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SELF REFERENCE EFFECTS AND HANDWRITING

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*Un ringraziamento speciale alla mia famiglia per avermi sempre incoraggiata ed essermi sempre stata vicino.*

*“To find yourself, think for yourself.”*

*Socrates*

# Abstract

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Chapter one introduces the notion of self reference and the role of handwriting in self referential processing. The self-reference effect reveals the capacity of people to encode information related to the self, independently by which level the self is implicated in the information (Rogers, 1977). The following chapters report experimental evidence that handwriting is a specific domain for the study of the self. Several experiments are described, based on discrimination and identification tasks.

Chapter two reports the first experiment, a pilot study that evaluates a possible specificity of self-related processing in discrimination tasks involving handwriting. In this experiment I used an implicit task, under the hypothesis that the discrimination between two handwritings is simpler when one of them is the own handwriting, rather than when both are others' handwritings. My results support this hypothesis and are in line with those by Chen et al. (2008), who found that the perception of own handwriting is special and related to the self, which implies that implicit self-related processing could be elicited by handwriting stimuli.

Chapter three reports the second experiment, on children of 3<sup>rd</sup> and 5<sup>th</sup> grade (about 8 and 10 year old, respectively). The aim of this study was to investigate the self reference effect and how the sense of ownership develops in children. Furthermore, I considered the relation of friendship to control for the familiarity of handwriting. Participants were pairs of best friends. I hypothesized that in children the discrimination between own, best friend and other handwritings was different between the two groups of children. I found that 3<sup>rd</sup> grade children manifest only a familiarity effect because they were able to discriminate between self/friend and other but not

between self and friend. This ability grows up in 5<sup>th</sup> grade children where I found a familiarity effect and self reference effect. This was in line with friendship (Rawlins, 1992) and handwriting (Ehri and McCormick, 2004) development.

Chapter four reports the third experiment, conducted in collaboration with Professor Erik Chang of the Institute of Cognitive Neuroscience of the National Central University, Taiwan. It was focused on the recognition and identification of handwriting dynamic traces. In this study I tried to explain if the action related knowledge contributes to recognize one's own past action (Knoblich and Flach, 2003). Participants responded to their own and other kinematic traces in a lexical decision task and an identification task included in a fMRI session. The lexical decision task revealed a significant effect of authorship and higher sensitivity for forward than backward traces. The fMRI experiment indicated that viewing traces elicited bilateral medial frontal, parietal, insula, ventral parietal activations and right superior frontal gyrus and temporal gyrus. These activations were in line with the literature. temporal gyrus and parietal lobule were implicated in central processes for writing Chinese characters (Lin et al., 2007). Activations in the left parietal lobule, the right superior temporal gyrus and left middle frontal gyrus were implicated in Chinese orthographic, phonological, and semantic processing. I found also activation in the visuospatial processing areas (SOG/SPL), visual pattern memory (MTG), and motor areas (MFG/SMG). These areas need to work synchronously for a relative long period, especially for unfamiliar character's traces. My results are in line with biological motion perception, that involves activation in temporo-parietal-occipital junction (Peelen et al., 2006, Peuskens et al., 2005).

In chapter five I described the fourth experiment, aimed at studying the effects of participant's gender and grammatical gender of the word whose handwriting should be classified on the classification of writer's gender. The

only specific hypothesis was referred to the own sex bias, according to which participants' responses in a yes/no task are biased towards the same-sex response. In other respects the study was exploratory, in the sense that no specific hypotheses were formulated in advance. Results showed two effects: the participant's responses were biased by both the gender of word and the gender of handwriting, in agreement with Cellerino et al. (2004).

Chapter six includes the general discussion of results obtained in the four experiments. Results confirmed that it is possible investigate self process with handwriting because it allows to explore different aspects of self. Handwriting points out self reference effects: self superiority in discrimination and identification, including also information about familiarity and authorship.

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# Chapter 1

## Theory about Self Reference in Handwriting

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### 1.1. Is self special?

The concept of self is debated in different disciplines sociology, psychology, philosophy, anthropology and cognitive science. Different methods are used to investigate the representations of the self, to evaluate if it can be considered special, and to distinguish between possible cognitive systems. The idea of a special self comes from both the different array of methods used to study it and the diversity of domains in which self-specific processing has been observed (memory, agency, face recognition, language, handwriting). (Gillihan & Farah, 2005).

