstein, 2007) and the related visualization software, GridWare (Lamey, Hollenstein, Lewis, & Granic, 2004). The state space grid method is a graphical approach that plots the behavioral trajectory of a system as it proceeds in real time through a grid that represents all possible behavioral states. Specifically, the state space grid of the present study had an x-axis of communion and a y-axis of agency. GridWare was used to visualize the joystick data for each participant into a state space grid diagram, and provide the duration that the participant’s behavioral trajectory spent in each of the cells in the grid. Then, attractors were identified using a winnowing procedure (Lewis, Lamey, & Douglas, 1999). The winnowing procedure consists of a series of runs, shifting from all cells occupied by the system to a smaller set of cells with each run. For each run, the expected values for cell duration are calculated as the total duration of the behavioral trajectory divided by the total number of cells occupied. Then, the actual duration the participant spent in each cell is compared with the expected values, and the squared deviations are divided by expected values, much like the $\chi^2$ statistics. The sum of squared deviations is then divided by the number of cells in the current run of analysis, providing a mean-squared heterogeneity value for the whole set of cells. Cells with the lowest duration values are then excluded in the next run (only one duration value is eliminated from each run). The procedure is repeated for the next run. As the number of runs increases, the heterogeneity value becomes smaller because of eliminated cells. The whole series of heterogeneity values is examined for a large drop or “scree”. A 50% drop in heterogeneity has been proposed as the threshold for categorizing a cell as an attractor (Hollenstein, 2013; Lewis, Lamey, & Douglas, 1999). After the largest drop in heterogeneity values, the remaining cells in the analysis are considered to be homogeneous (i.e., of equivalent durations), and these cells are identified as attractors. In the present analyses, the number and location(s) of each participant’s attractor(s) in the state space grid were recorded and correlated with their self-reported interpersonal values. To prepare the data for GridWare analyses, we transformed the negative-1000-to-positive-1000 scale on which agency and communion were rated to a negative-10-to-positive-10 scale by dividing the scores by 100 and rounding the results.
to the closest integer. Our decision to rescale the dimensions of the grid space to the size of 21-by-21 was based on our experience of what the GridWare program could handle as well as the joystick coders’ reports on the meaningful division of the joystick plane that they had in mind while coding.
Chapter 3
Results

1 Inter-rater reliabilities

1.1 SBI

Pearson’s product-moment correlations were computed to assess the reliabilities between the two SBI coders. The inter-rater reliability for agency ratings was .835, 95% CI [.776, .879], $t(138) = 17.807, p < 0.001$. The inter-rater reliability for communion ratings was .417, 95% CI [.270, .545], $t(138) = 5.386, p < 0.001$. The magnitude of the inter-rater reliability for communion was consistent with previous research concerning observers’ agreement on the personality trait Agreeableness (Connelly & Ones, 2010). Given that Agreeableness has been demonstrated to be a rotational variant of the communion axis (Trapnell & Wiggins, 1990), the inter-rater reliability in the present study is not surprising. Thus, for all subsequent analyses, the SBI scores rated by the two coders were combined to generate one SBI agency and one SBI communion scores each participant.

1.2 Joystick coding

The inter-rater reliabilities for the joystick time-series were computed using the approach specified by Sadler and colleagues (2009). The true score (shared) variance was compared to the total variance. True score variance was estimated as the mean of the cross covariances of the individual raters’ time series, and total variance was estimated as the variance of the aggregated (across coders) time series. The average reliability was .658 for agency and .527 for communion, suggesting reasonable agreement. All of the following analyses, except for the attractor analyses, were conducted aggregating across all coders and across all time points (i.e., the time series were collapsed into a single score for agency and a single score for communion, for each participant).

