ASPECTS OF HANDEDNESS: 
COGNITIVE AND AFFECTIVE VARIABLES

by

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ABSTRACT

The issue of whether differences exist between right-handed and left-handed people in cognition and emotion was addressed in two studies.

Study 1 was conducted with 974 right-handed and 108 left-handed Israeli schoolchildren aged 8 to 11 years. The test battery included cognitive and affective measures. Cognition was evaluated by The MEM Questionnaire, The Coloured Progressive Matrices and The Standard Progressive Matrices. Affective ability was assessed by The Self Concept Scale, The Anxiety Scale, The Intellectual Achievement Responsibility Questionnaire, and the Intrinsic-Extrinsic Motivational Questionnaire. Data on school achievement and teachers' evaluation of children's mental, emotional and social skills were also collected.

Results demonstrated no significant differences between right- and left-handed children on any performance tasks in either domain. Left-handed children showed similar capabilities on higher order verbal and non-verbal thinking and resembled the right-handed groups in the affective domain. They showed the same levels of anxiety, and obtained the same scores on self concept, motivation and locus of control. The findings also suggested the existence of stronger associations between Syllogism and Categorization and non-verbal cognitive processing, and between cognition and emotion in the left- as compared to the right-handed children. Teachers evaluated the left-handed children as having significantly lower social skills.
Study 2 focused on perception of emotion on chimeric faces (faces with a half sad half happy configuration). The sample consisted of 48 university students and computer workers; 21 right-handers, 21 left-handers and 6 switched-handed subjects. Data were collected on manual activity, and subjects were presented with booklets with pictures of chimeric faces and their mirror images. They were asked to judge which of the faces seem to be happier.

Findings showed significant differences between right- and left-handed subjects in their perceptual biases: right-handed subjects judged the left-positive configuration as happier and the left-handed subjects judged the right-positive configuration as the happier one.

The sum of the results seem to indicate that differences in self organization might exist between right- and left-handed individuals. Further research is needed to substantiate these findings.
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CHAPTER 1

INTRODUCTION

Handedness is a human characteristic manifested by individual differences in manual activity. Although people use both hands in action, a clear lateralization is seen for writing and fine motor skills, and while most people use their right hand in such activity, about 10% prefer the left hand for the performance of high precision manipulations.

The study of left-handedness is important from two main perspectives: (a) to acquire a better understanding of the phenomenon for its own sake, as a human characteristic that concerns a significant minority of the human race; and (b) to obtain a better understanding of cognitive and emotional aspects of the human mind. Blau (1946) has suggested that left-handedness might be regarded as an experiment made in nature and by nature, where an experimental question has been raised and we are confronted with the “end product” that needs proper interpretation. He also argues that left-handedness brings up the old question of structure and function of the human brain. It is perhaps in this sense that handedness seems most intriguing.

The interest in left-handedness has a long history: it is mentioned in the Bible (Book of Judges, Chapter 3; 15), detected in prehistoric findings from antiquity, and displayed in the art of ancient Egypt (Blau, 1946; Corballis & Beale, 1976). The interest continues to this day. The fact that differences in hand preference among individuals have persisted through the ages in spite of strict educational practices and social discrimination indicates that it is not an incidental error of nature but rather a significant trait.
Attitudes towards left-handedness

In spite of the fact that the occurrence of left-handedness was consistent over the years, sinistrality was regarded as a sinful mark of the devil. In a human world that holds a mental model that being different has a negative connotation, using the left hand was (and in some cultures still is) unacceptable by society, and left-handers were considered for ages as bizarre, insulting and devious people (Blakeslee, 1980; Corballis & Beale, 1976, 1983; Coren, 1992; Herron, 1980).

Hecaen and Ajuriaguerra (1964), who examined the ethical and religious aspects of the matter, argued that according to folk theories people were believed to live in an inner dichotomy, ruled by two sides: the right and the left. The right side was described as masculine, strong, active and positive and was, consequently, characterized by truth, honesty, power and justice. The left side, on the other hand, was described as weak, feminine, passive and was often associated with crime, negativism, and sinfulness. Hecaen and Ajuriaguerra claimed that this belief is reflected even in the way prayers and religious ceremonies in many cultures are directed to the right side, which represents the good and holy, as opposed to the left side, which is associated with sin, sinistrality and death.

Some reflections of such notions are represented in early psychoanalytic works as well. In The interpretation of dreams Freud (1953) explained that the appearance of right and left in a dream symbolizes moral values. By his interpretation, walking on the right side (in a dream) represents integrity and honesty, while walking on the left side symbolizes sin, and it may suggest homosexuality, incest, and other types of emotional problems.
Early theories

Many early theories have followed this approach to handedness, and there is an abundance of data describing left-handed people as inferior and highly associated with psychopathology, crime, and emotional instability (Corballis & Beale, 1976; Coren, 1992; Harris, 1980; Springer & Deutsch, 1989; Porac & Coren, 1981). This can be well illustrated by Cyril Burt's statement (1937) that "if it is even safe to treat left-handedness as a sign or symptom, it should be regarded rather as a mark of an ill-organized nervous system" (Burt, 1937, p. 287). More recent advice was given by Rudolf Steiner (1979) in his book Education as art, suggesting: "Correct the left-handed child" and this will help him overcome the "danger", and "save" him "from this bad habit". Steiner stressed the idea that "it is better to remain within the bounds of nature, and in most cases use the right hand...letting the brain develop with its original tendency" (Steiner, 1979, pp. 117-119).

New approaches: the brain-hand connection

Modern theories on handedness are based on an underlying idea about the existence of a close connection between the brain and the hand, and therefore many recent studies aim to unfold the nature of this linkage.

Manual development and dextrality were frequently described by anthropologists as being associated with the development of the brain in the human race. Evidence shows that major changes both in the hand and in hominid brain size, emerged at the same period, during the appearance of Homo Erectus (Donald, 1991). Some specialists have even suggested that these are dependent processes: that both manual proficiency and brain capabilities developed in parallel, along with the activity of tool making. Anderson (1966) described how brain and hand development becomes concurrently and
increasingly complex as one ascends the primate scale. Fox (1991) has argued that large areas of the cerebellum are concerned with the control of the hand, and that "the growth of this center must have been a response to the demand of tool making" (Fox, 1991, p. 59).

The interest in handedness grew extensively when neurobiological research on the brain indicated a relation between motor skills and cerebral organization and function (Bryden & Steenhuis, 1990; Corballis, 1983; Coren, Porac & Duncan, 1981; Harris, 1980; Hecaen & Ajuriaguerra, 1964; Springer & Deutsch, 1989). The fact that hand laterality is controlled by the contralateral brain hemisphere aroused much interest among the neuroscientific community, especially as it became clear that each of the brain hemispheres has its unique specialization.

Findings on brain laterality suggest that each of the hemispheres is specialized for a different type of processing, i.e., the left hemisphere is involved in linguistic and sequential processing whereas the right hemisphere is more involved in spatial and global processing (Galin & Ornstein, 1972; Gazzaniga, 1970, 1985; Sperry, Gazzaniga & Bogen, 1969). In addition, some findings also suggest that the right hemisphere is specialized for processing of perception and expression of emotions (Davidson, 1988; Davidson & Fox, 1982; 1989; Ley & Bryden, 1979; Springer & Deutsch, 1989).

Since the data on hemispheric asymmetry also indicated that differences exist between right-handed and left-handed people with respect to brain asymmetries (Cohen Levine, 1985; Harris, 1985; Levy, 1969, 1974), comparing right- vs. left-handed individuals became a central focus of research (Kee, 1987; Kimura, 1973 a, b, 1985; Koenig, 1990; Lewis, & Harris, 1990; Tan, 1985). This line of research is regarded by
neuroscientists as one of the keys for understanding brain organization and function (Coren, 1992; Hellige, 1993). Witelson (1987), who has focused on brain morphology in right and left-handed people suggested that the study of brain-behaviour relationships may help elucidate the mental process itself.

During the last thirty years handedness has been addressed from many different perspectives: through genetics (Annett, 1972), prenatal development (Bakan, 1977; Previc, 1991), neuroscience (Harris & Carlson, 1985; Tan, 1985; Witelson, 1985, 1987; Young, 1983), studies on emotions (Davidson & Fox, 1989; Soxby & Bryden, 1987) and animal studies (MacNeilage et al., 1987; Morris & Hopkins, 1993). Much consideration has been given to measuring handedness (Annett, 1970, 1972, 1992; Bryden, 1982; Bryden & Steenhuis, 1990, 1991; Oldfield, 1971; Peters, 1990) and many theories have been suggested to explain the origins of handedness (Annett, 1972; Bakan, 1977; Bakan et al., 1973; Geschwind, 1983; Geschwind & Galaburda, 1985; Previc, 1991; Witelson, 1987).

Although it is beyond the scope of this work to give a full account of all the aspects of handedness, a review of the literature shows that many questions regarding left-handedness are still open. Giesecke (1936) summarized in an early book on the development of handedness that "the nature of handedness is yet a moot question" (Giesecke, 1936, p. 1). What is even more surprising is that, basically, many of the theories and counter-theories in her account are still current today. It seems that, in spite of extensive research, many questions still remained unanswered. In 1977 Hardyck and Petrinovich (1977) claimed that many neuroscientists share "the frustration of seeing their theories of cerebral function unable to account for the bilateral, cerebral organization found in many left-handed" (Hardyck & Petrinovich,
1977, p. 248). More than a decade later Satz (1990) wrote the following citation in his introduction to Bishop's book on handedness, arguing that left-handedness upsets "all the different conceptions which have prevailed during the last century in connection with the pathology and physiology of the two hemispheres" (Satz, in Bishop 1990, p.IX).

What determines handedness?
There is still no consensus about what constitutes left-handedness and several explanations have been suggested in the literature. Annett (1972) proposed a genetic approach, explaining right-handedness by the existence of a right shift gene. When this gene is present on one or both chromosomes, speech will be lateralized to the left hemisphere with a preference for using the right hand. In people who lack the right shift gene, lateralization for speech and hand will be determined by chance factors. Following Annett's findings much attention was given to familial and non-familial sinistrality and some investigators therefore prefer to talk about right-handers and non-right-handers (Kinsbourne, 1988; Satz, Soper & Orsini, 1988).

Other investigators suggested that left-handedness is the result of a deviation from the natural course of development, occurring mainly during pregnancy. So, for instance, Geschwind and his colleagues (Geschwind, 1983; Geschwind & Galaburda, (1985 a,b,c) suggested that left-handedness occurs due to alterations in the left hemisphere caused by a combination of neurological, maturational and hormonal changes during pregnancy. Bakan (1977) has argued that it is a result of pre- or perinatal trauma, and Previc (1991) suggested that it depends on the position of the fetus during the last trimester of pregnancy.
It should be noted that, although left-handedness has been found to be related to all of these genetic and developmental factors, studies on causality of handedness have failed to come up with a satisfactory answer that could account for all the cases of left-handedness.

**Distinguishing handedness**

The question of how to define and identify who is left-handed became a focus of research, mainly because of the large variability in handedness among individuals. It seems that a straightforward definition of handedness could be based on the hand used in writing, which is a complex activity requiring a degree of skill. This approach was suggested by McManus (1984) and others (Bent and Rise, both cited in Hecaen & Ajuriaguerra, 1964; Brain, 1945; Roudinesco & Thyss, 1948), who proposed that handedness be determined on a functional basis and according to one's own report. However, this simple approach started to seem vague and inadequate from two different standpoints. On the one hand, the failure of studies on causality of handedness to account satisfactorily for all cases of left-handers called for a careful differentiation and a more accurate examination of the various types of handedness.

On the other hand, studies on brain asymmetry suggested that if handedness is related to brain lateralization it might represent only one of a number of variables, a single element in a more complex factor of "sidedness" (including eyedness, earedness and footedness). As a result, measurement of handedness became the subject of careful examination, and a large body of research was directed to it's determination by different standards and methods.

The most commonly used inventories for the assessment of hand preference are Crovitz & Zener's (1962) Test for handedness; Annett's (1970) Handedness research, and Oldfield's (1971) Edinburgh handedness inventory. Handedness is measured in all
of them by noting which hand is used for the performance of various manual activities (such as writing, throwing, using scissors and so on). The result gives a quantitative measure of hand usage based on the frequency of hand choice on this list of manual activities.

Yet the central question, whether handedness is quantitative or categorical (Bishop, 1990), has not been resolved. As opposed to the growing body of studies in which handedness is described quantitatively as ranging from strong right preference, through ambidextrality to strong left preference (Annett, 1970; Peters & Durling, 1978), McManus (1984) has argued that handedness should be treated as a categorical variable, because when we look at writing — the most strongly lateralized activity — no continuous range is found, and individuals show a strong preference for one hand only.

Steenhuis & Bryden (1989) have argued that both left-handed and right-handed people are very strong on the very "skilled" tasks such as writing or holding a needle, and show less hand specialization for less skilled activities, such as picking up small objects. At the third annual meeting of the Canadian Society for Brain, Behaviour and Cognitive Science which took place in 1993 in Toronto, Steenhuis argued that in her many studies on handedness she learned that individuals who described themselves as right-handed or left-handed were generally found to be lateralized in the way they represent themselves.

Another important point is that quantitative measurements show a significant difference among right-handed and left-handed people within their respective groups. While most of the dextrals appear to have a complete 100 percent right-hand dominance, the measurements show that there are no fully left-handed individuals, and even the most strongly lateralized show only about 70 percent of left-hand dominance (Hellige, 1993).
**Cognitive Aspects**

During the last two decades major changes occurred in our understanding of learning and human behaviour. Gardner (1985) referred to this as a cognitive revolution, the foundation of a new field of knowledge. The revolution in cognitive science brought about primary changes in the field, and a growing body of knowledge describes learning and development through a process-oriented approach, rather than focusing on quantitative measurements of cognitive performance and learning. A review of the literature on cognitive aspects of left-handedness shows that data are available mainly from descriptive or correlational studies. Comparative data on left-handed and right-handed children have been focused mainly on measuring performance, rather than on cognitive processing.

**Cognitive performance of the left-handed**

Many researchers have described left-handedness as linked to cognitive disorders (Best, 1985; Bishop, 1990; Burt, 1937; Molfese & Segalovitz, 1988; Obrzut & Hynd, 1991; Satz, Soper & Orsini, 1988; Temple, 1990), and to various pathologies such as brain damage (Bakan et al., 1973), dyslexia (Galaburda & Kemper, 1979), speech disorders (Ounsted, 1955), autism (Colby & Parkinson, 1977; Soper et al., 1986; Tsai, 1984), and psychiatric symptomatologies (Flor-Henry, 1983). However, these findings came mainly from studies which were not designed systematically to examine handedness. They were often based on samplings of a pathological population and therefore handedness might have been mediated by some other basic factor (see also Bishop, 1990, Hardyck & Petrinovich, 1977; Satz et al., 1988).
Findings from methodically designed studies which sampled the general population showed no significant differences between left-handed and right-handed subjects. One of the first methodical examinations of overall intellectual ability of left-handers was designed by Haefner (1929) who compared right- vs. left-handed high school students. Surprisingly Haefner's results showed no difference in attainment or in IQ between the groups. Hardyck and his colleagues (Hardyck et al., 1976) examined 7688 school children in California, on skills (i.e., hand preference, speed and persistence, listening attention), and various performance tasks (i.e., figure copying, intelligence, reading, spelling and arithmetic) and found no difference among left- and right-handed children. Similar results were reported by Douglas et al., (1967) (based on a British national survey of 5000 children), and Roberts & Engle (1974), who compared right- and left-handed 6 to 11 year old children on their mental ability and school achievements. (For more examples see also Balow, 1963; Bishop, 1990; Clymer & Silva, 1985; Harshman, Hampson & Berenbaum, 1983; Kershner & Chyczij, 1991; Newcombe & Ratcliff, 1973; Ullman, 1977).

These and other studies have demonstrated that when left-handed children were examined through sampling the general population, results showed them as being similar to others in their levels of performance and achievement. Nevertheless, it should be noted that in these studies children were mainly compared on learning skills and general abilities, or on levels of IQ tested by quantitative measures. The literature reveals no concentration on left-handed children's cognitive processing, or on the strategies they use while solving different types of problems.
Cognitive styles and handedness
The existing research on cognitive styles has also addressed handedness. Cognitive styles reflect typical ways of thinking, learning and processing information, and Messick (1976) has argued that cognitive styles serve as higher level heuristics that organize lower level strategies and operations, including abilities such as sequential processing, problem solving, and learning.

The theory about differences in cognitive styles is based on studies on brain laterality, which suggest that each hemisphere is involved in a different type of processing, and thus has led to the notion of hemisphericity. The assumption that individuals might differ in their cognitive style according to their dominant hemisphere has given rise to tendencies to apply the theory to teaching methods. Studies on occupational choice suggest that more "left brain thinking" might be involved in students' preferences for language and literature and more "right brain thinking" in preferences for graphic arts (Porac & Coren, 1982), artistic skills (Membert & Michel, 1980) and architecture (Peterson & Lansky, 1974, 1980).

Hemisphericity has raised much interest among educators and the question how to accommodate instruction techniques to students' cognitive styles has been often addressed at meetings of educational associations (for some examples of this approach see Bogen, 1975; Carbo, Dunn & Dunn, 1986; Drake, & Sobrero, 1984; Dunn & Reddix, 1990; Grigsby & Wilson, 1984; Lynes et al., 1987; Maycock, 1988; Miller, 1988). It has also raised much opposition from the traditional segments of the teaching profession (Shook, 1986), and from neuro-specialists, who have called for more caution with this approach (see Harris, 1985).
Many of the studies dealing with cognitive styles have focused on comparing right- and left-handed subjects' thinking styles (Cranberg & Albert, 1988; Membert & Michel; 1980) and creativity (Aliotti, 1981; Byrne, 1974; Deutsch, 1980; Harpaz, 1990; Newland, 1981).

As can be ascertained from the previous paragraphs, handedness is a complex, multi-faceted phenomenon, and therefore any attempt at acquiring some insight and understanding of underlying principles requires the investigation of several aspects at a time. Due to the scarcity of material on the emotional aspects of handedness, I found this topic particularly interesting and worthy of investigation.

**Affective Aspects**

A growing body of evidence shows that affective factors play an important role in people's lives and influence the way individuals make decisions, direct their behaviour and achieve their goals in general. Nevertheless, the nature of the relationships and the patterns of organization between emotional properties and behaviour, and especially between cognition and emotion, is a highly controversial matter.

Two central theories on emotion are suggested as guidelines for this study. The first is the theory of emotion proposed by Tomkins (1979; 1984), arguing that emotions play an important role by amplifying motivations, thereby making them the focus of attention. The second was developed by Oatley (Oatley, 1992; Oatley & Jenkins, 1996; Oatley & Johnson-Laird, 1987), who suggested a cognitive-communicative theory of emotions. Oatley proposed that all "emotions are part of a solution to problems of organizing
knowledge and action in a world that is imperfectly known and in which we have limited resources" (Oatley, 1992, p. 3). Oatley further argued that emotions arise when obstacles disrupt the fulfillment of a person's goals, disturbing plans and actions.

The present study focuses on the following emotional variables: anxiety, self-concept, motivation, and locus of control. These particular variables were chosen because they are important aspects of emotional life, and are known to be closely related to learning situations and to children's achievement at school and their behaviour in daily life. Gaining knowledge of these aspects in left-handed children could extend our understanding about the affective aspects of their behaviour.

**Anxiety**

Anxiety is an emotional state that was described by Izard (1971, 1977) as a combination of fear with guilt or anger, sometimes accompanied by feelings of "stress" and "tension" (Levitt, 1980). Anxiety was described by Darwin in his book *Expression of the emotions in man and animals* (1872), and became later a key concept in most personality theories. According to Freud, anxiety serves as a sign of alarm that warns the ego of a coming danger (Freud, 1936), and classical psychoanalysis regarded anxiety as a reaction to the increase in libidinal or aggressive energy, i.e., the organism's primary reaction to an instinctual experience of threat.