The self-reference effect is a capacity for people to encode information as related in some way to the self , independently which level the self is implicated in the information (Rogers 1977).

The concept of self is investigated by cognitive neuroscience. These studies were developed in hopes of determining if there are certain brain regions that can account for the encoding advantages involved in the self-reference effect. Legrand and Ruby (2009) reassumed the investigation of “self” with neuroimaging technique. This authors concluded that the “self representation” involved in a large cerebral network and there is a problem

regarding the methods of investigations related to a single process “self-specificity characterizes the subjective perspective, which is not intrinsically self-evaluative but rather relates any represented object to the representing subject.”.

My thesis is focused on handwriting as a specific domain for the study of the self. Several experiments are described, based on discrimination and identification tasks.

## **1.2 Self: minimal self and narrative self**

Several approaches to the self combine ideas between the philosophy of the mind and the cognitive sciences. These approaches can be divided into two characteristic of self – the ‘minimal’ self and the ‘narrative’ self. The *Minimal Self* refers to how one experiences it; i.e., to the a consciousness of oneself as an immediate subject of experience, with a non extension in time. The minimal self almost depends on brain processes and embedded body, but a person does not have to know or be aware of this to have an experience that still counts as a self-experience (Gallagher, 2000). The minimal self involves the senses of ownership and agency in the context of both motor action and cognition (paragraph .4).

The narrative self is extended in time to include memories of the past and intentions toward the future in the various stories that we and others tell about ourselves. Neuropsychological descriptions of episodic memory and its loss can help to circumscribe the neural substrates of the narrative self (Gallagher, 2000).

The minimal sense of self is also explained by the *immunity principle*. This is when a speaker uses the first-person pronoun (‘I’) to refer to him or herself, she cannot make a mistake about the person to whom she is referring. By contrast, when we use the first-person pronoun ‘as object’ it is possible to

misidentify ourselves. For example, in some experimental situations a subject's arm may be deafferented (the subject is deprived of normal proprioceptive feedback about the position of their limb and therefore cannot keep track of it without vision). Their visual perception of arm movements is then manipulated through mirrors or videotape. In such cases, the subject might be led to say, 'I am moving my arm to the left', when in fact the basis for his judgment is a videotape of someone else moving their own arm to the left. In that case, the subject makes a mistake about who is moving their arm to the left. Another scientific explanation is showed by Feinberg and Frith (1978) in schizophrenic experiences. A schizophrenic patient who suffers thought insertion, for example, might claim that she is not the one who is thinking a particular thought, when in fact she is the one who is thinking the thought.

The notion of a *narrative self-constitution* finds confirmation in psychology and neuroscience considering episodic memory (paragraph. 1.4.2). For Neisser's the conceptual self is not only in memory but also the considerations of the role that language and narrative play in developing our own self-concept. Gazzaniga (1995) based on his studies of split-brain patients, has suggested that one function of the left hemisphere of the brain is to generate narratives. Nonetheless, in properly designed experimental circumstances, the left hemisphere devises interpretations for meanings, actions and emotions produced by the right hemisphere. Such interpretations show consistency with the experiential context belonging to the left hemisphere rather than with the original right-hemisphere context. The left hemisphere, for example, might remain ignorant of the content or cause of an emotion generated in the right hemisphere, but the left-hemisphere experience of that emotion motivates an interpretation of the event in terms relevant to the content available to the left hemisphere. The interpretation

wove together autobiographical fact and inventive fiction to produce a personal narrative that enables the sense of a continuous self.

### **1.3 Physical self**

Our awareness of our self is explained by subjective experience in our physical body. People are able to recognize own images, own body, own action, it is possible investigate this with different methods and approach using face, action, voice.

#### **1.3.1 Face recognition**

The mirror self recognition test was developed by Gordon Gallup (1970), who explored self-awareness in chimpanzees. Self-awareness is inferred if the subject in front a mirror touches a mark on its own face. In humans this ability develops in children by the age of 18 to 24 months (Anderson, 1983; paragraph 2.4).

Other behavioural experiments show self face recognition also in an unfamiliar view. Tong and Nakayama (1999) showed faster responses when a subject had to identify his/her own face (rather than an unfamiliar face) even if the stimuli are inverted rather than upright.