2 The validity of the joystick technique in four-person interactions

Having established its reliability, we validated the joystick coding through a multitrait-multimethod matrix (MTMM; Campbell & Fiske, 1959). Pearson product-moment correlations
were computed to compare the joystick coding against the more conventional and well-validated SBI. Pearson’s correlation requires that the variables be independent of each other; however, as participants interacted in groups, their levels of agency and communion were likely not independent from those of the other participants, because of processes like interpersonal complementarity (e.g., Sadler et al., 2009). For instance, one participant’s communal behaviors might elicit communal behaviors from the other participants in his or her group; alternatively, one participant’s dominant behaviors might elicit submissive behaviors from the other participants in his or her group. Indeed, intraclass correlation coefficients (ICC) suggested group nesting in joystick communion, $\rho = .492$, $t(138) = 6.636$, $p < .001$, and SBI communion, $\rho = .259$, $t(138) = 3.147$, $p = .002$, although joystick agency, $\rho < .001$, $t(138) = 0$, $p = 1.000$, and SBI agency, $\rho < .001$, $t(138) = 0$, $p = 1.000$, did not show evidence of nesting. To circumvent this problem, joystick agency, joystick communion, SBI agency, and SBI communion were all group-mean-centered and the resultant group-mean-centered scores were used to compute Pearson product-moment correlations in the MTMM matrix. The MTMM matrix, displayed in Table 1, suggests that joystick agency had both convergent and discriminant validity while joystick communion has convergent validity.

3 Density distribution analyses

To assess the respective influence of group-level and person-level variance on joystick agency and communion scores, density distribution analyses were conducted. For each clip, the density distribution parameters (mean, standard deviation, skew, and kurtosis) were estimated from the joystick-coded agency and communion time-series. A baseline multilevel model was then tested for each density distribution parameter, with clips nested within participants and participants nested within groups. ICCs were then calculated from these baseline models to determine the extent of group-level and person-level dependencies in the data. The ICCs were summarized in Table 2.

For agency, differences between groups did not account for any variance in the location (mean) of the density distribution for agency, $\rho < .001$, $t(374) < .001$, $p = 1.000$. The majority of the variance was accounted for by individual differences, $\rho = .897$, $t(374) = 39.140$, $p < .001$, while a small amount of residual variance remained, which included the intra-individual variance the participants demonstrated across the 3 clips of the interaction. For the size (standard deviation)
of the density distribution, differences between groups accounted for half of the variance, \( \rho = .449, t(374) = 9.706, p < .001 \), while individual differences, \( \rho = .223, t(374) = 4.417, p < .001 \), and the residual accounted for the other half. Group differences did not significantly account for the variances in skew, \( \rho < .001, t(374) < .001, p = 1.000 \). Individual differences accounted for more than half of the variance in skew, \( \rho = .624, t(374) = 15.439, p < .001 \); whereas the residual variance accounted for the remaining 36.6% of variance. The variance in kurtosis was almost equally accounted for by individual differences, \( \rho = .422, t(374) = 9.001, p < .001 \), and the residual including intra-individual differences.

For communion, the variance in location is significantly accounted for by group differences, \( \rho = .420, t(374) = 8.956, p < .001 \), while individual differences, \( \rho = .374, t(374) = 7.811, p < .001 \), and the residual variance (including intra-individual differences) also each accounted for a significant amount of variance. Group differences accounted for the majority of the variance in size, \( \rho = .725, t(374) = 20.354, p < .001 \). Individual differences, \( \rho = .107, t(374) = 2.086, p = .038 \), and the residual variance accounted for about an equal amount of the remaining variance in size. Group differences, \( \rho = .309, t(374) = 6.283, p < .001 \), and individual differences, \( \rho = .227, t(374) = 4.514, p < .001 \), both significantly accounted for variance in skew; however, the majority of the variance was residual variance. Group differences, \( \rho = .364, t(374) = 7.548, p < .001 \), and individual differences, \( \rho = .157, t(374) = 3.079, p = .002 \), both significantly accounted for variance in kurtosis; however, the residual variance, which included intra-individual differences, accounted for more variance than the group and the individual levels.

4 Averaged interpersonal behavior and interpersonal values

As a preliminary step and point of comparison for the dynamic systems approach in examining the relationship between interpersonal values and interpersonal behaviour, we used interpersonal values to predict the averaged joystick agency and communion scores for each participant. The observed joystick agency scores were significantly predicted by the self-reported CSIV agency scores, \( b = 141.633, SE = 59.272, t(104) = 2.390, p = .019 \), \( semi\-partial R^2 = .052 \). Pseudo \( R^2 \) was calculated for each level according to the recommendations of Snijders and Bosker (1999, 1994). At the first level, the model reduced a large amount of error when predicting the level of
agentic behaviour for any given participant, $Pseudo-R^2_1 = .241$. At the second level, the model also reduced a large amount of error when predicting the level of agentic behaviour for any given group, $Pseudo-R^2_2 = .241$. The ICC was not significant, $q < .001$, $t(138) < .001$, $p = 1.000$, suggesting that the joystick agency scores of participants of the same group were independent and that a multilevel analysis was not necessary for these data; however, multilevel analysis was used to enable comparison with other analyses where multilevel modeling was necessary.