Recent cognitive theories consider anxiety as part of the regulating system that directs human behaviour. Carver & Scheier (1991) proposed that people set goals, standards and intentions, which serve as reference points for their activity. They then keep evaluating the results of their activity, and make adjustments to close the gaps towards more desired outcomes (based on a self-regulating feedback control).
Anxiety—according to this theory—rises in the presence of conflicts between competing reference values, or when discrepancy occurs between one's intended behaviour and other reference points (e.g., physical safety, acceptance by other people, personal comfort, or holistic personal integration). Carver & Scheier thus argued that anxiety is a signal that warns the individual to check priorities and immediate goals (see also Simon, 1967). A similar model is given in Oatley's (1992) theory of emotions.

**Anxiety and learning.**

The Yerkes & Dodson Law (1908) suggested a model to explain learning efficiency in terms of an optimal level of arousal required for activation. This law assumes that at extreme levels performance is inefficient. While very high levels of excitement are likely to paralyze efficient consideration and disrupt appropriate activity, because of disorganization, at low levels of arousal, boredom and distractions also jeopardize successful fulfillment of the task (Glanz, 1989a).

Further studies on the matter have shown that the effect of anxiety on learning situations and academic achievements is a rather complex matter. Some studies have demonstrated that high anxiety disrupts cognitive achievements (Alpert & Haber, 1960; Benjamin et al., 1981; Cattell & Scheier, 1967). Other works have yielded different results (Gaurdy & Fitzgerald, 1971; Spielberger, 1971; Spielberger & Katzenmeyer, 1959).

Spielberger et al., (1975) conducted a study on a large group of undergraduate college students. Students were sorted into five intellectual ability groups and then tested for anxiety levels and for academic achievement. Results showed that only the group of
low cognitive ability performed in accordance with low anxiety (which fits the Yerkes & Dodson Law). In all "mid" level intelligence groups, higher level of anxiety was related to lower cognitive performance, but the most anxious students showed better cognitive performance. Thus, the high achieving students showed both high and low levels of anxiety. Spielberger et al. (1975) concluded that grades of the most intelligent and least intelligent students were affected (and boosted) by anxiety. On the other hand, anxiety seemed to have a depressing influence on the academic achievements of students in the middle range of intelligence.

Similarly, Eysenck (1991) suggested that individual differences may depend on differences in content, capacity, distractibility and selectivity of people's attention, and every account of anxiety should consider these factors. Eysenck argued that highly anxious individuals have a pre-attentive bias towards threatening (rather than neutral) stimuli, have less available working memory for processing cognitive tasks, are more distractible, and show greater attentional selectivity. Low anxiety people, on the other hand, are more focused on neutral stimuli, have a greater capacity of working memory and are less distracted and less selective in their attention.

Carver & Scheier (1991) argued that anxiety has various effects on different individuals, and sometimes it has a positive energizing and focusing effect. They suggested, in addition, that the main difference between people who are high or low in test anxiety is not in their arousal reactions before and during testing procedures, but rather on how they perceive and respond to anxiety and to the situation; in other words, their personal expectations about the possible outcome (favorable vs. unfavorable). They argued that a person who has doubts about being able to cope with the task is more likely not to
persist on completing the task (see also Deffenbacher, 1980; Deffenbacher and Hazaleus 1985; Hollandsworth et al., 1979; Morris & Ponath, 1986).

**Self-Concept**

The "self" is one of the most fundamental concepts in psychology, and various terms depend upon it, for instance, "self-esteem", "self-regard", "self-attitude", "ego", "self-image" and "self-concept". Although there are no formal distinctions among these terms, the choice of terms often reflects the writer's point of view. Cognitive theories, that are more process oriented, have now introduced new related terms such as "self-attention" and "self-focus".

According to cognitive theories the concept of "self" or "self-concept" reflects one's inner representation of oneself. Carver & Scheier (1990) argued that it includes the "sense of personal continuity that characterizes every individual's personality" and the "organized body of knowledge that everyone has about who one is, what one feels and believes, and who one wishes to be" (Carver & Scheier, 1990, p. 317). Oatley (1993) has described the self as a "cognitive device that enables us to interact with other people in mutual plans and roles" and as "a model of our abilities and cognitive systems". He also suggested that, cognitively, the self is a representation of one's goals and capacities, (Oatley, 1992, p. 201). Our knowledge about our own ability is what enables us to plan efficiently towards achieving goals and taking part in joint action.

**Self-concept and learning.**

Self-concept plays an important role in learning situations, and educational research has often shown significant association between positive self-image and academic

An interesting study on the influence of parental attitude on children's self-esteem was conducted by Coopersmith (1967), who examined parents' educational attitude and their 10-12 year old children's self-esteem. Findings have shown that parents' attitude and educational practice could predict their children's self-esteem: children with a positive concept of self had educationally involved parents, who talked with their children, encouraged them and explained things to them in a non-arbitrary manner.

Kruse & Render (1986) have argued that improving self-image in low achieving children can improve their performance in learning situations, because it encourages them to cope with tasks that seemed difficult to them in the past. Carver & Scheier (1990) argue that in addition to acquisition of a more accurate representation of the self, self-directed attention has an impact on the guidance of behaviour. Generally people stick to a task up to the point where the goal seems beyond their capacity. Then an urge to give up on the task is evoked, and the persons become disengaged. However, sometimes this situation might actually enhance performance.

**Motivation**

The term "motivation", from the Latin word "motivus" (meaning movement), refers to psychological variables that influence a person's activity. It affects the direction and the goals of human action. Cattell & Child (1975) described motivation as a component in the dynamic process, and referred to it as an attitude that affects the "strength of
interest" in the course of action. Tomkins (1979; 1984) proposed that emotions amplify motivations, bringing them into the focus of attention, giving them urgency (Oatley, 1992). In sum, motivation affects the direction of activity, plays a major role in setting one's goals, and adds the energetic aspect to one's operations.

In discussing motivation one has to distinguish between two main types: "extrinsic motivation" — where a person depends for gratification on the outside to prompt his or her actions, and "intrinsic motivation" — which refers to cases where a person is motivated from the inside in guiding his or her activities.

Many studies have focused on the relationships between motivation and cognitive performance, showing that subjects who display higher cognitive performance have accordingly higher motivation to succeed (Deci et al., 1981; Feldman, 1989; French & Thomas, 1958; Glanz, 1989b; Harackiewicz, 1989; 1968).

The characteristics of a problem also affect one's level of motivation in coping with a task. Glucksberg (1962) argued that the level of difficulty affects motivation. One hundred and twenty eight students were asked to stick candles in a matchbox which then had to be fixed on a wall. One group received an easier starting point for solving the task than the other. Results showed a positive correlation between the level of difficulty of the task and the level of motivation. In addition, higher motivation added to readiness for working on the task. Glucksberg also reported similar results on a word recognition test.
Matsumoto (1981) demonstrated, by giving subjects a false difficulty score for the tasks that were assigned to them, that people's beliefs about the level of complexity and effort needed to fulfill the task affected their motivation for solving the problem.

Vinacke (1968) studied three groups of students (97-221 in each group) on three types of problems: easy mathematical questions, analogies and three-letter anagrams, under four atmosphere type conditions: (a) an ordinary atmosphere, (b) a competitive atmosphere (between sexes), (c) a "work-hard" atmosphere (putting a demand for speedy performance), and (d) a highly competitive and "work hard" atmosphere. On the anagrams, competition improved performance of both sexes. However, the "work-hard" demand lowered the effectiveness in both sexes. Feather (1965) also reported similar findings, showing that low anxiety contributes to motivation in solving difficult anagrams.

**Locus of Control**

The concept of "Locus of Control" was developed by Rotter (1954) within the context of social learning theory, and refers to an important aspect of emotion — the dimension of agency or responsibility related to emotional life, measuring to what extent one views oneself, someone else, or something else, as responsible for an outcome. Internal locus of control represents one's belief that oneself is responsible for the outcome of an action. External locus of control refers to one's belief that one's behaviour and the events in one's life are directed by some outside source.

Studies on locus of control indicate that internal locus of control has a more positive effect upon behaviour; as it gives a person a better capacity in coping with the environment (Phares, 1976). Similar results were reported by Lefcourt (1981), who
argued that individuals with internal locus of control seem to be more potent, assertive, and effective persons whereas those with external locus of control seem to be helpless, and less competent. An important related question is whether locus of control is a personality (trait) or situational (state) variable. Rotter (1975) argued that it is a situational factor, depending mainly on one's past experiences. So people who have failed at school might feel helpless in academic situations and thereby develop an external control orientation for similar specific contexts. They may, however, feel capable in other areas of their life (i.e., sports, social activities, everyday situations, etc.) and show an internal orientation of control for those aspects of their lives. Bar-Tal & Bar-Zohar (1977) who reviewed 36 studies on locus of control, including research on adults, concluded that there is a positive connection between intrinsic locus of control and academic achievement.

Left-handedness and emotion.

The review of the literature on emotional and personality aspects of left-handed individuals revealed that there is still much to be desired in this field too, and there are almost no systematically conducted studies on the matter. The data on the affective aspects of handedness come from two main directions: (a) from correlative studies, in which left-handedness was described as associated with a long list of deficiencies and emotional disorders, and (b) from studies of brain asymmetry.

The literature based on correlative studies linked left-handedness with a variety of pathologies and personality disorders such as psychiatric symptomatology (Blau, 1946; Flor-Henry, 1983, 1990; Steiner, 1979), autism (Colby & Parkinson, 1977; Soper et al., 1986; Tsai, 1984), homosexuality (Lansky et al., 1988), alcoholism (Coren, 1992; London, 1990; Smith & Chayatte, 1983), and criminal tendencies (Harburg, 1981;
Lombroso, 1903). Some investigators attributed to them higher frequencies of depression and suicidal tendencies (Bruce, 1895; Lishman et al., 1976; Sackheim & Decina, 1983) and have argued that such ailments in left-handed patients are more persistent and more difficult to cure. Coren (1992) has described left-handed people as suffering from insomnia, hypersomnia, high anxiety, and psychosomatic illnesses (i.e., hay fever, allergies, asthma, skin problems etc.), and as being accident prone, and therefore having shorter longevity (Halpem & Coren, 1990).

Studies on brain asymmetry and emotion were focused on hemispheric specialization for processing emotion, in which sophisticated methods were used to test subjects reactions to emotional stimuli (Hellige, 1993; Springer & Deutsch, 1989). Handedness was examined in this line of research because some studies indicated a difference between right-handed and left-handed people. Findings have generally shown more variety among left-handers in the direction of their hemispheric asymmetry, but none of these results seemed to be significantly conclusive.

Apart from the above studies in these two areas, I found no data on the affective aspects of left-handed individuals in learning situations or on their behaviour in daily life. Although it is widely accepted that emotions play an important role in people's behaviour, and a large body of data testifies to the role of affect in learning situations, there is no systematic research on the emotional aspects or the social abilities of left-handed individuals, nor on affective aspects related to learning situations in left-handed children.
The present research

A review of the literature reveals that left-handedness has indeed been examined from various angles, and the varieties of issues addressed reflect the complexity of the subject. Nevertheless, Giesecke's statement, more than 60 years ago, that left-handedness "is still a moot question" is still applicable today (Giesecke, 1936; Hardyck & Petrinovich, 1977; Hellige, 1993; Satz in Bishop, 1990).

In the present research I chose to investigate handedness from two different perspectives, by examining empirically some of the central issues related to the performance of the left- as compared to right-hander. In the first I focused on cognitive and emotional abilities, and in the second on perception of emotion with some relation to manual activity.

This was carried out by conducting two different studies: the first, described in Chapter 2, was concerned with right- and left-handed children's cognitive and emotional performance. The second study, described in Chapter 3, focused on right- and left-handed adults' perception of emotion on chimeric faces and on some aspects of manual activity. Through these two studies I hoped to gain a better insight into left-handedness and its implications for education and daily functioning.
CHAPTER 2
STUDY 1

Rationale

In spite of extensive research on handedness, we lack a clear description of left-handedness in children. Research on brain and behaviour of left-handed people has focused mainly on measuring subjects' responses to different modalities of input: visual, auditory, manual, and kinesthetic (Coren, 1992; Hoptman & Levy 1988; Kimura, 1983; Tan, 1985). Studies carried out on pathological populations, which included high proportions of left-handed individuals, have led to inaccurate representations of left-handedness as a general phenomenon (Best, 1985; Wolfese & Segalovitz, 1988; Obrzut & Hynd, 1991; Satz, Soper & Orsini, 1988). Since left-handers are a small minority of the general population, large samples were needed to study the subject. Therefore, the existing data on left-handedness from methodological studies carried out on the general population are somewhat scarce (Hardyck et al., 1976; Harshman, Hampson & Berenbaum, 1983; Roberts & Engles, 1974). There are no data on cognitive processing or on emotional and social functioning, and no one has focused systematically on emotional style, or on the way thought and emotions are organized in left- as compared to right-handed people.

The present study was designed to examine handedness in the cognitive and the affective domains. These follow a pilot study that I conducted in 1982.
A pilot study on handedness

The pilot study was conducted in Israel (Alony, 1982), while I was part of a team in a program for training school counselors to assess children's cognitive and emotional abilities. The program aimed to facilitate evaluation procedures within the educational system, and was meant to make schools less dependent on outside services.

The pilot study compared the cognitive performance of right-handed and left-handed children. The sample consisted of 54 children aged 9 to 10 years in three groups: a group of 18 left-handed children and two control groups, one of 18 randomly chosen right-handed children and the other of 18 matched right-handed children. It should be noted that a higher proportion of boys was found among the left-handed children (77% boys vs. 23% girls). The children were compared on verbal and non-verbal cognitive measures, using the MEM Questionnaire (Abstract Verbal Thinking Test)(Glanz, 1974) for verbal intelligence and the Coloured Progressive Matrices (Raven, 1962) for non-verbal intelligence.

No differences were found between the groups on overall cognitive performance, and there were no significant differences among the groups on any of the subtests of the MEM. Nevertheless, the results suggested possible differences in cognitive style between the groups, or differences in processing while addressing similar problems (Alony, 1982). One of the conclusions of the pilot study was that although the sample was too small for solid conclusions, "it is enough to warrant more investigation."

The present study

The present study was designed to investigate whether right-handed and left-handed children differ in their intellectual and emotional capacities. The children were compared
on a number of cognitive and emotional variables found to be related to achievements at school and in daily life. The main focus was on the following four areas: cognitive level, cognitive style, emotion, and the relationships between cognition and emotion. Besides evaluating children's performance from a quantitative point of view, an attempt was made to examine whether they differ in cognitive styles: namely, in global and analytic processing, and in organization of cognition and emotion.

This study is based on data from a large Israeli project, conducted with the collaboration of the Service for Counselling and Psychology of the Ministry of Education (Shefi), and was aimed at identifying the under-achieving students. Schools were informed only about cases where under-achievement was indeed exhibited. As part of the team that conducted this research, I planned and collected the data on handedness in the framework of the study of this topic. Information on handedness was based on teachers' reports, and was gathered by me from 1082 children.

**Design**

The study was designed as a survey study on many tasks measuring cognitive and affective variables. Background variables regarding information on children's family conditions and their performance at school were also investigated. The analysis was based on a comparison between two groups of children (left-handed vs. right-handed children). The dependent variables were the performance measures on the various cognitive and affective tasks administered in the study (as described below).
Hypotheses

The main research question of whether differences exist between left-handed and right-handed children in the cognitive and affective domain, was tested against the following specific hypotheses:

1) No significant differences would be found between left- and right-handed children with regard to the overall cognitive levels.

2) Differences would be found between left- and right-handed children with regard to cognitive style: right-handed children would do better on analytic thinking and left-handed children would do better on global processing.

3) No differences would be found between left- and right-handed children in their performance on tasks measuring emotion.

4) Differences would be found between the groups in their emotional styles.

5) Differences would be found between the groups in the nature of the relationships between cognition and emotion.

Definition of terms

The definition of right- or left-handedness was based on a functional criterion – i.e., the hand used for writing. Children using their right hand were defined as right-handed and children who write with their left hand were defined as left-handed.

Methods

Subjects

The subjects were 1082 children (48.4% boys and 51.6% girls), aged 8-11, in grades 3-5 from 27 elementary schools in the northern part of Israel. Children of these ages
were chosen because at this stage children are already consistent in their hand preference. The majority of the children were born in Israel to immigrant families (which is typical of the country). Most of the fathers were born in eastern countries (i.e., Moslem Middle Eastern and Asian countries) and most of the mothers — in Israel. Most children came from working and middle class families, from both rural and urban environments. The average number of children per family was 3-4 (ranging from 1 to 9 children).

Before the study, letters of consent describing its nature were sent to the families of all the children. The letters stressed the anonymity and confidentiality of individual scores and assured the freedom to withdraw from the study at any time. Only children whose parents signed a consent letter were included in the study.

The whole sample of this study consisted of two groups of children, one group of 974 children who were using their right hand in writing and the other, of 108 children, who were using their left hand (51% boys and 49% girls).

**Measures**

**Background Information**

Two questionnaires were developed to collect data concerning children's family background and their performance at school.

**Personal information.**

Personal information on the children participating in the study was gathered by an individual self report questionnaire, regarding the following items: age, gender, grade, hand used for writing (left/right), parents' country of origin (east/west), child's and
parents' country of birth (east/west/Israel), parental education (no schooling, elementary school, partial high school, full high school, trade school, college/university), parents' occupation (unemployed, unskilled laborer, skilled worker, small business manager, professional and academic staff), number of children in the family and the subject's order of birth.

School achievements.
Information on subjects' performance at school was collected through a teachers' evaluation questionnaire. Data were collected on math and language (Hebrew). Language was chosen because it correlates with general ability and is a basic underlying skill required for processing of most of the other subjects in school curricula. Math was chosen because it is known as a subject highly correlated with children's intellectual abilities, and especially with higher order logical thinking.

The teachers evaluated, in addition, each student's intellectual ability, his or her emotional development and his or her social capacity – based on the child's school work and conduct during classes. Teachers' evaluations on each of the three personal variables were given on a scale of 1 to 4 (with the higher score representing higher ability).

The cognitive aspects
One of the main objectives of this study was to compare the performance of left- and right-handed children on higher order thinking, measuring the children's ability to form concepts and to solve problems by making inferences through logical reasoning. Cognitive performance was evaluated on verbal and non-verbal tasks, focusing on the question whether differences exist in level and style between these groups.
Verbal cognitive ability.

Children's verbal logical processes were evaluated by The MEM Questionnaire (Glanz, 1989b), which is a psycholinguistic scale for children in grades 3-5 (aged 8-11) that deals with higher order thinking. The scale was designed following Aristo's model on thought, which describes cognition as a hierarchy of 6 levels, extending from the lowest level of concept to inferences: i.e., sensation, perception, codification, conceptualization, judgement and inference. The scale is focused on the three higher levels: i.e., concept formation, judgement and inference, and includes the following 9 subtests: Synonyms, Antonyms, Essentiality, Classification, Categorization, Proverbs, Analogy, Definition, and Syllogisms. Each of the 7 first subtests consists of 12 items. Definition and Syllogism consist of 6 items each. (For a copy of the questionnaire see Appendix I.)

The child is presented with a forced multiple choice questionnaire in two parts and is required to note the most appropriate and fitting answer to each item. Each correct answer is given one point. Scores on each part of the task range from 0 to 48 and the total scores ranges from 0 to 96.

Non-verbal cognitive ability.

Non-Verbal logical processes were assessed by The Coloured Progressive Matrices, (Raven, 1962) for the 8-10 year old pupils, and the Standard Progressive Matrices for those aged 10-11. The first version of these tasks was published in 1938 and has since been widely used as an intelligence test. Raven (1958) has described the task as measuring perception and clear thought. Das & Kirby (1979) suggested the test as an effective measure for simultaneous processes.
The Standard Progressive Matrices consists of 60 items consecutively presented. Each item includes a figure in which one part is missing, and the examinee is required to select the fitting part from a number of distractors (e.g., irrelevant shapes). The solution of the most complex items requires the child to form a concept about a series, and to ascribe that concept to another figure from another series. Solving such problems involves the combination of various types of thought, i.e., analogy, induction, and deduction. The relative dominance of each of these inference styles depends on the nature of the task demands and on the examinee’s individual strategy, or his cognitive style.

In the Coloured Progressive Matrices the items are more colorful, to facilitate focusing and encourage attention of younger children. This task consists of 36 items. On both tasks one point is given on each correct answer. Scores on the Progressive Matrices range from 0 to 60, and on the Coloured Matrices the range is 0 to 36.