Further evidence of self face recognition comes from neuropsychology and neuroimaging study that showed a predominant role of the right hemisphere. Patients with split-brain show better responses to self images presented in the right hemisphere (Preilwoski, 1979; Turk, 2002). Capgras Syndrome patients suffer from loss of self-recognition without either misidentifications of others after a right parietal-temporal damage. In a self face experiment left-hand reaction times were faster than right-hand reaction times when subjects were reacting to pictures of their own faces versus unfamiliar or famous person faces (Platek and Gallup, 2002).

### **1.3.2 Body recognition**

The self body representation is the internal representation of own body, own body actions is distinct from others actions. In clinical neurology asomatognosia evidence a clear distinction between knowledge of self and others. In this disturb patients after a brain damage have a paralysis of arm and steadfastly maintain the belief that the paralyzed arm is not theirs. (T.E. Feinberg, Habber Leeds 1990). Asomatognosia implies that awareness of one's hand and arm is special in sense of anatomic specificity. Another type of body-related information which self play a special role is information bodily movement (Jeannerod 1997, see par. 4)

### **1.3.3 Agency recognition**

The sense of agency represent the link between psychological self and physical self, specifically the recognition of being the cause of an action. (see. Par.1.7)

## **1.4 Psychological self**

The psychological self is a set of our personal traits, our autobiographical memory and the subjective perspective from which we view the world.

### **1.4.1 Traits**

Traits and knowledge of traits are one of methods used to study self reference effect and regards the different representation between own traits and others traits. Rogers et al (1977) compared memory for adjectives in four experimental conditions, in which the subject was asked to judge (a) the size of the letters that made up the word, (b) whether the word rhymed with another word, (c) whether the word was a synonym for another word, or (d) whether the word described the subject. At the end of the encoding phase, subjects were given a blank piece of paper and asked to recall as many of the words as they could. In the comparison between conditions (c) and (d) they found that words rated with respect to the self were better recalled than

words with more general semantic processing. Kelley et al. (2002) used a trait-adjective judgment task using three conditions: deciding whether the adjective described the subject (self condition) or President George W. Bush (other condition), or deciding whether the adjective was printed in capital or lowercase letters (case condition). If self reference effect evokes additional activation in the same regions as other-related processing, the authors would interpret this as evidence favoring the view that the SRE reflects the greater semantic organization and elaboration of the self relative to other. In contrast, if the distinct brain regions are activated by self reference, this would indicate that, “the self-reference effect results from properties of a unique cognitive self” (Kelley et al., 2002, p. 786). The self and other conditions activated similar regions in the left frontal lobe (dorsal and inferior frontal cortex), compared with the case condition. However, medial PFC (prefrontal cortex) is selectively engaged during self-referential judgments but not in other condition. The authors concluded that “self-referential processing is functionally dissociable from other forms of semantic processing within the human brain” (Kelley et al., 2002, p. 785).

#### **1.4.2 Autobiographic memory**

Autobiographic memory is a memory system consisting of episodes recollected from an individual's life, based on a combination of episodic (personal experiences and specific objects, people and events experienced at particular time and place) and semantic (general knowledge and facts about the world) memory (Williams, H. L., Conway, M. A., & Cohen, G. (2008)) The autobiographical knowledge base contains knowledge of the self, used to provide information on what the self is, what the self was, and what the self can be (Conway, M. A. 2005.). This information is categorized into three broad areas: lifetime periods (general knowledge about a distinguishable and specific time in a person's life, such as the period of university, or the first work), general events (more specific than lifetime periods and regarding single representations of repeated events or a sequence of related events.

General events is formed by clusters with a common theme, for this reason when one memory of a general event is recalled, it cues the recall of other related events in memory. ), and event-specific knowledge (is vividly detailed information about individual events, ESK memories have a high level of detail but this quickly fades with specific memories standing out, often in the form of visual images and sensory-perceptual features)(Conway, M. A., & Pleydell-Pearce, C. W. (2000)). De Renzi, Liotti, and Nichelli (1987) described a case of selective preservation of autobiographical memory. Their patient was left with a profound impairment of semantic memory after recovery from encephalitis, as well as severe anterograde amnesia and severe retrograde amnesia for world events. In contrast, her retrograde memory for personally experienced events was impressively good. An opposite case was described by Hodges and McCarty (1993).The patient was a 67-year-old war veteran with retrograde amnesia and the severe and persistent delusion that he was currently on leave from the Navy during World War II. The patient's retrograde memory was tested for events in his own life as well as two types of nonself-related information, famous people and world events. His knowledge of famous people was impressively preserved. However, his knowledge of world events was severely impaired, ruling out a truly specific impairment for autobiographical memory.