The observed joystick communion scores were not significantly predicted by the self-reported CSIV communion scores, $b = 6.698$, $SE = 8.511$, $t(104) = .787$, $p = .433$. Pseudo $R^2$ was calculated for each level according to the recommendations of Snijders and Bosker (1999, 1994). The model reduced prediction error of joystick communion scores at neither Level 1, $Pseudo-R^2_1 = -.001$, nor Level 2, $Pseudo-R^2_2 < .001$. The ICC was significant, $q = .492$, $t(138) = 6.636$, $p < .001$, suggesting that the joystick communion scores of participants of the same group were not independent and confirming that a multilevel analysis was necessary for these data.

5 Attractor analyses

Based on the winnowing procedure recommended by Hollenstein (2013), we did not find any cell that met the criterion of attractors (i.e., distinguished by a 50% drop in heterogeneity value). Nonetheless, we decided to explore the correlation between the locations of the cells in which the participants’ trajectories spent the longest time and the participants’ self-reported values. We did this analysis despite the failure to identify any attractors because, although commonly used, the decision on the 50% drop as attractor identification criterion is somewhat arbitrary. Therefore, multilevel-modeling was used to explore the correlation between the location of the most occupied cell and self-reported interpersonal values. The location of each participant’s most occupied cell was recorded as one score on the agency axis and one score on the communion axis. The resultant agency scores for the most occupied cells were modelled as a function of group-mean-centered self-reported agentic values as measured by the CSIV. Prior to analysis, the agentic value scores were group-mean-centered. A 2-level multilevel model was used to account for participants nested within group by estimating a random intercept and a random slope for each group. An unstructured covariance matrix and the between-within method of estimating degrees of freedom were used.
The agency scores of the most occupied cells were significantly predicted by the self-reported CSIV agency scores, $b = .998$, $SE = .489$, $t(104) = 2.04$, $p = .044$, semi-partial $R^2 = .038$. Pseudo $R^2$ was calculated for each level according to the recommendations of Snijders and Bosker (1999, 1994). At the first level, the model reduced a small amount of error when predicting the agency score of the most occupied cell for any given participant, $Pseudo-R^2_1 = .022$. At the second level, the model also reduced a small amount of error when predicting the agency score of the most occupied cell for any given group, $Pseudo-R^2_2 = .022$. The ICC was not significant, $q < .001$, $t(138) < .001$, $p = 1.00$, suggesting that the most occupied agency scores of participants of the same group were independent and that a multilevel analysis was not necessary for these data; however, multilevel analysis was used to enable comparison with other analyses where multilevel modeling was necessary. The most occupied communal scores were modelled as a function of group-mean-centered communal value scores. A 2-level multilevel model was used to account for participants nested within group by estimating a random intercept and a random slope for each group. An unstructured covariance matrix and the between-within method of estimating degrees of freedom were used. Self-reported communal value did not significantly predict the most occupied joystick communal score, $b = .092$, $SE = .103$, $t(104) = .900$, $p = .370$. Pseudo $R^2$ was calculated for each level according to the recommendations of Snijders and Bosker (1999, 1994). The model did not reduce prediction error of joystick communion scores at either Level 1, $Pseudo-R^2_1 < .001$, or at Level 2, $Pseudo-R^2_2 < .001$. The ICC was significant, $q = .435$, $t(138) = 5.685$, $p < .001$, suggesting that the most occupied communion scores of participants of the same group were not independent and confirming that a multilevel analysis was necessary for these data.
Chapter 4  
Discussion