**The affective aspects**

The second major theme in this research was centered on emotional aspects of children’s performance, aiming to address the question whether differences exist between left-handed and right-handed children in the affective domain. I concentrated on self-concept, anxiety, locus of control, and motivation, which are important aspects of emotional life and are known to be highly correlated with school achievement and behaviour in daily life. Most of the measures that were chosen for this domain describe affect on a quantitative level, suggesting, in addition, a more specified description of children’s affective styles.
Self concept.
The Self Concept Scale - ("He/She is...- I am...") (Glanz, 1981) was administered in order to evaluate children's perception of themselves. Two principal methods are applied in measuring self-concept: extrospective methods – in which inferences on a person's representation of self are based on observation of his or her behaviour, and introspective methods that refer to the way events are perceived through an individual's consciousness. Glanz's scale was designed to combine these two methods, by referring to the subject's representation of self, and his or her representations about his or her behaviours and relationships in various life situations (Glanz, 1981; Feldman, 1989). In this task the child is presented a questionnaire with 38 items. On each item a statement is given and three possible answers are suggested (i.e., "She is tall"), and the child is asked if she sees herself as similar to that child, or whether she is inferior or superior on that characteristic (i.e., "I am like her"/ "I am not as tall"/ "I am very tall"). Each answer type represents a different kind of self-concept, (i.e., a negative, a balanced or an excessively high type of self-concept). Eighteen of the test items relate to the subject's characteristic features (i.e., "he is healthy, "he is organized", etc.). In 13 items the subject is asked about his or her beliefs about other people's opinion of him or her, for instance: friends, teachers, father and mother (i.e., "he is liked by his friends in class", "the teacher thinks he is a good pupil"). Four of the items deal with the subject's attitude to his class and school (i.e., "he loves his class"), and in 3 items the child is asked about his or her parent's attitude towards his or her school-work (i.e., "his father thinks he is a good pupil"). The task is administered in different versions for boys ("I am... and he is") and for girls ("I am... and she is") due to the grammatical difference on gender in the Hebrew language.
The child's answers are grouped into three answer types: (a) negative ("I am not"), (b) balanced ("I am... as..."), and (c) excessively high ("I am very..."). Two different scoring scales are given on this task: one is a distinct score on each answer type (i.e., negative, positive, and excessively high). Scores on each of the answer types ranges from 0 to 38. In addition, a total score is calculated as follows: one point is given on each negative choice ("I am not..."), two points on each balanced choice ("I am...as") and three points on each excessively high answer type ("I am very..."). The range of the total score is 38 to 114. The different scores for each answer type give a more detailed description of the child's profile of self concept. (For a copy of the questionnaire see appendix II).

Anxiety.

Anxiety was evaluated by means of The Anxiety Scale ("I feel... and do...") (Glanz, 1989a). The subject is given a written questionnaire including 43 items. In each item 4 sentences are presented, and the child is asked to choose one sentence that he or she thinks best describes him or her i.e., " (a) "I like to laugh very much" (b) "I like to laugh", (c) "I do not like to laugh", (d) "I do not laugh but I cry a lot". The 43 items relate to feelings in specific situations i.e., "there will be a test tomorrow: and I...", general feelings i.e., "I feel that I am always in a bad mood...", feelings and behaviour in social situations i.e., "when friends tell me I have done something wrong, I...", reaction towards different people and attitudes i.e., "when I made a mistake which has been noticed by others, I...", and physical reactions connected with certain emotional states i.e., "When I do not succeed in something... I sweat". On each item, four possible answers are suggested, each reflecting a different anxiety type: a high anxiety type (1) average-high (2) average-low (3) and low anxiety (4). Separate versions of the task are administered for boys and girls.
Scoring is evaluated on two different scales. On one scale — a separate score is given for each answer type (based on the number of choices made for each answer type, i.e., high, average-high, average-low, low anxiety). Scores on each answer type range from 0-43. The other is a general total score calculated as follows: one point is given for a high anxiety answer, 2 points for an average-high, 3 points for the average-low and 4 points for the low anxiety answer. The range of the total score is 43 to 172. The separate scores given for each answer type provide a more subtle description of the child's profile of anxiety. (For a copy of the questionnaire see appendix III).

**Locus of control.**

The concept of "Locus of Control" was developed by Rotter (1954) within the context of social learning theory, and refers to an important aspect of emotion — the dimension of agency or responsibility related to emotional life, measuring to what extent one views oneself, someone else (or something else) as responsible for an outcome. To measure locus of control The Intellectual Achievement Responsibility Questionnaire (IARQ) (Crandall et al., 1965) was chosen. This test examines children's belief that they themselves, rather than others, are responsible for their intellectual-academic successes and failures or for their general achievements. The test items are focused on children's daily life events, and are specifically related to situations that arouse emotions and conflicts linked to events of success or failure at school.

The child is presented a 34 items questionnaire. Each item presents an event on which two explanations are suggested; one explanation reflects personal responsibility for an outcome (i.e., intrinsic control) whereas the other attributes responsibility to an external agent (i.e., extrinsic control). Seventeen of the items relate to successful events, and
seventeen others relate to failures. The child has to choose one answer, and gets one point for each response that reflects personal responsibility. The answers are grouped for successful events and for failure events. Results are described by two different scoring scales: (a) a general total score on the task and (b) separate scores for success (based on the number of answers that reflect taking responsibility on events of success) and for failure (based on number of choices for events of failure). Total scores range from 0 to 34. (For a copy of the questionnaire see appendix IV).

**Motivation.**

Motivation was tested by the Intrinsic - Extrinsic Motivational Orientation (Haywood, 1968). The task was based on the concept that individuals differ in motivational styles, according to the source of a motivation; some get engaged in an activity for its own sake, enjoying challenge and achievement (i.e., intrinsically motivated) whereas others depend for satisfaction on recognition and gratification that come from the outside (i.e., extrinsically motivated).

The task consists of 20 items, each presenting two professions, for instance: (a) Librarian or (b) Dentist. The child is asked to select one preferred profession, and explain his choice from a forced list of 10 reasons (e.g., "it is easier"; "I like nice things and places"). Half of the suggested reasons reflect intrinsic motivation and the other half reflect extrinsic motivation. One point is given for each choice of an intrinsic-motivated reason. Scores range from 0 to 20, and the final score gives an "IM" value (Intrinsic Motivation). An "EM" value (Extrinsic Motivation) can be calculated by subtraction of the IM score from 20 (EM = 20-IM).
**Procedures**

Some of the data reported here are part of a large existing data base of a previous study based on a sample of 1700 Israeli children aged 8-11. That study was designed by Glanz (1989b) and was conducted by Feldman (1989) with the collaboration of "Shefi", as part of a large-scale project that was conducted over several years to facilitate evaluation of improvement in education. School counselors were trained to assess children's cognitive and emotional abilities in order to make schools more independent in assessing their students. The aim of the original study was to identify under-achieving students who perform at school below their capacity.

As part of the research team at the time, I was involved in collecting data from teachers and in testing part of the children in their classes. I was not involved in the design and the choice of the measures implemented in the main study, but the question related to handedness was added to the study by my request. This data was based on Self report and Teachers' Report Questionnaires and was collected by me on 1082 children, as part of my plan to use this invaluable large sample for this study on handedness. Analyses of all the data on the sample of 1082 children reported in the present study was performed by me.

The present study follows a pilot study on handedness conducted in the past (Alony, 1982), as described above.

The data for the present study were collected over two years. Most of the classes were tested on the first year, with an interval of 5-8 days between tests. For the two parts of The MEM Questionnaire – there was a 3 days interval. The school counselors helped in
administration of the tests, after a 12 hour training on the nature and procedures of the tests. In addition, they were given guidance during the assessment processes. All the tests were administered during the first two hours of classes. The order of testing was as follows: The MEM Questionnaire – part I, part II; Anxiety Scale, Self Concept, Motivation and Locus of Control. The Progressive Matrices (Coloured and Standard) were given in between the other tests, (since the number of test books was limited).

Information on the students' background, and Teachers' Evaluation Questionnaires were collected by the counselors.

Results

In the first phase of the study and prior to data analysis, I addressed a basic question that needed to be resolved, regarding the influence of demographic variables on the children's performance and the effect it might have on the grouping of subjects in this study, as described below.

Demographic Influences and Formation Of Matched Groups Of Left- and Right-Handed Subjects

The first issue addressed in this study concerned the relationship between the demographic factors (as reflected by the socio-economic measures), and the incidence of left-handedness.
On the basis of the previous pilot study (Alony, 1982), I assumed the existence of a higher incidence of left-handedness among children of a higher socio-economic background, because parents with this background are less likely to force left-handed children to write with their right hands. To prevent possible errors in the interpretation of the results, it was therefore important to examine the relationship between these main factors at the initial stage of the study. Clearly, if this were indeed the case, the sample would have to be balanced on the variable that shows the main effect, by choosing a new control group that would thus be appropriately matched to the experimental group.

To resolve this basic issue, I first compared all the right-handed children (n=974) and all the left-handed children (n=108) on the demographic measures (i.e., father's and mother's country of birth, country of origin, education and profession), using a cross tabulation procedure and the chi-square test. As expected, findings showed clear differences among the groups, as left-handed children more often came from a higher socio-economic background than the right-handed children. Their fathers had a higher education, and there was a slight trend in the same direction regarding the mothers' education. In the professional domain I found that more fathers of the left-handed group were clerks or professionals (e.g., lawyers, doctors, accountants, etc.) whereas a higher proportion of fathers in the right-handed group were manual skilled workers. The children differed also in their familial origins: more left-handed children came from families in which the father was of a western origin (i.e., Europe, USA, Canada) and was born either in Israel or in a western country, whereas more right-handed children came from families of an eastern origin (note that there was almost no difference among the groups in the mother's country of origin, and only a minor difference related to the mother's country of birth). The chi-square tests showed that the father's country
of birth had the most significant role in explaining the difference in the distribution of the left-handed and right-handed groups (p<0.0001).

In addition a series of one-way analyses of variance (ANOVA) was performed in order to measure the effect of the demographic variables in explaining the differences among the groups on the dependent variables (i.e., school achievements, cognitive variables and affective variables). These analyses confirmed that demographic variables indeed explained the differences in children's performance. The most significant variable was again found to be the father's country of birth (which was highly related to all the other demographic variables).

At this point it was clear that comparing the left-handed children vs. the whole sample of right-handed children would be misleading; and therefore a new sample of right-handed children had to be chosen, matched to the experimental group on all the demographic variables, as stated in the opening paragraph above.

**Formation of a matched right-handed group**

Formation of a new group of right-handed children was accomplished through a matching procedure, based on the most significant demographic measure (i.e., father's country of birth), gender, and grade. For each left-handed child a computerized list of matching right-handed children was prepared, and then one subject was randomly selected from that list. At the initial stage of the study the whole sample consisted of 108 left-handed and 974 right-handed children, yet due to missing data on demographic variables on 5 left-handed children, only 103 right-handed children could be matched by the procedure described above.
From this point on, comparisons between the left-handed and right-handed groups were based on this matched sample consisting of 103 left-handed children and 103 matched right-handed children. In those cases where the analyses involved the whole sample of right-handed children \((n=974)\) this fact is specifically pointed out.

**Results on Children's Performance**

The results are reported in four sections. The first section contains a description of left- and right-handed children's cognitive performance. The second section relates to the affective aspects of the children's behaviour. The third section provides a description of the relationship between cognition and emotion in these children, and the fourth section provides information on the children's academic performance at school.

**Cognitive performance**

One of the main objectives of this study was to compare the performance of left-handed and right-handed children on higher order verbal and non-verbal cognitive tasks. This was done by measuring their ability to form concepts and solve problems that require reasoning and making inferences.

**Verbal cognitive ability.**

The comparison between left-handed and right-handed children on verbal abstract thinking as based on the MEM Questionnaire (Glanz, 1989b) showed no differences among the groups on overall performance. The left-handed group got a total mean score of 69.69 \((SD=13.52)\), and the total mean score of the right-handed group was 68.97 \((SD=12.34)\). It should be noted, in addition, that in general, the analyses for the full right-handed group \((n=974)\) followed those of the matched right-handed group.
The results on children's performance on the 9 sub tests of the MEM Questionnaire are presented in figure 1 (for means and standard deviations see appendix VI).

As may be seen in Figure 1, cognitive performance on all the subtests was similar, and there was a high resemblance in children's profiles on all these 9 subtests. However, it should be noted that the right-handed children scored slightly higher than left-handed children on Proverbs - a task that requires analyzing semantic context in a sequential logical order, and on Classification and Categorization, both of which tasks involve a basic degree of analytical and sequential thinking. The left-handed children showed a minor advantage on Synonyms, Essentiality and Analogy tasks that deal with
comparison and aspects of similarity, and also require an ability for generalization and association.

Non Verbal Logical Ability.
Assessment of children's capacity for non-verbal logical processing was evaluated by the Raven's Coloured (1962) and Standard Progressive Matrices (1958). As mentioned above, the tasks require a combination of various types of abstract thinking, namely the ability to apply induction, deduction and analogy in the process of problem solving.

Analogy is a process of making inferences from one instance to another. Induction is thinking that infers from the particular to the general, and deduction is the type of inference where conclusions about a particular case are made on the basis of general premises. All the problems in the Raven tasks present non-verbal data (Glanz, 1989b). Comparison between the right-handed and left-handed children on Raven's items showed no significant differences between the matched groups. The mean score of the left-handed children was 30.36 (SD=9.65) and that of the matched right-handed children was 30.47 (SD=7.38).

The relationships between the verbal and non-verbal cognitive measures.
To investigate the interrelationship between verbal and non-verbal cognitive processing, Pearson correlation analyses between these variables were calculated in each group (left-handed and right-handed) separately. Results showed positive and significant relationships between the verbal and non-verbal processing in both matched groups. In the left-handed group the correlation between the total MEM task and the Raven was $r=.53$ ($p<0.0001$), and in the right-handed group the correlation on these particular measures was $r=.42$ ($p<0.0001$). These results indicate that children who are
higher on verbal logical processing show better ability for non-verbal processing as well. Note that significant correlations were found in both groups of this study.

Concerning cognitive style, correlation analyses were performed between non-verbal processing and the 9 subtests of the verbal MEM questionnaire. Results of Pearson correlation, performed within each of the matched groups separately, showed positive and significant correlations between the Raven and most of the subtests of the MEM scale in both groups (ranging from \( r = 0.23 \), \( p < 0.05 \) to \( r = 0.60 \), \( p < 0.001 \)). Moreover, the correlation matrices within the left-handed and right-handed groups were quite similar on most of the subtests, indicating that there is a generally similar relationship between the cognitive processes of both groups of children in solving verbal logical problems and their processes for solving problems with visually presented spatial material.

However, significant differences were found between the groups in the way non-verbal processing was associated with the Categorization and the Syllogism tasks. In the left-handed group the correlation between the Raven and Categorization was: \( r = 0.56 \) (\( p < 0.001 \)) and in the right-handed group it was \( r = 0.26 \) (\( p < 0.05 \)) Similarly, different correlation patterns appeared between Raven and Syllogism; within the left-handed group the correlation between these two variables was \( r = 0.43 \) (\( p < 0.0001 \)) whereas the right-handed group showed a non-significant correlation of \( r = 0.14 \) (\( p > 0.05 \)). To examine the significance of these differences among the left-handed and the right-handed group (on each of the pairs of correlations mentioned above) the Fisher's Z transformation was applied. This procedure was chosen because it enables determination of whether two correlation coefficients differ significantly from each other (Spiegel, 1991). Results of the Fisher Z analysis demonstrated that the correlation coefficients are significantly different from each other, as follows: on the Categorization task \( Z = 2.316 \), \( p < 0.05 \), and on the non-verbal and Syllogism task \( Z = 1.958 \), \( p < 0.05 \). Although one must be cautious,
I must point out that a number of statistical comparisons of non-verbal scores with the other tasks are possible. In order to look for effects of handedness against the background of no significant main effects in cognitive or affective measures, I have conducted a number of significance tests on correlations between different aspects of the data. Since I have conducted many such tests, results at the $p<0.05$ level should be regarded as merely suggestive and not conclusive, and this is so for the rest of this chapter. The left-handed children may have approached solving problems that were spatially presented (such as the figure tasks of Raven's Matrices) in a mode that is closer to the way they process problems of logical inference; whereas, right-handed children may have relied on different modes when they solved these two problem types (Categorization and Syllogism), which are less associated with their processing strategies while dealing with non-verbal spatially presented questions.

In summary, I found that left-handed children were similar to right-handed children in their overall cognitive performance, both on verbal and non-verbal cognitive processing. Examination of children's performance on the different subtests of the MEM showed that left-handed children resembled the general population in all these respects. Both groups showed a highly similar profile and I found no significant differences in cognitive style between the groups. It should be noted, though, that right-handed children scored slightly higher on the Classification and Categorization subtests, while the left-handed children showed some advantage on Synonyms and on Analogy subtests. In addition, there were significant differences at the $p<0.05$ level that suggested different processing strategies applied by left-handed and right-handed children while solving verbal logical and non-verbal visually presented problems.
**Affective Measures**

The second central theme of this research concerned the emotional aspects of children's performance, posing the question whether differences exist between left- and right-handed children in the affective domain. All the parameters examined (i.e., self-concept, anxiety, locus of control, and motivation) are known to be highly correlated with school achievements and behaviour in daily life.

Children's overall performance on the affective variables is summarized in Table 1, presenting the total scores (means and standard deviations) within the left-handed and the matched right-handed sample. (See also Appendix VI).

Table 1.

**Means and standard deviations of children's total scores on the affective measures.**

<table>
<thead>
<tr>
<th></th>
<th>Right-handed (n=99)</th>
<th>Left-handed (n=101)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Self concept</td>
<td>86.13</td>
<td>12.70</td>
</tr>
<tr>
<td>Anxiety</td>
<td>129.98</td>
<td>14.32</td>
</tr>
<tr>
<td>Locus of control</td>
<td>20.12</td>
<td>3.47</td>
</tr>
<tr>
<td>Motivation</td>
<td>10.48</td>
<td>2.86</td>
</tr>
</tbody>
</table>
As may be seen from Table 1, the children of both groups were almost identical in their overall emotional expressions; they showed an equivalent amount of self esteem, a similar level of anxiety, got the same scores on locus of control, and presented an equal level of motivation. All t-tests performed to compare between the matched groups showed no differences between the groups on any of the emotional measures. Similar results were found when the whole sample of right-handed children (n=974) was compared with the left-handed group.

To evaluate children's affective styles, I examined their choices on the different answer types – on the self-concept and anxiety scales. The type of choices children make on the affective measures indicate tendencies towards negative, balanced, or excessively high levels for both of these characteristics, and therefore give a different kind of description of the children's emotional qualities. Results of the comparisons between the left-handed and right-handed groups on each of these aspects are separately described below.

**Self-concept.**

As may be seen from Table 1, the left-handed and right-handed children received similar total scores on the self-concept scale. Note that in addition to a total score, the Self Concept Scale provides a separate score on each of the three categories of the task (e.g., negative, positive, and excessively-high), based on the number of times the child chose each of the three answer types. Children's responses on each of the 3 answer types are presented in Figure 2.
Figure 2. Mean number of choices by children on each of the three answer types in the 38-item Self-concept scale (based on the choices each child made individually).

Two main observations emerge from Figure 2: first, one can notice the resemblance between both groups of children in the study. The second observation is that, no matter which group they belong to, all the children chose more of the excessively high answer type (which reflects an exaggeration in self-concept) and tended to choose fewer of the balanced answer types. Glanz (1981) suggested that this is a typical trend of performance on this task during childhood. He has also argued that towards the eighth grade children show a gradual decrease in their choice of the excessively high answer type, combined with a tendency to choose more of the balanced answer type. According to Glanz, such a change reflects children's growing ability to form a more realistic self evaluation and the development of a more accurate representation of themselves.
Anxiety.

With respect to anxiety, results showed no difference on the mean total scores between the groups (see Table 1). Note that in addition to a total score on anxiety, every child received also a separate score on each of the four answer types (i.e., negative, low average, high average, and high), thereby giving a more elaborate description of the children's profile on anxiety. The right-handed and left-handed children were compared on each of the answer types, and these results are presented in Figure 3.