## **1.5 Handwriting**

Handwriting is another way to investigate the self because contain information about self, agency, memory and it is unique for each person. But handwriting could be considered as self portraits and may activate the processing of physical and psychological self. For this reason I explain handwriting alone and not with other methods used to self investigations.

Chen et al. (2008) used handwriting to investigate self recognition. They described an experiment where participants were shown examples of Chinese handwriting. The results showed prominent differences in event-related potentials elicited by own and other handwriting condition. The temporal sequence in event-related potentials in own handwriting condition was different from other.

Handwriting is also a product of past action and there is no doubt that we can recognize own handwriting if we read an old diary, but it less obvious that we can discriminate other handwriting and if they saw the action of handwriting an experiment that explore handwriting action was made by Knoblich and Flach (2003) (paragraph 17.4). They found that people can recognize their own handwriting based on kinematic information and discriminate self from other, but if they manipulated velocity people can't identify handwriting. The authors concluded that velocity seemed to be a crucial aspect to identify past actions, whereas the familiarity of symbols did not affect self recognition.

## **1.6 Development of self in children**

Self-recognition is a prerequisite for children's expression of various self-conscious emotions, including embarrassment (Lewis, Sullivan, Stanger, & Weiss, 1989), empathy (Bischof-Kohler, 1994), and altruism (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). Harley and Reese (1999) have provided that self-recognition is necessary for there to be autobiographical memory (i.e., memories that happen to "me"). Asendorpf and colleagues (Asendorpf, 2002; Asendorpf & Baudonniere, 1993) found increases in imitative play associated with the presence of self-recognition in 20-month-old children.

Aspects of self development as an implicit sense of self occur during the first year of life (Butterworth, 1992; Meltzoff & Gopnik, 1993). Implicit self-knowledge in infancy is rest on intermodal perception and action. Different studies indicated that at least from 2 months of age, infants become increasingly systematic and deliberate in the exploration of their own body and the perceptual consequences of self-produced action. This exploration, in important for infants to develop the sense that their own body as a differentiated entity and agent in the environment. For example Rochat & Hespos (1997) tested newborn infants within 24 hours of their birth to see whether they would discriminate between double touch stimulation specifying them, and one way external tactile stimulation made by nonself objects. They use the rooting response: healthy infants manifest from birth an head turn with mouth opening after tactile stimulation at the corner of the mouth. Then the authors recorded the frequency of rooting in response to either external tactile stimulation, the experimenter stroking the infant's cheek, or in response to tactile self-stimulation when infants spontaneously brought one of their hands in contact with their cheek. They found that infants manifested rooting responses almost three times more often in response to external compared to self-stimulation. This experiment indicated that already at birth, infants showing evidence of an early sense of their own body, hence an early perceptually-based sense of themselves as differentiated entities.

But children begin to manifest explicit meta representation of self in the middle of the second year of life (Darwin, 1872/1965; Duvall & Wicklund, 1972; Lewis, 1992). Self meta representation, sometimes referred to as the mental state or the idea of "me" involves the knowledge of the recursive relation "I know that I know" as opposed to the no recursive relation "I know" that defines the sense of agency present at younger ages (Lewis, 1995, 2001, 2003a, 2003b).

Visual self-recognition has been used as a measure of a self awareness, through it had an advantage of being applicable from very early on. Visual self-recognition is assessed by surreptitiously applying a spot of rouge to a child's face and then observing whether he or she touches the spot when in front of a mirror (Lewis & Brooks-Gunn, 1979). In normally developing children, this mark-directed behavior typically begins around 18 months of age. It has been widely argued that the surprise - mark test measures self recognition and passing it is seen as evidence that the child knows what he or she looks like (Anderson, 1984). Another source of evidence come from children's speech: from the second year on children use self related terms such as "I" and "me" and are able to understand as well as say they own names. Surprising "I" and "you" are use correctly from that start and not interchanged despite the inversion required when listening to another person's use of personal pronouns. Children become able to refer to themselves by their own name and use that interchangeable with "I".