In general, the present study suggests that the joystick technique can be reliably and validly applied beyond dyadic interactions. The reliability calculated for the joystick time series are comparable in size to those reported by Sadler et al. (2009), who applied the technique to dyadic interactions. The MTMM matrix also demonstrates strong convergent validity for joystick agency, as it correlated very highly with agency measured by the more conventional and well-validated SBI. Joystick agency scores also showed discriminant validity, as the correlations with other traits and methods in the MTMM were much lower. Joystick communion also demonstrates convergent validity as it had a moderate correlation with communion measured by the SBI. While this correlation of .331 is drastically lower than the correlation between joystick agency and SBI agency, its size is consistent with the observers’ agreement on the personality trait Agreeableness reported in the meta-analysis by Connelly and Ones (2010). Given that Agreeableness has been demonstrated to be a rotational variant of the communion axis (Trapnell & Wiggins, 1990), the size of the correlation between joystick communion and SBI communion in the present study is reasonable. Unlike joystick agency, joystick communion did not show discriminant validity as it correlated equally strongly with SBI communion and SBI agency. Unlike the SBI, the agency and communion dimensions of the joystick scores were not orthogonal in the present study. A possible explanation is that as the joystick technique provides the possibility of ratings that cover the entirety of the interpersonal circumplex (i.e., a person’s behaviour can be characterized at any point in the two-dimensional space of agency and communion), it is possible that the joystick coders might have been responding to the Extraversion, a rotational variant of the agency axis (Trapnell & Wiggins, 1990), of the participants.

Interpersonal values are not the only source of influence on people’s behavior; the characteristics and dynamics of the group can also influence how agentically and communally the participants behaved during the interaction. Thus, we also examined the influence of groups on participants’ joystick scores, using density distribution analyses (Fleeson, 2001), to provide perspective and insight into our analyses of values and interpersonal behaviors. Overall, the density distribution analyses revealed that the groups have a much stronger influence on communion scores than on
agency scores. The ICCs revealed that the group-level variance did not account for any variance in the mean of joystick agency scores, whereas it accounted for 42.0% of the variance in the mean of joystick communion scores. This suggests that there were “warm groups” and “cold groups”, where members from some groups interacted in a much more communal way than members from other groups. Group-level variance accounted for 44.9% of the variance in the size or standard deviation of the agency density distribution, whereas it accounted for 72.5% of the variance in the size of the communion density distribution. This suggests that some groups were much more variable along the agency and the communal axes in their interactions, while other groups were more restricted in the ranges they occupied along agency and communion. The finding also suggests that the range of communion is influenced more by the group than the range of agency is. Group-level variance had very little influence on the shape of the agency distribution, whereas it had a moderate influence on the shape of the communion density distribution. Density distribution analyses also demonstrate that there were more individual differences in agency scores than in communion scores. Specifically, the variance between individuals within groups account for the majority of the variance (89.7%) in the mean of agency distributions, whereas it accounted for less than half of the variance (37.4%) in the mean of communion distributions. Between-individual variance accounted for 22.3% of the total variance in the size (standard deviation) of agency distributions, whereas it only accounted for half as much variance (10.7%) in the size of communion distributions. Between-individual variance also accounted for much more variance in the shape, characterized by skew and kurtosis, of the agency distributions (62.4% and 42.2%) than in the shape of the communion distributions (22.7% and 15.7%). In short, density distribution analyses revealed that group-level differences contributed substantially more to communion scores, whereas individual-level differences contributed more to agency scores than to communion scores. These conclusions provided useful insight in understanding the results from the later analyses.

Contrary to our expectations, the attractor analysis did not reveal the presence of attractors in any behavior trajectory. The failure to identify any attractors in the trajectory is partly due to the lack of variability in participants’ trajectories. Upon a close examination of the trajectories of all participants, we found that instead of spanning a large portion of the interpersonal state space, the trajectories almost always concentrated at the upper right quadrant (agentic-communal). This lack of variability in system trajectories may be the reason why no attractors were identified (T.
Moreover, because of the restricted range of the trajectories, the presence of attractors, if they were present, may be difficult to interpret. Specifically, because the system only spent time at one place of the state space, the attractor would simply be at the center of this place. In this case, it would be hard to determine where the attractor had begun and where the non-attractor region had ended. In fact, it could be argued that the entire trajectory was an attractor (T. Hollenstein, personal communication, July 27, 2015).

Results from the density distribution analyses can provide some potential explanation for the reason of this lack of variability. Specifically, density distribution analyses suggest that the means and standard deviations were relatively stable within person across the three clips; the majority of the variance was attributable to group differences and individual differences. Therefore, we were perhaps unable to identify any attractors within each participant’s trajectories partially because participants were more strongly influenced by their dispositions and the characteristics of their groups than by any transient and dynamic properties of the interaction. In addition, the 50%-drop criterion might also contribute to our ability to identify attractors. While a 50% drop in heterogeneity is the commonly practiced criterion for distinguishing attractor cells from non-attractor cells, the decision on 50% as the adequate magnitude of change is rather subjective (T. Hollenstein, personal communication, July 27, 2015). The data we utilized is also far more fine-grained than is typically reported in GridWare literature, in that we have at least 1800 data points per trajectory and had a state space grid of 441 grids (the typical GridWare studies have fewer than 100 data points per trajectory and fewer than 100 grids in the state space; Holleinstein, 2013). As a result, the transition from one state space grid cell to another is much smoother, making it harder to meet the 50%-drop criterion. However, it should be noted that due to the lack of variability in the trajectories, even if an attractor were to be identified through the use of a more lenient criterion, it would still be difficult to interpret its meaning and significance, for the reasons mentioned earlier.