Figure 3. Mean number of choices by right-handed and left-handed children on each of the four answer types in the 43-item Anxiety-scale (based on each child's individual choices).
Examination of children's answers on each of the four answer types (on a scale from low anxiety to high anxiety), as presented in Figure 3, shows that all the children chose more of the low anxiety answer type, while the high anxiety answer type was the least selected. A comparison between the groups, using a t-test procedure showed no significant differences both on the total score and on the number of choices made on each answer type, yet note that there was a marginally significant effect in that left-handed children chose fewer of the low anxiety answer type (t=1.86, p=0.06) (two tailed) than the right-handed children.

**Locus of control.**

Regarding the subjects' Locus of Control, evaluation concentrated on events related to children's daily life and their academic achievements, with specific focus on events that evoke feelings and conflicts in situations of success and failure at school. As mentioned above, the scale measures to what extent children viewed themselves as responsible for an outcome, i.e., to what extent children believe that they themselves, rather than others, were responsible for their intellectual-academic successes and failures.

Examination of children's responses on the Locus of Control questionnaire, using t-test analyses, showed no differences between the matched groups on the total scores. The mean total score of the right-handed group was M=20.11 (SD=3.48) and of the left-handed group M=19.21 (SD=10.48). No differences were found on the number of choices children made on events of success or of failure (results were also similar for of the whole sample of right-handed children). All the children had a slight tendency to see themselves as more responsible for an outcome on events of success and allocated
responsibility to circumstances or to others in situations of failure (for more details see appendix VI).

Motivation.
Results on Haywood's Intrinsic-Extrinsic Motivational Orientation Questionnaire showed, likewise, a high similarity between left-handed and right-handed children in their general motivational trends (see Table 1). Calculation of the Intrinsic-Extrinsic aspect of motivation showed a minor tendency (in both groups) towards the intrinsic direction. It should be noted, in addition, that the results for the whole sample right-handed children (n=974) were also similar.

In summary, no significant differences were found between left-handed and right-handed children on the various affective measures, yet slight differences in trends of emotional style can be noticed between the groups, as will be further discussed.

Relationships between cognition and emotion.
One of the main hypotheses in this research was that differences will appear between the groups in the relationships between intellectual and affective aspects; namely, that cognition and emotion would be organized in different patterns in left-handed vs. right-handed children. The relationships between cognitive logical processes (verbal and non-verbal) and all the affective aspects (self-concept, anxiety, locus of control and motivation) were examined by Pearson correlation analyses. To evaluate whether the correlation coefficients between cognitive and affective measures within each group differ across the groups, the respective correlations were compared by the Fisher Z Transformation procedure (Spiegel, 1991).
Results of Pearson correlations between the cognitive and affective measures (based on total scores) showed that most of the total scores of the affective measures showed no significant association with children's cognitive performance, and both groups were quite similar in this respect. A significant difference between the groups was observed on the total score of the self-concept scale: in left-handed children I found a significant negative association between self-concept and verbal cognition ($r = -0.26, p<0.05$) and a similar tendency was found with non-verbal cognition as well ($r = -0.20, p>0.05$), while right-handed children showed no such association. It should be also noted that there was a weak negative association between non-verbal cognition and anxiety in both groups.

Comparison between the groups, using the Fisher Z procedure revealed a significant difference between the groups in the strength of the correlations between the MEM total score and the results on the self-concept scale ($Z = 2.44, p<0.05$).

To get a more specified description of children's affective style I examined the choices they made on the different answer types on anxiety, self-concept, and locus of control tasks.

**Anxiety and cognitive performance.**
As mentioned above, in addition to a total score on anxiety, every child received a separate score on each of the four categories of anxiety, based on the number of his or her choices on each of the answer types (e.g., low, average low, average high, and high). This analysis gave a more elaborate profile of the children's character with regards to anxiety, indicating whether each of them tends to high or moderate anxiety.
To examine the relationships between verbal and non-verbal processing and children's anxiety configurations, Pearson correlations were performed between each of the four answer types and total scores on the MEM and Raven. Results of these correlations in both groups are presented in Figure 4.

**Figure 4.** Pearson correlations between children's choices on the 4 categories of the Anxiety scale and A: verbal processing (MEM), and B: non-verbal processing (Raven).
As can be seen in Figure 4, both verbal and non-verbal cognitive processing were positively associated with the choices in the middle of the anxiety scale and negatively associated with the more extreme answer types (both high and low anxiety).

A similar pattern of relationships was found in left-handed and right-handed children between anxiety and both cognitive tasks, yet on verbal processing all the correlations were higher (numerically) and more noticeable among the left-handed children. It should be noted, in addition, that in the left-handed group average-high anxiety was positively correlated with total verbal cognition ($r=.35$, $p<0.005$), whereas in the right-handed group there was practically no correlation between this anxiety answer type and cognitive verbal performance.

The same pattern was seen on non-verbal cognitive processing. Children who chose more of the average anxiety types did better on non-verbal cognition, whereas children who chose more of the extreme anxiety types scored lower on the Raven task. Note that in the left-handed group low anxiety was significantly and negatively correlated with the Raven tasks ($r=-.35$, $p<0.005$); whereas, in right-handed children the correlation between non-verbal processing and low anxiety was non-significant ($r=-.17$, $p>0.05$).

Self concept and cognitive performance.

The linear correlations between each child's choice of the three answer types of self-concept (negative, balanced/positive and excessively high) and (a): verbal processing (MEM), (b): non-verbal processing (Raven) are presented in Figure 5.
Figure 5. Pearson correlations between the cognitive total scores and children's choices on the three answer types on the Self-concept scale.
As can be seen in Figure 5, both verbal and non-verbal cognitive processing were positively correlated with the choices of positive-balanced answer types in both groups, indicating that children with a better intellectual ability tended to see themselves in a balanced light. In the left-handed group the correlation between the total MEM score and balanced Self Concept was $r = .49$ ($p<0.0001$), while in the right-handed group it was $r = .24$ ($p<0.05$).

A different trend appeared between the groups in the relationships between verbal cognition and the extreme self-concept answer types; in the left-handed group verbal cognition was not associated with negative self-concept, while in the right-handed group negative self-concept was associated with lower cognitive functioning. On the other hand right-handed children's exaggerated high self-concept had no relationship to cognitive performance, (meaning that left-handed children with an excessively high self-concept scored lower on verbal cognitive tasks). Comparison between the groups on this aspect, using the Fisher Z procedure revealed a significant difference in the correlations between the MEM total score and the excessively high answer type on the self-concept scale ($Z = 2.31$, $p<0.03$).

Non-verbal cognition was significantly and positively associated with the positive balanced answer types; no association was found with the negative answer types, and a negative association was found between non-verbal cognition and the excessively high self-concept answer type. Note that in both groups the association between non-verbal cognition and children's choice on the self-concept answer types showed a similar pattern.
Analysis of Pearson correlations between the nine subtests of the MEM questionnaire and children's choices on the three answer types of the Self-concept scale, which enable a better observation of the children's cognitive-emotional patterns are presented in Figure 6.

**Figure 6.** Pearson correlations between the number of children's choices on the Self-concept scale and each of the nine subtests of the MEM Questionnaire as a function of children's choices of negative, balanced, or excessively high self-concept answers.
The main observation emerging from the graphs presented in Figure 6 is the existence of a strong consistency in the patterns of relationships between cognition and children's responses on the Self-Concept Scale. In general, the children with better cognitive abilities chose more of the balanced answer type, while extreme self-concept, both negative and excessively high, were negatively correlated with cognitive abilities.

Another consistency shown clearly in Figure 6, (see also Appendix VII ) is the existence of a different pattern among the groups in this respect. Results show that in the left-handed group, balanced/positive self-concept was significantly and positively correlated with all the subtests, while in the right-handed children, balanced self-concept was significantly correlated only with Synonyms. The left-handed children showed, in addition, a pattern of stronger negative relationships between cognitive performance and excessively high self-concept, while in right-handed children this relationship was less marked, and not significant. On the other hand, in right-handed children negative self-concept was more closely related to low cognitive achievements. Almost no correlations with negative self-concept were found in the left-handed group.

Comparison between the respective correlation coefficients (which appeared within each group separately) by Fisher's Z transformation, showed the existence of significant differences between the groups on the correlations between excessively high Self-Concept on each of the following subtests: Classification \((Z=2.08, \ p<0.05)\); Proverbs \((Z=2.14, \ p<0.05)\), Analogy \((Z=2.16, \ p<0.005)\). Note that on all of these measurements significantly negative correlations appeared only in the left-handed group.
Comparison between the respective correlation coefficients (which appeared within each group separately) by Fisher's Z transformation, showed that significant differences between the groups exist between negative self-concept on Categorization ($Z=2.8$, $p<0.005$); Proverbs ($Z=2.14$, $p<0.05$) and Analogy ($Z=2.16$, $p<0.05$).

In summary, following the general trend that cognitive achievement is well associated with positive and balanced self-concept, the left-handed children showed higher correlations between verbal cognition and the balanced self-concept answer type, and significantly negative association with the excessively high self-concept. Cognitive performance in the right-handed children, on the other hand, seemed to be less correlated with affective variables, and the main answer type that showed significant (negative) correlations was the negative type of self-concept. This indicated that in left-handed children both balanced and excessively high self-concept are related to cognitive ability; whereas, in right-handed children cognitive performance was much less associated with emotional aspects.

**School Achievements**

The data on school achievements in the academic and personal domain (based on school grades and Teacher's Evaluation Questionnaires) are presented in Table 2.
Table 2.

Means and standard deviations of right-handed and left-handed children on the school achievement measures

<table>
<thead>
<tr>
<th></th>
<th>Right-handed (n=99)</th>
<th>Left-handed (n=101)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Math</td>
<td>8.02</td>
<td>1.56</td>
</tr>
<tr>
<td>Language</td>
<td>8.21</td>
<td>1.44</td>
</tr>
<tr>
<td>Intellectual ability</td>
<td>3.33</td>
<td>0.82</td>
</tr>
<tr>
<td>Emotional ability</td>
<td>3.31</td>
<td>0.94</td>
</tr>
<tr>
<td>Social ability</td>
<td>3.41</td>
<td>0.76</td>
</tr>
</tbody>
</table>

No significant differences were found between the left-handed and right-handed children in their academic achievements at school. Left-handed children did as well as right-handed children in Language, and showed similar performance in Math. No differences were found also in the personal domain, and there were no significant differences in teacher's reports on the intellectual level of the groups, or in their emotions in daily life. Note that while teachers described the left-handed children as similar to right-handed in academic performance, they described the left-handed children as significantly lower on social skills ($t=2.79$, $p=0.006$) (two tailed).

Findings showed significant and positive correlations between children's performance on academic and cognitive processing tasks; the correlation between Math and MEM total score was $r=0.61$, $p<0.0001$ in the left-handed group and $r=0.59$, $p<0.0001$ in the right-handed group. Most of the MEM subtests were also positively correlated with Math in both groups. The correlations in the left-handed group ranged from $r=0.18$ ($p>0.05$) to
\( r = .44 \) (\( p < 0.0001 \)), and in the right-handed group from \( r = .17 \) (\( p > 0.05 \)) to \( r = .49 \) (\( p < 0.0001 \)). Correlations between Math and non-verbal processing was positive and significant in the right-handed group (\( r = .23, p < 0.05 \)) but not significant in the left-handed group (\( r = .13, p > 0.05 \)).

Language achievement at school was significantly and positively related to verbal processing, ranging from \( r = .34 \) to \( r = .76 \) among the left-handed children, and from \( r = .22 \) to \( r = .80 \) in right-handed children. Correlations with the Raven tasks were \( r = .22, p < 0.05 \) in the left-handed group, and \( r = .13, p > 0.05 \) in the right-handed group.

**Gender effects**

Two way analyses of variance (ANOVA) were performed to examine the effects of gender, handedness and their interactions. Table 3 presents Means on children's cognitive and affective skills and their academic achievements.

Table 3.

Means of the cognitive, affective and school achievement measures of right-handed and left-handed children

<table>
<thead>
<tr>
<th></th>
<th>Right-handed</th>
<th></th>
<th>Left-handed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Verbal cognition</td>
<td>69.80</td>
<td>69.09</td>
<td>69.27</td>
<td>70.00</td>
</tr>
<tr>
<td>Non-verbal cognition</td>
<td>31.02</td>
<td>30.61</td>
<td>29.04</td>
<td>31.03</td>
</tr>
<tr>
<td>Anxiety</td>
<td>133.33</td>
<td>126.75</td>
<td>130.90</td>
<td>123.23</td>
</tr>
<tr>
<td>Self-concept</td>
<td>85.34</td>
<td>87.24</td>
<td>84.11</td>
<td>81.68</td>
</tr>
<tr>
<td>Motivation</td>
<td>10.28</td>
<td>10.52</td>
<td>10.04</td>
<td>11.00</td>
</tr>
<tr>
<td>Locus of control</td>
<td>19.63</td>
<td>20.67</td>
<td>19.23</td>
<td>19.16</td>
</tr>
<tr>
<td>Mathematics</td>
<td>8.13</td>
<td>7.96</td>
<td>8.29</td>
<td>7.91</td>
</tr>
<tr>
<td>Language</td>
<td>8.26</td>
<td>8.21</td>
<td>8.18</td>
<td>8.29</td>
</tr>
</tbody>
</table>

As can be seen from Table 3, except for anxiety, no differences were found between the groups on gender by hand on any of the measures. Right- and left-handed boys,
and right- and left-handed girls showed similar performance on all tasks. Except for the results on anxiety, there were from the analyses of variance no significant main effects of handedness or sex on any measure, and no significant interactions between handedness and sex.

Results show a significant difference between boys and girls on Anxiety, $F(1, 190)=13$, $p<0.0001$. Girls in general showed a higher level of anxiety (note that on this task a higher score indicates lower anxiety), however, on the anxiety measure there was no main effect of the hand used in writing, $F(1, 190)=2.32$, $p=0.13$, and no significant interaction was found between gender by hand, $F(1, 190)=0.08$, $p=0.78$.

**Discussion**

The results of this study showed that left-handed children are quite similar to right-handed ones in their overall cognitive and emotional abilities. They exhibited equal capacities for higher order cognitive processing such as concept formation, judgement and inference, and they did not score lower than the right-handed children on any of the performance tasks tested. This contradicts reports linking left-handedness with a long list of cognitive deficiencies (Annett, 1970; Bishop, 1990; Burt, 1937; Feinetal., 1984; Satz, Soper & Orsini, 1988; Sunseri, 1982; Temple, 1990; Tan, 1985) and supports Hardyck's position (Hardyck et al., 1976) that left-handers sampled within the general population are found to be similar to right-handers (see also Clymer & Silva, 1985; Douglas et al., 1967; Newcombe et al., 1975; Roberts & Engle, 1974; Satz & Fletcher, 1987; Swanson et al., 1980). I found that in a large sample of 1082 school
children, including carefully matched sub-samples, there were no differences between the groups. Moreover, the resemblance between the left- and right-handed children did not appear only in test situations, where children were asked to solve problems in a controlled setting designed to examine their intellectual capacity, but was also found in children's school performance in daily life, as shown in their academic achievements in Language and Mathematics.

The left-handed children also did not differ from right-handers in the affective domain; they expressed the same levels of anxiety, showed similar motivation and achieved the same scores on locus of control. Even their levels of self-concept resembled those of the right-handed children. This finding adds, in a meaningful way, to our understanding of the emotional life of left-handed children, since only a few systematic studies of this aspect have been performed.

Following these results, teachers' evaluations of the children's abilities were somewhat surprising. Although left-handers matched the right-handers on school achievements and on all the tasks implemented for study evaluations, the left-handed children were described by their teachers as slightly lower in cognitive and emotional abilities, and significantly lower in social skills. Two possible explanations may account for this fact: (a) that the left-handed children were indeed inferior in their social skills and the teachers' reports reflected their objective estimations of the children's ability, or (b) that the teachers' evaluation reflected a biased attitude towards the left-handed children. It is clear that whatever the true explanation, these findings have implications for the education of the left-handed child, and suggest that further consideration should be given to the matter. If the first explanation is correct, we must examine why children
who, as a group, perform exactly like others both cognitively and emotionally, and have similar achievements at school, develop social skills inferior to those of their right-handed friends. Needless to say, if the second explanation is correct, this too calls for special educational attention.

Another significant finding was that although both handedness groups resembled each other in every aspect of their cognitive and emotional functions, differences in patterns of relationships between verbal and non-verbal cognitive processing and between cognition and emotion were discernible between them.

The relationship between verbal and non-verbal cognition

Left-handed children tended to show higher associations between verbal and non-verbal processing, and these associations were positive and significant on the Syllogism and Categorization verbal tasks. Glanz (1974) has argued that problems in syllogism could be solved in different ways: some subjects approach these problems in a gestalt way. Others solve them by a sequential approach. The fact that in left-handed children stronger associations were found between this task and non-verbal problems of the Raven might suggest that left-handed children approach these problems in more of a gestalt way. The fact that the task of Categorization was significantly more associated with these children's non-verbal processing might suggest that it too is performed in a more gestalt-like manner. This might raise the question of whether right-handed children actually use different strategies in solving verbal and non-verbal problems, where left-handed children tackle the spatially presented problems using procedures that are closer to their strategies for processing verbal problems.
The validity of this question might be further supported by the relationships between the Raven and children's skills in Mathematics and Language. The right-handed children showed significant correlations between Raven and Mathematics, while the left-handed children showed stronger associations between non-verbal processing and Language.

Messick (1976) has argued that cognitive styles serve as higher level heuristics that organize lower level strategies and operations, including abilities such as sequential processes, problem solving and learning. One might suggest that in this respect the results suggest differences in processing style between the groups. Thus, although this finding does not support theories of hemisphericity, which assume distinct analytic vs. global thinking style differences between left- and right-handed individuals, it nevertheless reflects some variation that calls for further investigation of the cognitive processes used by left-handed vs. right-handed subjects.

**Relationships between cognition and emotion**

Another finding in the present study was that variations were found between the groups, suggesting differences in the way cognition and emotion are interrelated, and implying differences in self-organization. It should be noted that, although the following part of my discussion is somewhat preliminary and speculative, these results seem to indicate a pattern.

The results showed that in the left-handed group all forms of anxiety were more strongly associated with performance. This might imply that emotional aspects were more involved in the left-handers' intellectual processes as compared to the right-handed group.
Children also showed a positive relationship between balanced self-concept and non-verbal ability, whereas extreme self-concept was negatively correlated with performance. However, on the verbal tasks I found some differences in the patterns of the relationships between cognition and emotion in the two groups.

While right-handed children showed no significant association between balanced self-concept and all the verbal subtests (except Synonyms), the performance of left-handed children on all the tasks was positively associated with a balanced representation of themselves. Oatley (1992) has suggested that the self is a model of one's abilities and cognitive systems. The present results might suggest either that left-handed children obtained a better model of themselves or that they were more aware of this model, and therefore the two aspects of cognition and emotion seemed to have stronger correspondence within this group.

Another distinct difference between the groups was found on the extreme answer types. While I found that left-handed children tended generally towards the balanced or more negative self-concept, no correlations were found between the negative answer type and verbal cognition in this group. Significant negative correlations appeared, however, between the excessively high self-concept type and Classification, Proverb, and Analogy.

In the right-handed group I found a different pattern. While the right-handers generally scored higher on the excessively high self-concept, no correlations were found in this group between exaggerated self-concept and verbal cognition. More surprising was the finding of significant negative correlations between the negative answer types and Categorization, Proverbs and Analogy.
These results imply that left- and right-handed children might differ from each other, not in their general levels of anxiety or in their conceptions of themselves (on which only slight variations were found), but rather in the way cognition and emotion or, more specifically, anxiety and self-concept were associated with the children's cognitive performance.

Lewis (1995, 1996) proposed that cognitive appraisals, which direct people's activity are strongly based on a positive feedback between cognition and emotion. The present results might suggest that right- and left-handed children show different patterns of self-organization.

It could, of course, be argued that this suggestion is not well founded, since children's emotions during cognitive processing were not actually checked in real time, whereas cognitive performance in this study was actively tested by measuring how children solve real problems and apply their thinking faculties. This argument has some merit, since the measures of emotional aspects were all based on children's self report. Thus, they might only reflect the children's beliefs about themselves. Nevertheless, the differences in patterns that appear between left- and right-handed children do warrant further investigation.

Differences related to gender among left-handed individuals were often discussed in the literature, suggesting higher frequency of left-handedness among males as compared to females. In addition, significant differences in performance by males and females were repeatedly mentioned (Bishop, 1990; Coren, 1992; Hecaen & Ajuriaguerra, 1964).
Results of the present study showed no differences in the frequency of left-handedness between boys and girls, and no differences were found between left-handed boys and girls in any of the performance measures. Results showed similar abilities on verbal and non-verbal cognition, on academic achievements and on all the affective measures as well.

A significant difference was found, though, on anxiety. Girls showed generally higher levels of anxiety than boys, but no differences were found in this respect between the handedness groups. It should also be noted that, since anxiety was measured in this study by self report, this difference might in fact be based on gender differences in willingness to discuss feelings, rather than on real emotional differences.

**Limitations of this study**

A central problem in the design of this study was that left-handed children were chosen on the basis of their own and their teachers' statements as to which hand they use in writing. Handedness was not tested by any of the relevant inventories suggested in the literature.

Another major problem is that the significant differences found between the left-handed and right-handed groups were discovered post hoc, in the context of no large differences in main effects. Because a large number of significance tests was performed, the levels of \( p<0.05 \) found in this study must be regarded as indicative of the need for further research.
Future research

The results of this study suggest that it would be beneficial to extend it, in order to examine cognitive performance of left-handed children through a process-oriented approach, so as to acquire a better understanding of their cognitive strategies. This would be especially interesting if studied in relation to the integration of different thinking strategies.

It is also important to understand more about emotional aspects of left-handed children, not only through tools based on self-report, but also by using emotional diaries, narratives, or reactions to stories and real-life episodes.
CHAPTER 3

STUDY 2

Background and Rationale

Based upon the fact that no significant differences between right- and left-handed children in their cognitive, emotional and academic abilities were found in Study 1, I decided to study judgement of right- and left-handers on chimeric faces, which is a known measure of brain laterality. Through this task I expected to get a better understanding of handedness.

Investigation of subjects' reactions to emotion displayed on faces in general is a central theme in cognitive and neurological research, and is one of the methods used to examine hemispheric specialization in the affective domain (Ekman, 1992; Hellige, 1993; Luh, Rueckert & Levy, 1991; Rinn, 1984; Sackheim, Gur & Saucy, 1978). Special attention has been given in the literature to both expression (Alford & Alford, 1981; Borod, Koff & White, 1983; Dodson et al., 1984; Moscovitch & Olds, 1982; Rubin & Rubin, 1980) and perception of emotions (Ahern et al., 1991; Bennett et al., 1987; Gilbert & Bakan, 1973; Ley & Bryden, 1979; Strauss & Moscovitch, 1981; Safer, 1981).

Perception of emotion on faces.

Studies on perception of faces have consistently shown that right-handed people have a bias for the left side of the visual field for both expression and perception of emotions. These results in normal subjects were generally explained in terms of brain
asymmetries, and it is suggested in the literature that the hemisphere that is more activated while performing a task causes a bias in the contralateral visual field. Thus on verbal tasks, which involve the left hemisphere, there would be a bias to the right visual field, while spatial and emotional stimuli that involve the right hemisphere would be better processed if located in the left visual field.

An example of this approach is given in Levy's study (1976) on esthetic preferences in right- and left-handed people. Levy presented vacation slides (e.g., street scenes, architecture, wildlife, and natural scenery) simultaneously with their mirror images, asking subjects to choose which of the two pictures they preferred. She found that right- and left-handers differed in their preferences (although not to a significant degree), and concluded that the results reflect a left field bias generated by a selective activation of the right hemisphere in right-handed people.

The perception of emotion on faces is generally explained in terms of a right hemisphere primacy for processing all emotions: i.e., higher activation of the right hemisphere, when emotional stimuli are involved, elicits a bias for the stimulus presented in the viewer's left visual field (Gilbert & Bakan, 1973, Harris & Snyder, 1992; Hellige, 1983; Levy, Trevarthen & Sperry, 1972; Ley & Bryden, 1979; Young et al., 1990).

The first studies on brain asymmetries for perception of faces were conducted with split brain patients. When stimuli were presented tachistoscopically to these subjects, researchers had full control as to which hemisphere was stimulated, and this could, of course, suggest straightforward answers (Levy & Trevarthen, 1977; Levy, Trevarthen, & Sperry, 1972; Milner & Dunn, 1977). Yet, when stimuli are presented to normal
subjects, in free vision or even using tachistoskopical methods, interpretation of the results becomes a more complex matter, and therefore other related factors should be considered (e.g., stimuli properties, memory functions, cognitive operations, etc.). (See also Moscovitch, 1983; Davidson, 1992).

Another basic question examined in the literature is whether only the right hemisphere is specialized for emotion. Dimond, Farrington & Johnson (1976) argued for the existence of a differential emotional response from the right and the left hemispheres; i.e., that the left hemisphere is specialized for processing positive and pleasant emotions, and the right hemisphere is involved with the negative and horrific ones. This theory is now known as the Valence hypothesis (Davidson, 1992; Davidson & Fox, 1982; Reuter-Lorenz & Davidson, 1981). Results of studies following this approach were inconsistent, and tend to indicate that hemispheric specialization for negative and positive emotions is more related to experiencing and expressing emotions, rather than with the perception of emotions (Best, Womer & Queen 1994; Bryson et al., 1991; Christman & Hackworth, 1993; Davidson, 1992; Harris & Snyder, 1992; Schiff & MacDonald, 1990; Tucker, 1981).

Perception of emotion on chimeric faces.
Chimeric faces are faces in which each half of the face displays a different emotion. The term comes from the name of the strange Greek mythological monster "Chimera", and is used to refer to unreal and obscure figures.

Levy, Trevarthen and Sperry (1972) introduced the chimeric pictures (and faces) task in a study with split brain patients, using a tachistoskopical procedure. Jaynes (1976) further developed the method, by presenting a cartoon chimeric face, with a half
happy/half sad configuration, and its exact mirror face in a free vision task. Jaynes, who showed the faces to almost a thousand people, asking them which of the two faces seems happier, found that most people judged faces with a left positive configuration as happier than a right positive configuration, and this was consistently confirmed in all subsequent similar studies (Hellige, 1983; Jaynes, 1976; Schiff & Truchon, 1993). These findings were then generally explained by the idea that peoples' bias for the left positive configuration indicates the activation of the right hemisphere during judgement; or in other words, that people choose the left positive configuration as happier due to the fact that their right hemisphere is involved in processing emotions (Hopfman & Levy, 1988).

Schiff and Lamon (1989, 1994) found that experiences such as the contraction of subjects' muscles on the left side of their face, or squeezing a rubber ball with their left hand, induced negative emotions, like sadness. Similar activation of the right side of the face or the hand induced more positive emotions in people. In a study with chimeric faces, Schiff and Truchon (1993) found that a negative bias for judging faces with a left negative configuration was alleviated by right hand contraction (but not by left hand contraction); left-positive faces generated weak positive biases which were hardly affected by either hand contraction. On neutral faces right hand contraction changed biases in a positive direction, whereas left contractions generally created a negative shift in the biases. Schiff and Truchon argued that these results "reflect emotional changes and shifts in lateral attention resulting from activation of the hemisphere contralateral to the contraction" (Schiff & Truchon, 1993, p. 1351).

Since Jaynes (1976) noticed that left-handed subjects showed different judgement, most of the studies with chimeric faces were controlled for handedness, and mainly

Only a few studies with the chimeric faces tasks were conducted with left-handers as well (David, 1989; Gur & Gur, 1983; Hoptman & Levy, 1988; Levy et al., 1983; Luh, Redl & Levy, 1994). The basic assumption in this line of research was that, if judgement differences were found among left-handers, this might be attributed to the existence of differences in brain asymmetries among left-handed people. All the investigators have reported some differences in judgement in left-handed subjects, yet none of these results was assessed as being conclusive.

Luh, Redl & Levy (1994), for example, compared right and left-handed subjects on a free vision chimeric task, and their conclusions are typical. Summarizing their findings, they said: "...left-handers are more diverse in their patterns of cerebral lateralization than right-handers, with some individuals manifesting very large perceptual asymmetries, either consistent with or opposite to those seen in right-handers, and some individuals manifesting smaller or no perceptual asymmetries" (Luh et al., 1994, p. 143). David (1989) also reported on a significant and reliable bias towards the left hemiface in right-handed subjects. However, no consistency was perceived in the judgement of the "non right-handers".

Similar evaluation of findings can be found in other studies which focused on handedness and brain asymmetry, such as, for instance, studies on verbal vs. non-verbal processing, or on specialization for processing emotion (Hellige, 1993; Springer & Deutsch, 1989). Here too, although findings have generally shown more variety
among left-handers in the direction of their hemispheric asymmetry, none of the results seemed conclusive.

The present study

Only a few studies have been carried out on perception of emotion on chimeric faces with left-handed people, and their results have been inconsistent. This study was designed to compare right- and left-handed subjects in their judgement of chimeric faces under conditions that might be more sensitive than those under which tests were administered in the past (David, 1989; Hoptman & Levy, 1988; Levy et al., 1983): I assumed that simultaneously exposing faces that are composites of two opposite emotions together with their mirror image would elicit different judgements by the two handedness groups.

The main hypothesis of the present study was that right- and left-handed subjects differ in their perceptions and show distinct judgements about which of the two chimeras seems happier.

Another assumption in the present study was that left- and right-handers show stronger biases when the chimeric faces are presented one above the other and are smaller, since this way of presentation requires subjects to devote more attention and concentration to the stimuli presented. This way of presentation was used to test the validity of the results.
Hypotheses

More specifically the hypotheses in this study were as follows:

1. Differences will be found between the groups on perception of emotion on the chimeric faces when presented side by side: the right-handed subjects will judge the face with a positive configuration on the left side of the face as happier, whereas the left-handed subjects, will describe the face with a right-side positive configuration as happier.

2. Subjects in both groups will show stronger biases, in the same direction, when the faces are small and presented one above the other (which might imply different processing when the task requires more focusing and concentration).

3. While left-handed subjects will perform more tasks with their non-dominant hand, both groups will perform fine and precise motor tasks with both hands coordinated.

4. More familial left-handedness will be found among left-handed as compared with right-handed subjects.

Design

This study had a "between-within" subject design. The comparison between left- and right-handed people was the "between subjects" variable. In the chimeric faces tasks, the type of stimulus presented (left negative-left positive) was the "within subjects" variable. Another "within" variable was the subjects' reaction to different modes of presentation of the faces (as described in the procedure).

The dependent measures were the subjects' judgement of each stimulus, and their reaction to different ways of presentation of the faces (horizontal vs. vertical).
Methods

Subjects

The subjects were 48 adults (24 males and 24 females): 21 right-handed, 21 left-handed and 6 switched-handed subjects. Five of the switched-handed subjects reported that they tended to use their left hand in writing during their first years at school, but were switched by their parents into using their right hand. One subject was a right-handed child till the age of 8, and then was switched to using his left hand due to an arm injury.

It should be mentioned that testing switched-handed subjects was not part of the original design of this study, yet during collection of the data it was decided to collect data on people who told the interviewer that they started using one hand (mostly the left) during childhood but were switched into using the other hand by their parents and teachers.

The sample was drawn from two settings: some of the subjects were students at The Ontario Institute for Studies in Education and others were employees in a company for computer design. The mean age of the subjects was 28. Handedness in this study was determined by the individual's self report. Right-handed and left-handed people were chosen opportunistically (equally controlled for sex). Only subjects who signed a letter of consent were included in this study.
**Measures**

Data were collected by presentation of two sets of pictures of chimeric faces (Appendix VIII) and a self report questionnaire on handedness, including a short interview (see Appendices IX and X).

**Judgement of chimeric faces**

Six chimeric faces that were used in the Schiff & Truchon (1993) study and their mirror faces were presented to the subjects in the format of a booklet. The faces were drawn by Schiff & Truchon after David's (1989) example. The basic chimeric face in the present study had a left-positive/right-negative configuration, and it was presented together with its mirror image on a single page, and then presented in an opposite configuration on a separate page (each couple of faces would thus appear twice in the booklet, one arrangement being the mirror image of the other), so that a counterbalanced effect would be maintained. Subjects had to judge for each page which of the chimeric faces looked happier, the one with the smile on the left or the one with the smile on the right.

Two sets of booklets were presented: a set of 12 pictures, in which the faces were presented side by side (showing the 6 basic faces and their mirror image), and a second set of six pictures in which three of the same faces (and their mirror images) were differently displayed. These faces were smaller and presented vertically, one above the other. All the pages in each of the booklets were arranged in a random but fixed order, so that all the subjects followed the same sequence of presentation.
Scores were assigned as follows: 1 point was given for each choice of the face with a happy configuration on the left side of the face as being happier, and 0 for choosing the face with a happy configuration on the right side as being happier. Scores on the side by side version of the pictures ranged from 0 to 12. On the version with faces one above the other scores ranged from 0 to 6.

**Measures of handedness**

Data on manual activity during the performance of different tasks were collected by self-report questionnaires and observation of performance. Contrary to studies focused mainly on determining the subject’s dominant hand, I was interested in a more detailed description of hand operation. Data were gathered on the following aspects of handedness: use of the dominant hand, use of both hands in a coordinated manner for executing various skilled activities, and of the non-dominant hand for the performance of fine and complex tasks (for an example of the tasks see Appendix IX).

**The Handedness Questionnaire.**

To learn about handedness I used Coren's (1992) *Handedness Questionnaire*, a 12-item inventory that was designed to determine strength of handedness. The subject is given a list of fine manual tasks (e.g., write, draw, throw a ball to hit a target, hold a thread when threading a needle, etc.) and is asked to note which hand he or she uses for each activity (i.e., left, right or either). Coren suggests giving three points for each "right hand" answer, 2 points for an "either" answer and 1 point for each "left-hand" answer. This way the total score gives a description of the direction and strength of handedness. In the present study I used Coren’s questionnaire somewhat differently, focusing on the nature of manual activity for skilled tasks in right-handed and left-handed individuals. Ten of the items were presented. A score of 1 point was given
for each choice (i.e., left, right, either) and a sum score for each answer type was calculated separately. Each subject was given three scores: a score on using the right hand (ranging from 0 to 10), a score on using the left-hand (ranging from 0 to 10) and a score on using either hand (ranging from 0 to 10).

**Bi-manual activity.**
A self-report questionnaire was designed to gather information about performance of skilled activities with both hands coordinated. The subject was presented a list of six tasks (i.e., eating, sports, typing, playing a musical instrument, driving a car and riding a bicycle), and was asked whether he or she performs these tasks by using both hands coordinated, or does he use only his preferred hand. Subjects' responses were collapsed into two activity types: "both hands" and "dominant hand". Each type was scored separately, with scores ranging from 0 to 6 on each activity type.

In addition, subjects were asked to make a list of other activities that they performed with both hands coordinated. Each additional activity got one point. A total score on bi-manual activity was calculated based on the sum of all the activities which the subject performs with "both-hands".

**Use of the non-dominant hand.**
To assess the use of the non-dominant hand for performance of fine and complex activities, I used a self report questionnaire designed for this study. Subjects were asked to report how often they use their non-dominant hand while performing fine and complex tasks, (i.e., cutting with scissors, cutting with a knife, writing, and opening a can). Each item was scored on a scale from 0 to 5 (from never to every day). The sum score on non-dominance was the sum result of all four items. In addition, subjects were
asked to list other fine or complex tasks which they performed with their non-dominant hand. Each additional non-dominant activity got a score of three points (the average score on the "non-dominant" items). The total score on usage of the "non-dominant hand" was based on the summed scores of the items mentioned above.

**Direction of drawing a line and hand posture.**

Hand posture and direction of drawing a line were determined by observation. During the interview, the subject was asked to draw a horizontal line and the interviewer observed his or her performance, and noted the direction in which the line was drawn; i.e., from left to right, from right to left, paper held sideways etc. Notes were taken to describe whether the subject's hand posture was inverted or non-inverted. The task was given following Levy & Reid (1978), who suggested that inverted handwriting might indicate differences in hemispheric specialization for language.

**Familial handedness.**

Information on familial left-handedness was gathered by a self report questionnaire. Subjects were asked to note whether their first relatives (i.e., father, mother, siblings and children) were left-handed. Scores were based on counting the number of left-handed relatives, and ranged from 0 upwards.

**Procedures.**

The subjects were told that the study was concerned with the effects of handedness on education and daily life, and that they would have to answer questions regarding use of different hands, and give their reaction to some pictures. After signing a letter of consent, they were individually tested in a quiet room in the following order:
1. A set of the 12 side by side chimeric pictures were presented, with the following instructions: "We would like to show you some pictures of faces. Please look at the two faces on each page and note which one of them seems happier."

2. The subjects were asked to draw a horizontal line, and then were given the questionnaire on handedness and on bi-manual activity. The interviewer observed each subject's direction of drawing, and his or her handwriting to determine whether it is inverted or non-inverted.

3. A second set of six chimeric pictures, in which the faces were arranged one above the other, was presented to the subject. The instructions were: "We would like to show you another set of pictures, please look at the nose of each face and note which one looks happier. These pictures are presented in a different way and it is very important that you stare right at the tip of the nose of each face separately, before giving your answer."

4. The interview on handedness was given, referring to use of the non-dominant hand, and familial left-handedness.

**Results**

**Judgement of chimeric faces**

The main hypothesis of the present study was that right-handed and left-handed people would differ in their reaction to displays of emotion on chimeric faces, and make significantly different judgements about which of the two presented chimeras seemed happier.

To assess the effect of handedness on subjects' judgement of emotion on the chimeric faces, the subjects (right, left and switched-handed) were compared on both versions
of the task (i.e., pictures side by side, and one above the other) using an analysis of variance (ANOVA).

Pictures side by side.

Mean scores on subjects' judgement on the side by side version of the task are presented in Figure 7. (See also Appendix XI).

![Figure 7. Mean scores (based on points given for the happy face to the left) on the judgement of the chimeric faces of the right-handed (n=21), left-handed (n=21) and switched-handed (n=6) subjects]

An analysis of variance (ANOVA) carried out to compare subjects' judgement on the horizontal presentation showed a significant group effect $F(2, 44)=8.82; p<0.001$. Post
Post hoc analysis indicated a significant difference in judgement between the right- and left-handed individuals (Scheffe p<0.05). Right-handed subjects tended to choose the left positive configuration as happier, whereas the left-handed subjects chose the face with the right positive configuration as the happy one. Results of Post hoc on right-handed vs. switched-handed was not significant (Scheffe p>0.05).

Pictures one above the other
Mean scores of subjects' judgement on the vertical version of the task are presented in Figure 8. (See also Appendix XI).

Figure 8. Mean scores (based on points given for the happy face to the left) on the judgement of the chimeric faces of the right-handed (n=21), left-handed (n=21) and switched-handed (n=6) subjects.
The results on the presentation of pictures one above the other showed a significant group effect $F(2, 44)=8.77; p<0.001$. Post hoc analysis indicated a significant difference in judgement between the right- and left-handed individuals (Scheffe $p<0.05$), and between the right- and switched-handed subjects (Scheffe $p<0.05$). Right-handed subjects tended to choose the left positive configuration as happier, whereas the left-handed and switched-handed subjects chose the face with the right positive configuration as the happy one.

Comparing the two presentation techniques.

Another hypothesis of this research was that different ways of presentation of the pictures, i.e., side by side or one above the other, will elicit differences in subjects' judgements of the faces, assuming that the faces one above the other will elicit stronger biases to the left in right-handers and to the right in left-handers. Table 4 presents right-handed, left-handed and switched-handed subjects' perception of emotion displayed by the chimeric faces (in percentage).
Table 4.
Percent of choice of the happier chimeric faces by right-handed, left-handed, and switched-handed subjects on the pictures presented side by side and one above the other.

<table>
<thead>
<tr>
<th>Pictures side by side</th>
<th>Right-handed n=21</th>
<th>Left-handed n=21</th>
<th>Switched-handed n=6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-positive configuration</td>
<td>71.7%</td>
<td>32.2%</td>
<td>40.3%</td>
</tr>
<tr>
<td>Right-positive configuration</td>
<td>28.3%</td>
<td>67.8%</td>
<td>59.7%</td>
</tr>
<tr>
<td>Pictures one above the other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left-positive configuration</td>
<td>79.2%</td>
<td>35.7%</td>
<td>36.2%</td>
</tr>
<tr>
<td>Right-positive configuration</td>
<td>20.8%</td>
<td>64.3%</td>
<td>63.8%</td>
</tr>
</tbody>
</table>

As can be seen in Table 4, subjects of all three groups showed individual differences in their biases of the chimeric faces. Comparison of the groups' biases showed that right-handers showed a slightly stronger bias (to the left side of the face) than the left-handers (to the right side of the face). The switched-handed subjects showed more versatility in their biases.