Our hypothesis that interpersonal values should be reflected in observed behaviors was partially supported by our findings. We analyzed the relationship between the self-reported interpersonal values and the observed interpersonal behaviors in two ways. First, we used the self-reported interpersonal values to predict the averaged joystick agency and communion scores. These analyses revealed that agentic interpersonal values significantly predicted agentic behaviors during the leaderless group discussion interaction. However, communal values did not predict
communal behaviors during the interaction. The density distribution analyses can also provide insight when explaining this difference. Specifically, the density distribution analyses suggest that there were a lot of individual differences in average agency scores, whereas for average communion scores, much of the variance was accounted for by group differences and there were not a lot of individual differences. The lack of individual differences in communion behavior scores may be a contributing factor to the lack of correlation between communion behavior scores and communal values. We also used self-reported interpersonal values to predict the location of the most occupied cell in the state space grid. Similar to what we have found with the averaged joystick agency scores, we have found a small positive relationship between the most occupied agency score and the self-reported agentic values. As with the average communion behavior scores, the most commonly occupied communion behavior score did not significantly correlate with communal values. Like with the average communion behavior scores, the most commonly occupied communion behavior scores showed very little variation across participants – the standard deviation was only 0.751 on a 21-point scale. This lack of variability can potentially explain the lack of correlation with communal values. Our two approaches in examining the relationship between interpersonal behaviors and interpersonal values yielded similar results, suggesting that in this particular study, the average of a behavior trajectory is similar to the most commonly occupied region of that trajectory. For the present study where the range of participants’ behavioral trajectories was restricted, attractors – if any were identified – would not have provided much additional insight into the phenomena relative to the means.

The main limitation of the current study was the general lack of within-person variability in participants’ behavior. The current study had only presented one situation to the participants. It is possible that the well-defined co-operative problem-solving task did not provide enough situational variation to perturb the participants’ behavior trajectories, and offset the trajectories to the more unusual behavioral states. The set-up of the four-people interaction could also have artificially restricted the level of variability in participants’ behavior. Namely, in a four-people interaction, the four participants would, for the most part, have to take turns talking in order to solve the puzzle. Unlike in dyadic interactions where one person would by-definition act more dominantly than the other, in four-people groups, the most common behavioral state for participants would be to listen agreeably to other group members. Because the participants were compelled by the situation to act in this submissive and communal way, the time they could
spend in other states was reduced and their idiosyncratic tendencies in interpersonal behavior might have been obscured. Furthermore, while behavior coding is considered to be a way to objectively measure behavior, the process of aggregating the coding by all the coders artificially restricts the variability of the time series. Aggregating the scores provided by multiple observers is desirable for analyses that rely on the mean levels of behavior; however, it may be less ideal for analyses that rely heavily on the variability of behavior, like the attractor analyses used by the current study. Future studies for demonstrating the dynamic qualities in individual behavior, therefore, should utilize behavior recordings from a variety of situations over a longer span of time, ensuring that there is adequate variability in behavior trajectories for the assessment of attractors and other dynamic constructs. For instance, ecological momentary assessment (EMA), whereby phenomena are assessed as they occur, may be more apt at answering research questions pertaining to the dynamic qualities of individual behavior.

In conclusion, the present study demonstrates that traits differ in the degree to which they are affected by situational and dispositional factors and shows some support for the hypothesis that interpersonal values are reflected in interpersonal behaviors. However, the present study could not provide support for Carver and Scheier’s (1998) conceptualization of values as attractors in behaviors; further studies that are more specifically designed for intra-person dynamic systems analyses are needed for this purpose.
References


Wiggins, J. S. (1991). Agency and communion as conceptual coordinates for understanding and measurement of interpersonal behavior. In W. Grove & D. Cicchetti (Eds.), *Thinking*