A similar trend was found for both techniques of presentation. However, it should be noted that while right-handers showed a slightly stronger bias in the same direction for the left side of the face when pictures were presented one above the other, the left- and switched-handed subjects showed slightly stronger bias to the right side of the face on the pictures were presented side by side.
To evaluate whether the mode of presentation had an effect on the subjects' judgement of the pictures, a repeated measures analysis of variance (ANOVA) was carried out with the two versions of the task (i.e., pictures side by side and one above the other) being the two levels of the repeated factor. Only the pictures that were presented in both versions of the task were used for this analysis. Results showed that handedness had the main and significant effect in explaining the subjects' perception of the chimeric faces $F(2,43)=9.87, p<0.0005$. The version of the task had no significant effect on subjects' judgement $F(1,43)=161, p=0.69$.

**Direction**

The subject's natural preferred direction for drawing a line was observed by the interviewer during the task performance. Results are presented in Table 5.
Table 5.

Distribution of the right-handed, left-handed and switched-handed subjects according to their direction in drawing a line.

<table>
<thead>
<tr>
<th>Subject group</th>
<th>Right-handed</th>
<th>Left-handed</th>
<th>Switched-handed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction of line</td>
<td>n=21</td>
<td>n=21</td>
<td>n=6</td>
</tr>
<tr>
<td>Left to Right</td>
<td>20</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Right to Left</td>
<td>0</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Sideways / inverted</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

As can be seen from Table 5, almost all the right-handed subjects drew a line from the left to the right. Most of the left-handed drew a line from the right to the left, yet more versatility can be noticed in this group: six left-handed subjects drew the line either with their hands inverted or holding the page strongly shifted. Results of chi-square =40.13, DF=6, p<0.0005.

The relation between the direction of drawing a line and handedness was so close that no analyses needed to be performed separately as a function of line-drawing.

**Manual activity**

In the present study data were collected on manual activity, focusing on the use of different hands in action, performance of skilled tasks with both hands coordinated, and the use of the non-dominant hand by right and left-handed subjects.
**Handedness questionnaire.**

Results on the handedness questionnaire are presented in Figure 9.

![Bar graph showing mean scores on tasks performed with the right-hand, either-hand, and left-hand among the right-handed, left-handed and switched-hand subjects.]

Figure 9. Mean scores on tasks performed with the right-hand, either-hand, and left-hand among the right-handed, left-handed and switched-hand subjects.

It is clear from Figure 9 that the right-handed subjects performed all the tasks presented in the questionnaire with their right hand only. More versatility was found in the left-handed and the switched-handed groups. Left-handed performed 78% of the tasks with their left hands, and 19% - with their right hands. All subjects showed a preference for one hand on these activities, and almost none of them were performed with both or either hand.
Bi-manual activity.
The groups were compared on performance of fine skilled tasks by using both hands in a coordinated manner. Mean scores in the right-handed group was $M=2.17$ (SD=1.98); in the left-handed group $M=2.00$ (SD=1.87) and in the switched-handed group $M=1.67$ (SD=2.25).

A one way analysis of variance (ANOVA) was carried out to compare among the groups. Results showed that no difference exists among the groups $F(2,45)=1.02$, $p=0.37$. This indicates that all the subjects were similar in performing tasks which require the coordination of both hands.

Using the non-dominant hand.
Figure 10 presents means on the degree (frequency and amount) of use of the non-dominant hand by the right-handed, left-handed and switched-handed subjects.

![Bar Chart]

Figure 10. Means on the degree of using the non-dominant hand by right-handed, left-handed and switched-handed subjects.
A clear difference can be seen between the right-handed and left-handed subject in the degree of task performance with the non-dominant hand. The switched-handed subjects show more resemblance to the left-handers. A one way analysis of variance (ANOVA) was performed to compare between the groups (left-handed, right-handed and switched-handed) on the frequency of using the non-dominant hand. Results showed a significant main effect of the group $F(2,45)=9.64$, $p<0.001$. Post hoc analyses showed a significant difference between the right-handed and left-handed group (Scheffe $p<0.05$) and also between the right-handed and switched-handed groups (Scheffe $p<0.05$).

**Familial left-handedness**

A one way analysis of variance (ANOVA) was performed to compare the groups on the number of their left-handed first relatives. Results showed the existence of no difference between any of the groups (left-handed, right-handed and switched-handed): $F(2,44)=0.4$, $p=0.76$. Another ANOVA carried out to compare the groups on the existence of switched-handed first relatives also showed no differences $F(2,45)=0.50$, ($p<0.61$). These results indicate that the occurrence of left-handed or switched-handed first relatives did not differ in any of the groups tested.

**Discussion**

The main hypothesis of this study was that right- and left-handed people differ in their judgement of emotion on chimeric faces. This hypothesis was indeed confirmed. While right-handed subjects judged the faces with a left-positive configuration as happier, left-handers perceived the right-positive configurations as happier. More variability was
observed in the judgement of switched-handed subjects, who resembled the left-handed group (including one subject who switched from using his right hand to using his left hand for writing and other activities). The fact that similar results appeared on both versions of the task, in which pictures were presented side by side and one above the other, as well as on the repeated measures analysis, adds to the validity of this finding.

These results are in accordance with other findings that have consistently shown a left-side perceptual bias in right-handed subjects (Cohen Levine & Levy, 1986; Hoptman & Levy, 1988; Levy et al., 1983b; Luh et al., 1991; Wirsen et al., 1990). Left-handers were found to differ significantly from right-handers in their perception of chimeric faces with a right side bias. The results of previous studies comparing right- and left-handers on the chimeric faces task also suggested the existence of differences between the groups, but these differences were generally described as insignificant (David, 1989; Hellige, 1983; Jaynes, 1976; Levy & Heller, 1981; Levy et al., 1983a; Luh et al., 1994).

The fact that results on facial perception in this study were more significant than in other studies employing chimeric faces might be related to the nature of the stimulus (e.g., type of faces, way of presentation). Levy and her colleagues (Cohen Levine & Levy, 1986; Hoptman & Levy, 1988; Levy & Heller, 1981; Levy et al, 1983; Luh et al., 1994) presented faces based on a composite of half-happy/half-neutral expression (based on photographs, and presented with their mirror image). In the present study the chimeras were cartoon half-happy/half-sad faces, and each face was presented together with its mirror image (i.e., side by side or one above the other). It seems that it is easier to distinguish between two opposite emotions than between a distinct
expression and a neutral one; and therefore the faces shown in the present study might provide a more sensitive measure of expression, and thus be easier to "read". I also considered the possibility that cartoon faces project a more pronounced expression, because of our cognitive ability to make sense of semantic messages transmitted by cartoon materials. However, in one of the studies (Luh et al., 1994) both cartoons and photographs were presented, with no differences in result, which suggests that this aspect has no special effect on subjects' judgement of emotion on faces. The faces used in David's (1989) study served as models for the chimeras in the present study (see also Schiff & Truchon, 1993). However, the differences he found in the bias of left-handers were insignificant. It seems to me that in our case, the differences in the results might be related to the way the faces were presented. David showed the faces one at a time, and this might have had less impact on the subjects. Hellige (1983) used the original Jaynes chimeras (1976), but presented them as two pairs to a page, with small differences between the two pairs (asking subjects to choose the happiest face), which again might be less easy to "read". The more significant results in the present study might also be related to the participation of switched-handed subjects. This study showed that switched-handed subjects show greater versatility in their judgements. If more switched-handed subjects had been included as non-right-handers in other studies, this might have had a greater effect on the significance of the results.

Previous studies using chimeric faces have revealed large variations in the magnitude and direction of the perceptual biases among right-handers. Levy et al. (1983b) attributed such differences to individual differences in hemispheric arousal while dealing with differential tasks. Luh et al. (1991) found that individual differences in perceptual biases were stable across a number of different tasks. Individual differences in subjects' bias were found in the present study as well. Right-handers generally
showed a slightly more consistent bias than left-handers, and switched-handed subjects basically resembled the left-handers but were more versatile. It is interesting that although technique of presentation (i.e., side by side or one above the other) had no main effect in explaining subjects' judgement of the faces, the way stimuli were presented elicited different reactions in the different groups. The right-handers showed a slightly stronger bias when the pictures were presented one above the other; the left-handers, on the other hand, showed a stronger bias on the pictures presented side by side. Interestingly, the proportion of individual differences that was found in the present study was of similar value for both right- and left-handed subjects (although in opposite directions). This coincides with reports from previous studies (Hellige, 1983).

These results show a pronounced and different trend between right- and left-handed individuals in their perception of the faces. The question is: how could these results be explained, and what sense do they make?

According to the right hemisphere advantage hypothesis (Reuter-Lorenz & Davidson, 1981; Schiff & Truchon, 1993), a left bias in the perception of chimeric faces indicates a right hemisphere dominance for processing emotion. This leads to the logical conclusion that the right-side bias for the perception of chimeric faces in left-handed people indicates a left hemisphere dominance for emotion. It may also indicate a more global reversal in hemispheric dominance in right- and left-handed people. Neurological research in the last two decades has shown, however, that in spite of neurological differences between the two handedness groups, there is probably no reversal in brain asymmetries between right- and left-handers in other areas of performance (Hellige, 1993; Kinsbourne, 1983; Levy & Gur, 1980). In the present research, the results of Study 1 also showed that right- and left-handers were very similar in many areas of
performance, whereas it might be expected, if they were indeed reversed in brain structure or in inner organization, that clearer differences would be found between the groups, especially in their cognitive styles (i.e., analytical vs. global).

Following the valence hypothesis, the results on the face task might suggest that in right-handers, the right hemisphere dealing with negative emotions is more involved, while in left-handers, the left hemisphere controlling positive emotions is more involved. Thus, since results of studies on the valence hypothesis have generally shown that this differentiation between the hemispheres in processing emotion is more related to experiencing and expression than in perception of emotions (Best, Womer & Queen 1994; Bryson et al., 1991; Christman & Hackworth, 1993; Harris & Snyder, 1992; Schiff & MacDonald, 1990), this explanation has to be further examined. If there is indeed a reversal in brain laterality between right- and left-handers, the relationships between emotion and hemispheric control in left-handers would appear to be even more complex.

Results of the present study have demonstrated that right- and left-handers showed distinct biases in their judgement of chimeric faces. The main implication of these results is that on this task there are differences in brain laterality between right- and left-handed individuals. Although different explanations have been suggested for the differences in brain organization underlying the judgement of faces, the present study was not designed to contribute to these explanations.

**Manual activity**

Another central theme in this research concerned people’s manual activity during the performance of fine motor tasks. The data collected in this study were centered on the
way right-handers and left-handers use their dominant hand, and perform with both hands in a coordinated manner, and on the degree of usage of their non-dominant hand. The findings showed, as predicted, that right-handers used mainly their right hand in activities requiring subtle manipulations, while left-handed subjects sometimes also used their right hand for such activities. When subjects were specifically asked how often they used their non-dominant hand while performing fine skilled activity, significant differences were found between the groups. Whereas right-handers recounted avoiding such activities, left-handed subjects reported quite a high frequency of using their right hand.

Although this is a well-known fact, it has been examined in the past as a reflection of the degree of brain laterality. The main assumption is that the weaker hand laterality, generally found in left-handers, is caused by a weaker brain laterality originating from differences in primary brain function of left-handed people. This explanation is based on an underlying assumption that strong hand preference indicates a strong brain laterality, whereas greater versatility in manual activity is presumably caused by a weaker brain asymmetry.

I submit that the difference between right-handers and left-handers in hand dominance, reflected by greater versatility in fine task performance with the non-dominant hand, are the result of much training and procedural learning. From personal knowledge, observations and reports given by left-handed people, I suggest that the ability to perform subtle tasks with the non-dominant hand does not come easily to left-handers. It is rather a result of training in an effort to overcome their natural course of movement and direction, in order to gain control and master complex and unnatural gestures. Evidence for this is often suggested in popular books on handedness, describing the
difficulties of the left-hander who "lives in a right-hander's world." Coren (1992) also argued that tools such as can-openers, kitchen items, knives, food slicers, etc., are all designed in favor of right-handed people, just as are pieces of equipment in the office, in the workplace, in leisure activities and even in cars. It is therefore argued that left-handers must develop special skills and train themselves to use their right (non-dominant) hand for operating in the world.

That manual activity can be mastered equally well by right- and left-handers is observed from the data collected on performance of complex manual activity with both hands coordinated. Note that right- and left-handers reported similar abilities to use both hands for mastering a musical instrument, driving, participating in sports, operating machinery, typing, using a personal computer, etc. This indicates that, through exercise and training, everyone can train both hands to master elaborate movements, and to control and manipulate fine and complex tasks or minute objects. The point is that right-handers have less need to use their left hand for skillful manipulation, while left-handers must learn to do so in order to operate in many areas of life.

The switched-handed group.

As mentioned earlier, data collection on switched-handed subjects was not intended initially, and in fact I was not especially aware of their distinction as a group. It was only during interviews with subjects that the switched-handed subjects attracted my interest, because of their strong awareness of the fact that they had been "switched" into using their right hand in writing. It was my impression from the start that these subjects performed in a more versatile manner, both in their manual activities and in their judgement of the faces. Later on, analysis of the data corroborated this impression. It therefore seems that although in the present study this group was small, the data
connection between brain and hand.

Further investigations of switch-handed people could lead to additional insight into collected on their performance (both manual and in perception of emotion) indicate that...
CHAPTER 4

GENERAL DISCUSSION AND CONCLUSIONS

Two significant findings emerge from the present studies. The first study shows that right- and left-handed children are highly similar in both their cognitive and their emotional performance. The second study shows that right- and left-handed individuals differ significantly in their perception of emotion on chimeric faces.

It could be argued that the results of the two studies show an apparent contradiction, since the first one seems to imply no significant differences between the groups, whereas the second shows a significant main effect in the perception of faces as related to handedness. This seeming discrepancy might however be explained in terms of differences in inner organization.

In Study 1 right- and left-handed children showed equal abilities in the cognitive and in the emotional domains, but there were some suggestive findings to indicate that the two groups differed with respect to the inner organization between verbal and non-verbal processes, and between cognition and emotion. Whereas in right-handed children these aspects were not related to each other, significant relationships were found between verbal and non-verbal processing in left-handed children. In addition, the two groups showed significantly different patterns in the relationship between children's self-concept and their verbal cognitive performance. Positive self-concept seemed to play an important role in the performance of the left-handers, while the two aspects where not related to each other in the right-handed group. Moreover, significant differences were observed between the groups in the patterns of
relationships between extreme levels of self-concept and performance on Proverbs, Analogy and Classification, and Categorization. It is interesting that on these subtests children from both groups showed patterns that also differed from their usual behaviour, indicating that they may have found these particular tasks more difficult cognitively or emotionally.

In Study 2, which was specifically designed to maximize an inter-group difference in performance on a psychological and particularly emotion-dependent variable, significant differences were observed in right- and left-handed subjects' perception of chimeric faces, and there was a large main-effect difference as a function of handedness. The existence of differences in brain asymmetries between right- and left-handers is well established in the literature, although there is no agreement on their direction and magnitude (Bryden, 1982; Hellige, 1993; Herron, 1980; Kinsbourne, 1980; Levy & Gur, 1980; Springer & Deutsch, 1989). The present data provide consistent evidence that right- and left-handers do judge chimeric faces differently. In other words, right- and left-handed individuals reach different conclusions about emotional expressions when they view spatially presented pictures and their mirror images. Alternative speculations exist for explaining these differences. However, the research reported here was not designed to test these alternatives.

**Some speculations on the implications of brain structure**

From a behavioural perspective, the results presented here suggest different brain organization in right- and left-handed individuals. Dynamic theories postulate that people's activity is directed by their inner self-organization, which is strongly based on a positive feedback between cognition and emotion (Lewis, 1995, 1996; Oatley, 1992,
Oatley & Jenkins, 1996). The findings of Study 1 might therefore imply that right- and left-handed children show different patterns of self-organization, since in that study stronger relationships were found between verbal and non-verbal processing and between cognition and emotion in the left-handed children, while in the right-handers these aspects were less related to each other. Such associations imply that linguistic and spatial functioning are more strongly associated with each other in left-handed than in right-handed children. These results are also in accordance with previous findings that the right hemisphere is more involved than the left in spatial processing and in processing emotion, as suggested in the literature (Hellige, 1993; Bryden, 1982; Brown, 1983).

The results might therefore imply a more highly developed interrelationship between the two hemispheres in left-handed than in right-handed individuals. Interestingly, Witelson (1985) found that the sizes of certain areas of the corpus callosum in the brains of mixed-handed and left-handed subjects were larger and different from those of right-handed subjects. This might be attributable to more interrelated activity and feedback, rather than to a primary structural difference between right- and left-handed people.

The leading theory in the field of research on the human brain is based on the representation of the brain as a central command post, controlling human activities in a top-down operating manner. From this perspective, when differences in function appear, they are attributed to structural differences in brain organization. Therefore, when differences were found between right- and left-handers in brain asymmetry for language, spatial processing or perception, they were construed as a reflection of a

Accordingly, it might be expected that Study 1, in which right- and left-handers were compared on many cognitive, emotional and functional variables, would show significant main effect differences between the groups as a function of handedness. However, the results showed that both handedness groups were highly similar in all the measurements tested.

I would therefore like to propose that the differences in brain organization implied by the present results do not rule out an additional influence, acting simultaneously, of the periphery on the center, such as might occur as a consequence of differences in habits of scanning and attention allocation between the groups. Moscovitch (1986) developed a framework to explain visual laterality studies. In his model both hemispheres are described as separate information-processing systems, possessing separate components and resources as well as a shared pool of resources. According to this model, hemispheric processing is affected by changes in stimulus, response, or cognitive factors. Inter-hemispheric transmission, which is described as automatic, is also involved in the way in which the hemispheres process information or alter responses.

It is thus possible that, apart from being the result of structural differences in brain asymmetry, handedness is related to brain activity in a more dynamic, bi-directional way. Although the hand is controlled in a top-down manner by the brain, a bottom-up, procedural type of operation is also present. Through manual and other activities, which are performed on a procedural level, the brain reacts and adjusts itself to stimuli and
information gathered in a data-driven manner, as suggested in the Moscovitch model. This idea is also supported by the studies of Schiff and his colleagues (Schiff & Lamon, 1989, 1994; Schiff & Truchon, 1993), who demonstrated that when individuals activate their face or hand muscles on different sides of the body, changes occur in their perception and experiences of emotions. These findings raise the following interesting question: how does the fact that in daily life left-handed individuals activate their left hand more frequently than their right hand influence their brain activity in general?

If we examine handedness from a dynamic point of view, there is another interesting aspect of left-handedness, besides the strength or the degree of handedness resulting from the intensity of hemispheric control. This is related to the fact that through more frequent manual activity of different hands, bottom-up changes might influence brain activity, leading to the development of new attentional habits, scanning habits, and the modifications of other task allocation processes.

Such ideas stemming from the present research and from the research literature on the subject call for further investigation into the nature of these intriguing phenomena.


Gazzaniga, M. S. (1985). The social brain it's case of the left brain not knowing what the right brain is doing, and therein lies our capacity for belief. *Psychology today, November*, 29-38.


Miller, C. A. (1988). Do left or right brain training exercises have a greater effect upon College Calculate achievement? A paper presented at the Annual meeting of the National Council of Teachers of Mathematics (Chicago, IL, April, 1988).


APPENDIX I

BAR-ILAN UNIVERSITY

SCHOOL OF EDUCATION

THE MEM QUESTIONNAIRE - Part I
(Abstract Verbal Thinking Test)
By Iosef Glanz

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by Gabriel & Sari Alony

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Paragraph 1

SYNONYMS

In every line there is a main word followed by 5 words. Only one of them says exactly the same thing as the first word. You have to find which of the 5 words in each line is the most similar to the main word and underline this word.

Example: Luna - Book, Cart, Star, Moon, Shirt
We shall underline the word Moon since it means the same as the word Luna. Proceed in a similar manner on the following lines:

1. Meal  Minister  Crown  Refrigerator  Circle  (*
2. Wall  Gate  Way  *  Balcony  Deck
3. Path  Newspaper  Fold  Jet  *  Drawer
4. Injury  Sun  *  Deviation  Whistle  Turn
5. Tradition  Book  Fame  Oak  Mark  *
6. Darkness  Coat  Yard  Pit  *  Forest
7. Step  Tear  *  Jump  Dive  Painting
8. Concealing  *  Emptying  Whitening  Arranging  Melting
9. Filling  Scanning  Planting  Uprooting  Guarding  *
10. Hero  Merciful  *  Quick  Courageous  Tyrant
11. Poor  Rich  *  Tired  Small  Soft
12. Fresh  Gay  *  Thin  Fragile  Beautiful

(*) The right synonym in the Hebrew language
**ANTONYMS**

At the beginning of each line there is a meaningful word. On the right side of each main word there are other words. You have to choose the word which is most opposite to the first one.

Underline the chosen word.

Example: Day - Hour Morning Sun Time Night
We'll draw a line under the word night, as it is the most opposite among the other words to the word day.

Follow the example:

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>White</td>
<td>-</td>
<td>Hot</td>
<td>Spicy</td>
<td>Green</td>
</tr>
<tr>
<td>2.</td>
<td>Floor</td>
<td>-</td>
<td>Bag</td>
<td>Chest</td>
<td>Ceiling</td>
</tr>
<tr>
<td>3.</td>
<td>Baby</td>
<td>-</td>
<td>Soft</td>
<td>Elder</td>
<td>Nice</td>
</tr>
<tr>
<td>4.</td>
<td>West</td>
<td>-</td>
<td>North</td>
<td>Sea</td>
<td>Desert</td>
</tr>
<tr>
<td>5.</td>
<td>Short</td>
<td>-</td>
<td>Wide</td>
<td>Deep</td>
<td>Tall</td>
</tr>
<tr>
<td>6.</td>
<td>Pure</td>
<td>-</td>
<td>Clean</td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>7.</td>
<td>Private</td>
<td>-</td>
<td>Single</td>
<td>Depressed</td>
<td>Public</td>
</tr>
<tr>
<td>8.</td>
<td>Rare</td>
<td>-</td>
<td>Near</td>
<td>Ubiquitous</td>
<td>Distant</td>
</tr>
<tr>
<td>9.</td>
<td>Liquid</td>
<td>-</td>
<td>Thin</td>
<td>Cold</td>
<td>Hot</td>
</tr>
<tr>
<td>10.</td>
<td>Animal</td>
<td>-</td>
<td>Mineral</td>
<td>Plant</td>
<td>Fish</td>
</tr>
<tr>
<td>11.</td>
<td>Strong</td>
<td>-</td>
<td>Agile</td>
<td>Pink</td>
<td>Enlightened</td>
</tr>
<tr>
<td>12.</td>
<td>Thin</td>
<td>-</td>
<td>Spoiled</td>
<td>Thick</td>
<td>Sharp</td>
</tr>
</tbody>
</table>
At the beginning of each line is a meaningful word. On the right of each main word there are several words. You have to chose among these words one word that indicates something that is always connected to the first word. Underline the chosen word.

Example: Apple - Gold Long Peel Ribbon Glass
We will underline the word Peel since it indicates something which is always present in an Apple.

Follow the example:

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowers</td>
<td>Plants</td>
<td>-Fabric</td>
<td>-Garden</td>
<td>-Story</td>
<td>-Fruit</td>
<td>-Sitting</td>
<td>-Boiling</td>
<td>-Seeing</td>
<td>-Scream</td>
<td>-Mocking</td>
<td>-Tall</td>
</tr>
<tr>
<td>Machines</td>
<td>Pens</td>
<td>Springs</td>
<td>Water</td>
<td>Picture</td>
<td>Sand</td>
<td>Breaking</td>
<td>Cleaning</td>
<td>Hearing</td>
<td>Despair</td>
<td>Boasting</td>
<td>Nearby</td>
</tr>
<tr>
<td>Pavements</td>
<td>Rulers</td>
<td>Wood</td>
<td>Soil</td>
<td>Prayer</td>
<td>Smoke</td>
<td>Turning</td>
<td>Ironing</td>
<td>Explaining</td>
<td>Trouble</td>
<td>Annoying</td>
<td>Dragged</td>
</tr>
<tr>
<td>Shutters</td>
<td>Letters</td>
<td>Plastic</td>
<td>Path</td>
<td>Ornament</td>
<td>Roots</td>
<td>Pacing</td>
<td>Arranging</td>
<td>Pressing</td>
<td>Wall</td>
<td>Waiting</td>
<td>Devoted</td>
</tr>
<tr>
<td>Stairs</td>
<td>Leather</td>
<td>Seat</td>
<td>Shed</td>
<td>Time-table</td>
<td>Mines</td>
<td>Drowning</td>
<td>Hanging</td>
<td>Winking</td>
<td>Escape</td>
<td>Hiding</td>
<td>Common</td>
</tr>
</tbody>
</table>
Paragraph 4
CLASSIFICATION

In every one of the following lines is a word(s) that do(es) not fit the other words. In each line, underline the word(s) that do(es) not fit.

Example: Apple, Grape, Candy, Plum, Peach.
We will underline the word Candy, since all the others are fruits and the Candy is not a fruit.

Do the same thing in the following lines.

1. Book - Copybook Pen Eraser Cart
2. Hotel - Sky Restaurant Hall Flat
3. Piano - Flute Medicine Violin Trumpet
4. Board - Clock Diary Knife Calendar
5. Story - Statue Novel Poem Article
6. Idea - Opinion Song Reflection Thought
7. Chewing - Drinking Baking Tasting Swallowing
8. Dressing socks - Putting on shoes Spilling Putting on a hat Putting on
9. Counting - Running Adding Multiplying Subtracting
10. Pleasant - Liked Nice Hated Handsome
11. Good - Merciful Decent Honest Clever
12. Grandfather - Daughter Mother Uncle Father
THE MEM QUESTIONNAIRE - Part II
(Abstract Verbal Thinking Test)
By Iosef Glanz

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Paragraph 5

CATEGORIZATION

In the following lines are words which belong to the same group. On the right side of the line is a list of words. You have to choose the word that indicates the group to which the words in the line belong. Underline the chosen word.

Example: Rabbit Crow Horse Dog

<table>
<thead>
<tr>
<th>Plants</th>
<th>Tools</th>
<th>Animals</th>
<th>Professions</th>
</tr>
</thead>
</table>

We will underline Animals since all the words in the line — Rabbit, Crow, Horse, Dog indicate animals.

Follow the example:

1. Hammer Screwdriver Knife Saw

<table>
<thead>
<tr>
<th>Food</th>
<th>Zones</th>
<th>Tools</th>
<th>Vegetables</th>
</tr>
</thead>
</table>

2. 1. 8. 10. 37.

<table>
<thead>
<tr>
<th>Directions</th>
<th>Shelters</th>
<th>Waves</th>
<th>Numbers</th>
</tr>
</thead>
</table>

3. France China Brazil Sweden

<table>
<thead>
<tr>
<th>Airplanes</th>
<th>Countries</th>
<th>Sentences</th>
<th>Classes</th>
</tr>
</thead>
</table>

4. King Minister President Officer

<table>
<thead>
<tr>
<th>Authors</th>
<th>Merchants</th>
<th>Judges</th>
<th>Leaders</th>
</tr>
</thead>
</table>

5. Punishment Rebupe Reprimand Reward

<table>
<thead>
<tr>
<th>Education</th>
<th>Thought</th>
<th>Creation</th>
<th>Competition</th>
</tr>
</thead>
</table>

6. Love Joy Fear Hate

<table>
<thead>
<tr>
<th>Trips</th>
<th>Voices</th>
<th>Liquids</th>
<th>Emotions</th>
</tr>
</thead>
</table>

7. Hot Blue Noise Spicy

<table>
<thead>
<tr>
<th>Thoughts</th>
<th>Wishes</th>
<th>Decisions</th>
<th>Senses</th>
</tr>
</thead>
</table>

8. Extravagance Generosity Anger Seclusion

<table>
<thead>
<tr>
<th>Character</th>
<th>Wealth</th>
<th>Heartiness</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. First</td>
<td>Excellent</td>
<td>Last</td>
<td>Average</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>10. Ancient</td>
<td>Yesterday</td>
<td>Before</td>
<td>Now</td>
</tr>
<tr>
<td>11. School</td>
<td>Grades</td>
<td>Teachers</td>
<td>Books</td>
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<tr>
<td>12. Football</td>
<td>Tennis</td>
<td>Basketball</td>
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In the following lines there are various proverbs quoted from the Jewish tradition. Next to each proverb you will find four sentences out of which you have to choose the one closest to the intention and meaning of the proverb. Underline the sentence chosen for each proverb.

Example:

Do not look at the vessel but at its contents.
1. Do not be curious.
2. Do not use bottles.
3. Do not attach importance to the way things or people look but rather to their inner self.
4. Do not seek out the strong people.

We shall underline sentence 3 since it expresses the meaning of the proverb in the best way. Proceed in the same way with the following lines:

1. Do not cast stones in a well you drank from.
   a. Do not drink water from a stone filled well.
   b. Remove stones from a water filled well.
   c. Drink from a water filled well.
   d. Do not be ungrateful and do not repay good actions by ingratitude.

2. If I am not for myself - who will be?
   a. A person needs a friend.
   b. One has to help himself
   c. A person has to help others.
   d. Love thy neighbor as thyself.

3. Fathers ate unripened fruit and their sons' teeth are aching.
   a. Parents may eat unripened fruits, children should not.
   b. If people have sons - they like to eat unripened fruits.
   c. When parents sin, their children bear the consequences.
   d. If children suffer from toothache, their parents feel it.

4. Man is close to himself.
   a. Everyone has a neighbor.
   b. A person loves himself more than others do.
   c. Others love a person more than he loves himself.
   d. Everyone lives in his own home.

5. Love thy neighbor as thyself.
   a. Love your friend as much as he loves you.
b. Seldom love your friend.
c. Love your friend as much as you love yourself.
d. Do not love your friend.

6. **If you do not plow on sunny days, what will you eat on rainy days?**

a. On sunny days one plows, on rainy days one eats.
b. One has to separate between the sun and the rain.
c. On rainy days the sun is not seen.
d. If one does not prepare in advance for his needs, it will be very hard for him to cover those needs in the future.

7. **Let a stranger praise you, and not yourself.**

a. Others will praise you and you will praise them.
b. Others should praise you, and if they do not - do it yourself.
c. Let others praise you and do not do it yourself.
d. If others praise you, do it as well.

8. **Both the righteous and his neighbor will be rewarded.**

a. The Righteous does good for the Wicked.
b. It is good for us to have neighbors.
c. All neighbors are good.
d. The Righteous and those close to him will be rewarded.

9. **Fine talker and fine doer.**

a. Some people are very demanding.
b. There are people who talk too much.
c. There are beautiful people.
d. There are people who deliver what they promised.

10. **A soft tone will stop anger.**

a. If one replies softly and weakly, it only increases the anger.
b. A soft and quiet reply soothes one's anger.
c. Torturing a weak person satisfies the strong.
d. Softness and weakness always provide success in life.
11. **He who has been bitten by a snake fears a rope.**

   a. Whoever has been harmed by something will fear whatever resembles it.
   b. Whoever has been bitten by a snake uses a rope for protection.
   c. A snake looks like a rope.
   d. Whoever has been bitten by a snake will always know fear.

12. **Your actions will get you closer, and your actions will get you farther.**

   a. Whoever is close is not far.
   b. People love or hate you according to your deeds.
   c. One's deeds do not matter.
   d. A person feels who is close and who is far.
ANALOGIES
(Completion according to example)

In the following lines one is required to complete a pair of words according to the example given for the previous pair. You are first presented with a pair of words and, according to the relationship between these words, you are required to create a new pair, where the first word is given and the second one has to be chosen among five suggested.

Example A:
The hat is to the head what shoes are to:
arm, eyes, feet, ears, forehead.
We shall trace a line under the word feet, since shoes are for the feet as a hat is for the head.

Example B:
The pen is to the copybook what the chalk is to:
desk, book, ink, blackboard, chair.
We shall underline the word blackboard, since chalk is to a blackboard what a pen is for a copybook.

Follow these examples for the following lines:

1. The letter is to a book what sound is to:
   doll, radio, cart, binoculars, magician.

2. Black is to white what bad is to:
   big, strong, gentle, pleasant, good.

3. Sleeps is to fatigue what eating is to:
   boredom, laziness, anger, hunger, fear.

4. Joy is to success what sorrow is to:
   failure, victory, repair, competition, trade.
5. Swimming is to water what flying is to:
   rocket, air, aircraft, bird, balloon.

6. Evening is to the night what dawn is to:
   hour, week, morning, afternoon, midnight.

7. Speed is to a runner what precision is to:
   salesman, marksman, gardener, rebel, cowboy.

8. Rails are to a train what a road is to:
   car, boat, airplane, pedestrian, tractor.

9. A is to C what Q is to:
   D, S, W, N, L.

10. Effort is to achievement what sowing is to:
    planting, rooting, uprooting, stoning, reaping.

11. Election is to president what succession is to:
    commander, teacher, driver, king, minister.

12. Now is to later what Thursday is to:
    Monday, Yesterday, Sunday, Wednesday, Friday.
Paragraph 8

DEFINITION

(Word explanation)

In the following lines you will be required to define the word at the beginning of the line by two words that you will choose out of seven suggested. One word has to describe the group to which the word to be defined belongs, and the second word should describe its specific characteristic.

Example A:

Chair - material, furniture, trip, writing, fabric, seating, pole.

We should trace a line under the words: furniture and seating, since a chair is a piece of furniture designed for seating.

Example B:

Wine - food, olives, grapes, drink, pomegranates, apples, shops.

We underlined the words: grapes and drink, since wine is a drink made out of grapes.

Follows the examples:

1. Train - car, wagons, ropes, trade, trip, swimming.
2. House - ball, clouds, building, game, habitation, garden.
3. Pen - talk, cut, writing, electricity, light, tool.
4. Laughter - anger, expression, crying, happiness, hit, flower.
5. Teacher - sends, book, teaches, stick, runs, person.
6. Sabbath - mountain, rest, reading, first, office, room, day.
SYLLOGISM

In each of the following lines you will find two sentences. After the two sentences you will find in each case three other sentences, out of which you have to choose the one most suitable as a conclusion of the two sentences. Underline the sentence that you find most suitable.

Example:

a. All flowers are plants.
b. All anemones are flowers.
c. Choose among:

1. All flowers are anemones.
2. All anemones are plants.
3. Anemones are not plants.

The underlined sentence is: all anemones are plants, since it is the most appropriate conclusion to sentences a. and b.

Follow the example:

1. a. All the athletes train.
b. Footballers are athletes.
c. Choose among:

1. Footballers are people.
2. All trainees are footballers.
3. Footballers train.

2. a. All charitable people do good unto others.
b. Righteous people are charitable.
c. Choose among:

1. Righteous people do good unto others.
2. Charitable people are quick minded.
3. Righteous people do not do good unto others.

3. a. People are not angels.
b. Soldiers are people.
c. Choose among:

1. All people are soldiers
2. Soldiers are not angels.
3. Soldiers are strong.

4. a. All teachers teach.
b. Some people are teachers.
c. Choose among:

1. Some people teach.
2. All people teach.
3. All teachers are good.

5. a. He who restrains himself is a hero.
b. He who forgives restrains himself.
c. Choose among:
   1. He who forgives is righteous.
   2. He who forgives is a hero.
   3. A hero does not forgive.

6. a. Wise people perceive the future.
b. Impulsive people are not wise.
c. Choose among:
   1. Impulsive people perceive the future.
   2. Impulsive people are quick-witted.
   3. Impulsive people do not perceive the future.
THE SELF CONCEPT QUESTIONNAIRE
By Iosef Glanz

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by Gabriel & Sari Alony

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Instructions:

Fill in the following details:

Last name: First name:
School: Class:

Now please read the explanation and the following instructions:

In the following pages of this questionnaire you will find descriptions of various children. Every line describes the characteristic of one child. You have to point out whether you resemble this child in that characteristic, or you have more or less of it. In every case, after the description of this child's characteristic you will see: "I am like him", "I am not as ... as him", "I am very ...". If you think you are like that child - trace a line under "I am like him", if you think you are less than him in this particular characteristic - underline "I am not as .... as him", and if you think you have a lot of that characteristic, underline "I am very...".

Here are two examples of what you are required to do:

1. He is tall:
   1. I am like him. 2. I am not as tall. 3. I am very tall.

In this case, if you think you are as tall as him, you underline "I am like him"; if you think you are not so tall, you underline "I am not as tall", and if you think you are very tall, you underline "I am very tall ". Underline the description you think fits you.

2. He likes candies:
   1. I am like him. 2. I do not like candies very much.
3. I like candies very much.

In this case, if you think you like candies as much as him, underline "I am like him"; if you think you do not like candies very much, underline " I do not like candies very much", and if you think you like candies very much, underline " I like candies very much ". Underline the description you think fits you.

It is very important that you should mark exactly what you think about yourself. Now please follow these instructions:

a. Work quietly, without talking to your friends.

b. If something is not clear to you, please raise your hand, and someone will explain it to you.

c. Turn the page and start working only when told.

d. Answer the questions by order. Proceed to a new question only after answering the previous one.

e. Answer all the questions. If you do not feel very sure about an answer, mark the one closest to your thought.
In the following lines you will find descriptions of children. In every description think about yourself and underline the one that fits you: "I am like him", or: "I am not as ... as him", or: "I am very ...".

1. He is healthy:
   1. I am like him. 2. I am not so healthy. 3. I am very healthy.

2. He is strong:
   1. I am like him. 2. I am not so strong. 3. I am very strong.

3. He is good looking:
   1. I am like him. 2. I am not so good looking. 3. I am very good looking.

4. He is clean:
   1. I am like him. 2. I am not so clean. 3. I am very clean.

5. He is organized:
   1. I am like him. 2. I am not so organized. 3. I am very organized.

6. He is clever:
   1. I am like him. 2. I am not so clever. 3. I am very clever.

7. He knows a lot:
   1. I am like him. 2. I do not know as much. 3. I know a great many things.

8. He speaks nicely:
   1. I am like him. 2. I do not talk very nicely. 3. I talk very nicely.

9. He writes nicely:
   1. I am like him. 2. I do not write very nicely. 3. I write very nicely.

10. He plays well:
    1. I am like him. 2. I do not play very well. 3. I play very well.

11. He is trustworthy (usually says the truth):
    1. I am like him. 2. I am not very trustworthy (do not usually say the truth). 3. I am very trustworthy (always say the truth).

12. He is kind-hearted and helps his friends:
    1. I am like him. 2. I am not very kind-hearted and do not help my friends much. 3. I am very kind-hearted and I help my friends very much.

13. He lives in peace with his friends:
    1. I am like him. 2. I do not live very much in peace with my friends. 3. I live very much in peace with my friends.

14. He will be important (people will praise and respect him):
    1. I am like him. 2. I will not be very important. 3. I will be very important (all the people will praise and respect me very much).

15. He behaves nicely in class during the lessons:
    1. I am like him. 2. I do not behave very nicely in class during lessons. 3. I behave very nicely in class during lessons.
16. He participates actively in the lessons in class:
   1. I am like him. 2. I do not participate actively in the lessons in class.
   3. I participate very actively in the lessons in class.

17. He does his homework nicely:
   1. I am like him. 2. I do not do my homework nicely. 3. I do my homework very
      nicely.

18. He is a good pupil:
   1. I am like him. 2. I am not a very good pupil. 3. I am a very good pupil.

19. He is liked by his friends in class:
   1. I am like him (I am also liked by my friends in class). 2. I am not liked very
      much by my friends in class. 3. I am very much liked by my friends in class.

20. His friends like to play with him:
   1. I am like him (my friends also like to play with me). 2. My friends do not
      like very much to play with me. 3. My friends like very much to play with me.

21. His friends like to come to his house:
   1. I am like him (my friends also like to come to my house). 2. My friends do
      not like very much to come to my house very much. 3. My friends like very
      much to come to my house.

22. His friends like him to come to their houses:
   1. I am like him (my friends also like me to come to their houses). 2. My friends
      do not like me to come to their houses very much. 3. My friends like me very
      much to come to their houses.

23. The teachers think he is a good pupil:
   1. I am like him (my teachers also think I am a good pupil). 2. My teachers do
      not think I am a good pupil. 3. My teachers think I am a very good pupil.

24. The teachers think he will be important:
   1. I am like him (my teachers also think I will be important). 2. My teachers do
      not think I will be important. 3. My teachers think I will be very important.

25. The teachers love him:
   1. I am like him (my teachers love me). 2. My teachers do not love me very much.
      3. My teachers love me very much.

26. His father thinks he is a good pupil:
   1. I am like him (my father also thinks I am a good pupil). 2. My father does not
      think I am a good pupil. 3. My father thinks I am a very good pupil.

27. His father thinks he will be important:
   1. I am like him (my father also thinks I will be important). 2. My father does
      not think I will be important. 3. My father thinks I will be very important.

28. His father loves him:
   1. I am like him (my father loves me). 2. My father does not love me very much.
      3. My father loves me very much.
29. His mother thinks he is a good pupil:
   1. I am like him (my mother also thinks I am a good pupil).
   2. My mother does not think I am a good pupil. 3. My mother thinks I am a very good pupil.

30. His mother thinks he will be important:
   1. I am like him (my mother also thinks I will be important).
   2. My mother does not think I will be important. 3. My mother thinks I will be very important.

31. His mother loves him:
   1. I am like him (my mother loves me). 2. My mother does not love me very much. 3. My mother loves me very much.

32. He loves his class:
   1. I am like him (I also love my class). 2. I do not love my class very much. 3. I love my class very much.

33. He thinks he is being taught the right things in his class:
   1. I am like him (I think I am being taught the right things in my class). 2. I do not think I am being taught the right things in my class. 3. I think I am being taught the right things in my class.

34. He thinks his class suits him:
   1. I am like him (I think my class suits me). 2. I do not think my class suits me. 3. I think my class suits me very well.

35. He wants to study in the future (Primary and High School) in a similar school:
   1. I am like him (I want to study in the future in a similar school). 2. I do not want to study in the future in a school similar to mine. 3. I would like very much to study in the future in a school similar to mine.

36. He loves his house:
   1. I am like him (I love my house). 2. I do not love my house very much. 3. I love my house very much.

37. He thinks that people behave at home the way he is taught at school:
   1. I am like him (I think in my home people behave the way I am taught at school). 2. I do not think in my home people behave the way I am taught at school. 3. I think in my home people behave very much the way I am taught at school.

38. He wants people to behave in the future at home, in much the same way as today:
   1. I am like him (I want people to behave in the future at home in much the same way as today). 2. I do not want people to behave in the future at home the same way as today. 3. I would like people to behave in the future at home in much the same way as today.
Instructions:

Fill in the following details:

Last Name:  
First Name:  
School:  
Class:  

Read carefully the following instructions and explanations:

In the following pages of this questionnaire you are required
to describe how you feel and behave in various situations. Choose
one sentence out of four which you think best describes you. To
better understand what you are required to do see the following
example:

Underline you choice.

1. I like to laugh very much.
2. I like to laugh.
3. I do not like to laugh.
4. I do not laugh, but cry a lot.

1. When I want something very much and it is difficult to get:
1. I despair and give up quickly.
2. I give up after a certain time.
3. I do not care and continue to try and get it.
4. I am glad there are difficulties which have to be overcome.

2. There will be a test tomorrow:
1. And I am so tense that I cannot even play quietly.
2. And I am a little tense.
3. And I do not care.
4. And I am glad.

3. I feel:
1. That I am always in a bad mood.
2. That I am frequently in a bad mood.
3. That I am usually in a good mood.
4. That I am always in a good mood.

4. When others look at me:
1. It is very difficult for me to do something (like drawing or
   handicraft) and I stop.
2. It is difficult for me to do something, but I do not stop.
3. I do not mind doing something.
4. I am glad to do something.

5. When friends tell me I have done something wrong:
1. I get very angry and do not play with them anymore.
2. I get angry but still play with them.
3. I do not care.
4. I am happy because I know they do it for my own good.
6.  
1. I frequently get so excited that I feel my hands or feet are shaking. 
2. I sometimes get excited and feel my feet or hands shaking a little. 
3. I do not get easily excited and I do not feel my hands or feet shaking. 
4. I never get excited and I always control my feet and hands. 

7. When I do my homework: 
   1. I cannot concentrate and my mind wanders. 
   2. I think a lot about other subjects and can hardly finish my homework. 
   3. I do not think about anything else. 
   4. I think only about my homework and nothing interferes with it. 

8. When I do not succeed at something: 
   1. I always think it is my fault and I feel a lot of shame. 
   2. I think many times that it is my fault and I feel shame. 
   3. I do not think it is my fault. 
   4. I do not think it is my fault and I checkout what happened. 

9. 
   1. I feel very sorry for my life and would like to change it. 
   2. I feel sometimes sorry for my life and would like to change a few things in it. 
   3. I do not think about my life. 
   4. I am happy about my life and would like it to always remain like today. 

10. When I am about to compete in a game with my friends: 
   1. I always think I will not succeed. 
   2. I think many times that I will not succeed. 
   3. I do not think about whether I will succeed or not. 
   4. I almost always think I will succeed. 

11. When the teacher asks me to answer a question: 
   1. I panic, get confused and do not answer. 
   2. I do panic a little, get confused but I do answer. 
   3. I do not mind answering. 
   4. I am glad and answer with confidence.
12. When I do not succeed at something:
   1. I sweat profusely.
   2. I sweat a little.
   3. I do not sweat.
   4. I do not get excited and I am confident I will succeed some other time.

13. When I have to choose between two options, like two games, or two friends, or a game and a movie or a game and a lesson:
   1. I find it extremely difficult to decide and many times I do not decide and I leave everything.
   2. I find it difficult to decide and I make up my mind after a long time.
   3. I do not find difficult to decide.
   4. I decide quickly after thinking about which is the more desirable.

14. When I have to get home after dark and there is nobody outside:
   1. I am very frightened and run home quickly.
   2. I am a little frightened.
   3. I do not mind.
   4. I am glad.

15. I worry a lot about many things and sometimes cannot sleep because of my worries.
   1. I worry about many things.
   2. I hardly have any worries.
   3. I do not worry at all and sleep very well.

16. When friends play:
   1. I am afraid to play with them and I stand aside.
   2. I am shy and sometimes do not join them.
   3. I do not mind playing with them.
   4. I am always happy to play with them.

17. When a guest comes home, like a teacher or school inspector:
   1. I am very frightened and even do not answer the guest's questions.
   2. I am frightened but I do answer the guest's questions.
   3. I do not mind at all.
   4. I am glad and always participate in the conversation.

18. I frequently feel pains in my body and have an upset stomach.
   1. I sometimes feel pains in my body and have an upset stomach.
   2. I seldom feel pains in my body and seldom have an upset stomach.
   4. I am happy I have a strong body and do not have pains.
19.  
1. I usually do not finish things that I begin.  
2. I frequently do not finish things that I begin.  
3. I usually finish things that I begin.  
4. I finish things that I begin even when they are difficult.

20. When I am in a tall building and have to look down from the roof:  
   1. I am frightened and do not look down.  
   2. I am a little frightened but do look down.  
   3. I do not mind looking down.  
   4. I am happy to look down.

21.  
1. I daydream frequently (imagine a lot of things) and do not notice what is happening around me.  
2. I sometimes daydream.  
3. I do not daydream.  
4. I always know what happens around me and I do not daydream.

22. When I see my friends succeed in school:  
   1. I am very sad.  
   2. I am a little sad.  
   3. I do not mind.  
   4. I am happy.

23. When people promise me good things:  
   1. I strongly disbelieve them.  
   2. I do not really believe them.  
   3. I do not know whether to believe them or not.  
   4. I believe them.

24.  
1. I always feel tired.  
2. I frequently feel tired.  
3. I do not tire easily.  
4. I am tired only after hard work and at night before I go to sleep.

25. When I get home and there is nobody there:  
   1. I am afraid to enter and wait outside until somebody comes.  
   2. I am a little afraid but enter by myself.  
   3. I do not mind entering.  
   4. I am happy to enter.
26. When I go to school:
   1. I am always afraid I did not put everything I need in my schoolbag and I return to check it.
   2. I sometimes worry that I did not take everything I need.
   3. I do not think about my schoolbag.
   4. I am always certain I have taken everything necessary.

27.
   1. I blush a lot among people.
   2. I sometimes blush among people.
   3. I do not blush among people.
   4. I am always confident among people.

28. When I am wronged (somebody causes me unjustified harm):
   1. I cry a lot and do not speak with my friends for the whole day.
   2. I cry a little.
   3. I do not mind.
   4. I try quietly to convince these people that I have been wronged.

29. When I prepare a recitation and have to deliver it in front of people:
   1. I am afraid and do not deliver it.
   2. I am shy and can hardly deliver it.
   3. I do not mind delivering it.
   4. I am happy to deliver it.

30.
   1. I have a lot of nightmares.
   2. I sometimes have nightmares.
   3. I do not have nightmares.
   4. I have pleasant dreams.

31. After I made a mistake which has been noticed by others:
   1. I remember it for a long time and feel sorry.
   2. I remember it for a few days and feel sorry.
   3. I quickly forget it.
   4. I laugh at it and know that I will do better the next time.

32. When friends want to get close to me:
   1. I know they need something from me.
   2. I know they probably also need something from me.
   3. I do not think about what they want.
   4. I know they want a closer friendship.
33. When something new has to be done:
   1. I am frightened.
   2. I am somewhat frightened.
   3. I do not mind.
   4. I am happy.

34. I frequently feel sorry for myself and do not feel like doing anything.
   2. I sometimes feel sorry for myself.
   3. I do not feel sorry for myself.
   4. I always feel well and want to do a lot.

35. When I am among friends:
   1. I always think about how to succeed and not make a mistake.
   2. I think a lot about how to succeed.
   3. I do not think about how to succeed.
   4. I think that even if I might make a mistake, it is not important.

36. When people say I am a bad child:
   1. I feel very bad about it.
   2. I feel sorry about it.
   3. I do not mind.
   4. I laugh at it since I know they do not mean it.

37. When I walk in the street and see a big dog in front of me:
   1. I am frightened and I return home.
   2. I am somewhat frightened and walk on.
   3. I do not mind.
   4. I am happy and pet the dog.

38. When somebody talks to me:
   1. I feel many times that I do not notice and do not understand what is being said.
   2. I feel sometimes that I do not notice what is being said.
   3. I do notice what is being said.
   4. I pay attention and understand everything.

39. When I see a bug at home:
   1. I am very frightened and I run away.
   2. I am somewhat frightened and I try to drive it away.
   3. I do not mind.
   4. I am glad and try to watch it from close up.

40. I would like to live in some other town.
   2. I would like to live on some other street.
   3. I do not want to live anywhere else.
   4. I would always like to live where I live now.
41. When I am late to school:
   1. I am afraid and do not enter the class.
   2. I am ashamed but I enter the class.
   3. I do not mind.
   4. I apologize and sit down nicely and happily.

42. When I need to do homework:
   1. I am afraid to do it alone, and always ask for help.
   2. I am somewhat afraid to do it alone, and sometimes ask for help.
   3. I do not mind doing it on my own.
   4. I am happy to do it alone.

43. 
   1. I always feel I cannot sit still.
   2. I frequently feel I cannot sit still.
   3. I usually feel good when sitting still.
   4. I always feel good sitting still.
Appendix IV
Intellectual Achievement Responsibility Questionnaire

Circle your answer

(1) If a teacher passes you to the next grade, would it probably be
   a. because she liked you, or
   b. because of the work you did?

(2) When you do well on a test at school, is it more likely to be
   a. because you studied for it, or
   b. because the test was especially easy?

(3) When you have trouble understanding something in school, is it usually
   a. because the teacher didn't explain it clearly, or
   b. because you didn't listen carefully?

(4) When you read a story and can't remember much of it, is it usually
   a. because the story wasn't well written, or
   b. because you weren't interested in the story?

(5) Suppose your parents say you are doing well in school. Is it likely to happen
   a. because your school work is good, or
   b. because they are in a good mood?

(6) Suppose you did better than usual in a subject at school. Would it probably happen
   a. because you tried harder, or
   b. because someone helped you?

(7) When you lose at a game of cards or checkers, does it usually happen
   a. because the other player is good at the game, or
   b. because you didn't play well?

(8) Suppose a person doesn't think you are very bright or clever,
   a. can you make him change his mind if you try, or
   b. are there some people who will think you're not very bright, no matter what you do?

(9) If you solve a puzzle quickly, it is
   a. because it wasn't a very hard puzzle, or
   b. because you worked on it carefully?

(10) If a boy or girl tells you that you are dumb, is it more likely that they say that
     a. because they are mad at you, or
     b. because what you did wasn't really very bright?

(11) Suppose you study to become a teacher, scientist, or doctor and you fail. Do you think this would happen
     a. because you didn't work hard enough, or
     b. because you need some help, and other people did not give it to you?
(12) When you learn something quickly in school, is it usually  
a. because you paid close attention, or  
b. because the teacher explained it clearly?  

(13) If a teacher says to you, "your work is fine" is it  
a. something teachers usually say to encourage pupils, or  
b. because you did a good job?  

(14) When you find it hard to work arithmetic or math problems at school, is it  
a. because you didn't study well enough before you tried them, or  
b. because your teacher gave problems that were too hard?  

(15) When you forget something you heard in class, is it  
a. because the teacher didn't explain it very well, or  
b. because you didn't try very hard to remember?  

(16) Suppose you weren't sure about the answer to a question your teacher asked you, but your answer turned out to be right. Is it likely to happen  
a. because she wasn't as particular as usual, or  
b. because you gave the best answer you could think of?  

(17) When you read a story and remember most of it, is it usually  
a. because you were interested in the story, or  
b. because the story was well written?  

(18) If your parents tell you you're acting silly and not thinking clearly, is it more likely to be  
a. because of something you did, or  
b. because they happen to feel cranky?  

(19) When you don't do well on a test at school, is it  
a. because the test was specially hard, or  
b. because you didn't study for it?  

(20) When you win at a game of cards or checkers, does it happen  
a. because you play real well, or  
b. because the other person doesn't play well?  

(21) If people think you're bright or clever, is it  
a. because they happen to like you, or  
b. because you usually act that way?  

(22) If a teacher didn't pass you to the next grade, would it probably be  
a. because she "had it for you", or  
b. because your school work wasn't good enough?  

(23) Suppose you don't do as well as usual in a subject at school. Would this probably happen  
a. because you weren't as careful as usual, or  
b. because somebody bothered you and kept you from working?
(24) If a boy or girl tells you that you are bright, is it usually
   a. because you thought up a good idea, or
   b. because they like you?

(25) Suppose you became a famous teacher, scientist, or doctor. Do you think this
   would happen
   a. because other people helped you when you needed it, or
   b. because you worked very hard?

(26) Suppose your parents say you aren't doing well in your school work. Is this likely
   to happen more
   a. because your work isn't very good, or
   b. because they are feeling cranky?

(27) Suppose you are showing a friend how to play a game he has trouble with. Would
   that happen
   a. because he wasn't able to understand how to play, or
   b. because you couldn't explain it well?

(28) When you find it easy to work arithmetic or math problems, is it
   a. because the teacher gave you especially easy problems, or
   b. because you studied your book well before you tried them?

(29) When you remember something you heard in class, is it usually
   a. because you tried hard to remember, or
   b. because the teacher explained it well?

(30) If you can't work a puzzle, is it more likely to happen,
   a. because you are not especially good at working puzzles, or
   b. because the instructions weren't written clearly enough?

(31) If your parents tell you that you are bright or clever, is it more likely
   a. because they are feeling good, or
   b. because of something you did?

(32) Suppose you are explaining how to play a game to a friend and he learns quickly,
   would that happen more often
   a. because you explained it well, or
   b. because he was able to understand it?

(33) Suppose you're not sure about the answer to a question your teacher asks you
   and the answer you give turns out to be wrong. Is it likely to happen
   a. because she was more particular than usual, or
   b. because you answered too quickly?

(34) If a teacher says to you, "try to do better", would it be
   a. because this is something she might say to get pupils to try harder, or
   b. because your work wasn't as good as usual?
## Appendix V

### List of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Sense</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognition</strong></td>
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<td></td>
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<tr>
<td>MEM Questionnaire</td>
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<td>Synonym</td>
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<td>Classification</td>
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</table>

The higher score indicates lower anxiety.

The lower score indicated lower self concept.
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<td>0 - 34</td>
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<td>0 - 17</td>
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*the higher score indicates better*
Appendix VI

Means and standard deviations of the cognitive and affective measures among Left-handed, Matched Right-handed and the Whole sample of Right-handed.

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<tr>
<th>&quot;Mem Questionnaire&quot;</th>
<th>Left-handed (n=101)</th>
<th>Matched Right-handed (n=99)</th>
<th>Whole Sample RH (n=974)</th>
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<td>Total</td>
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APPENDIX VII

Pearson correlations between the cognitive measures and children's choices on the Self Concept scale.

<table>
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<tr>
<th>Cognitive Measures</th>
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<td>.38***</td>
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<td>.22</td>
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<td>.39***</td>
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<td>.30**</td>
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<td>Categorization</td>
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<td>Proverbs</td>
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<td>Syllogism</td>
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<td>.36**</td>
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</table>

* p<0.05  
** p<0.005  
*** p<0.001
Appendix VIII

Chimeric Faces
A QUESTIONNAIRE ON HANDEDNESS

A. Please draw a horizontal line.

B. Please read each question below, decide which hand you use for each activity and then put a check mark next to the answer that describes you:

With which hand do you normally:

1. Write.
2. Draw.
3. Throw a ball to hit a target.
4. Use your racquet for tennis, squash, etc.
5. Hold a hammer when driving a nail.
6. Hold a match to strike it
7. Hold a thread when threading a needle
8. Use your toothbrush
9. Use your comb
10. Use eraser on paper

--- left --- right --- either

C. In the following tasks do you use both hands in a coordinated way, or only your preferred hand?

<table>
<thead>
<tr>
<th>The activity</th>
<th>both hands</th>
<th>dominant hand</th>
</tr>
</thead>
</table>

1. Eating
2. Sports (e.g. baseball, hockey, golf etc.)
3. Playing a musical instrument
4. Driving a car or a motorcycle
5. Typing
6. Riding a bicycle

D. Are there any other activities that you perform with both hands

------------------------------------------------------------------
------------------------------------------------------------------
------------------------------------------------------------------
E. Are there left-handers in your family?
Please put a check mark in the right column.

<table>
<thead>
<tr>
<th>Relatives</th>
<th>yes</th>
<th>no</th>
<th>don't know</th>
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</thead>
<tbody>
<tr>
<td>1. Father</td>
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<td></td>
</tr>
<tr>
<td>2. Mother</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Siblings</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. Children</td>
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<td></td>
</tr>
</tbody>
</table>

F. How often do you use your non-dominant hand while performing the following tasks?

1. Cutting with scissors (e.g. finger nails, hair)
2. Cutting with a knife
3. Writing
4. Opening a can

Categorization scheme:

6. Every day, very often.
5. Once a week.
4. Once every two weeks.
3. Once a month.
2. Have you ever?
1. Never.

G. Are there any other fine or complex tasks that you perform with your non-dominant hand?

H. Do you have any memories related to the use of your preferred hand?

I. The handwriting is inverted ----- non-inverted-----.
Appendix X
List of variables on the chimeric faces study

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Low</th>
<th>High</th>
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<td></td>
<td></td>
</tr>
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<td>0</td>
<td>12</td>
</tr>
<tr>
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<td>6</td>
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<tr>
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<td>Using left hand</td>
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<tr>
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<tr>
<td>Bi-manual activity</td>
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<td>up</td>
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Appendix XI

Means and Standard deviations of judgement of chimeric faces, manual activity and familial left-handedness among right-handed, left-handed and switched-handed subjects

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<th>Left-handed (n=21)</th>
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<td>M</td>
</tr>
<tr>
<td>Judgement of chimeric faces</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Side by side</td>
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<tr>
<td>Using non-dominant hand</td>
<td>4.33</td>
<td>5.03</td>
<td>14.28</td>
</tr>
</tbody>
</table>