### **1.6.1 Self-concept in children**

The way in which children conceive the self varies to some extent according to age and depends on the stage of cognitive growth achieved.

Several changes in children development of self become evident at age of 7. About the concrete-abstract dimension several research indicate a clear-cut progression in children's self-description, in fact young children described themselves with physical characteristics. Only from the age of 7 children also refer to psychological characteristics such as abilities, beliefs and dispositions. In the absolute and comparative dimension younger children focus on self without reference to others; older children describe themselves in comparison with other. Ruble shows in different studies that children are not affected by comparative standards till age of 7 or 8. Children under 7 years old use social comparison information only to judge appearance and action, they have some capacity to comparing themselves with other at least when the differences are highly salient and concrete but in self evaluation an

form of social comparison does not too seem to be natural or high priority. Whereas older children are capable to evaluating competence and ability and will therefore make a point of seeking out any comparative data that throw light on their own status. However not till the age 9 on comparative references appeared with increasing frequency.

In the final developmental change from “self as public” to “self as private” younger children do not distinguish between private feeling and public behavior and older children consider private self as true self. Children younger than 6 cannot distinguish between private feelings and public behavior; from about 8 they do make distinction and regard private self as the “true” self (Selman, 1980). It is interesting note the critical age of 7 8 about the development of self awareness, only than children can assess themselves independently of performance in particular situation, and it seems the developing ability to move away from purely concrete view and adopt more abstract conceptions underlies this change.

### **1.6.2 Children Handwriting**

Writing is just one aspect of language and writing acquisition is inexorably connected to acquisition of other language skills. It is known that children’s phonological development (ability to produce and differentiate between sounds) is related to reading, writing and speaking, that visual and orthographic skills (recognition of shapes and shape forms) are related to reading and writing acquisition and that morphological awareness (knowledge of word forms) is used in reading and writing (McBride-Chang, 2004).

Children begin to write at an early age by making simple drawings that represent things and by making shapes on paper that represent letters. There are two aspects to consider when looking at how children acquire writing skills, the first is the process of writing; the second is the production or writing.

### 1.6.3 Stages of Reading and Writing

#### ***Emergent Stage of Reading and Writing***

Children in this stage memorized words (sight word reading) or they guess the words from context. Children at this stage are usually in pre kindergarten or kindergarten, and they use environmental print to identify words. They may be able to recognize letters found in their name when seen in other contexts. They either didn't understanding the alphabetic system, or are in the beginning to be aware of the relationship between letters and sounds. This stage include the *prealphabetic phase* (Henry and McCormick, 2004), the *logographic phase* (Frith, 1985), and the *selective-cue phase*. Children in this stage may write using scribbles or letter-like forms (Bear, Invernizzi, Templeton, and Johnston, 2004). Teachers can use read aloud and shared reading to support children's to understand the concepts about of correspondence between letters and sound activating phonemic awareness.

#### ***Beginning Stage of Reading and Writing***

The beginning stage includes children in kindergarten and first grade. These children begin to read to actually and being able to read because they match sounds and letters. This children vocalizes the letter sounds as they read aloud, and to read slowly in a word-by-word manner (Bear et al., 2004). This stage is called the *partial alphabetic stage* by Ehri and McCormick (2004), because children working knowledge of the alphabetic system without a full understanding of vowels. The corresponding stage of spelling development is the *letter-name alphabetic stage*. This stage of spelling usually finds children just starting to understand beginning and ending sounds and spelling phonetically (Bear et al., 2004). The use of predictable texts is important at this stage, since it will help support readers trying to understand and make sense of print.

### ***Transitional Stage of Reading and Writing***

The transitional stage begins at second grade when children start to decode commonly recurring letter patterns as units (Ehri and McCormick, 2004). Children at this stage are said to be at the *consolidated-alphabetic stage* as their focus shifts to spelling patterns, which might include onsets, rimes, and syllables. In the corresponding stage of spelling development, *within-word pattern spelling*, children are able to consolidate single-letter sounds into patterns or chunks, and words with regular spelling patterns are internalized (Bear et al, 2004). Children are able to read with more fluency and expression, and they can correctly spell most words with single syllables and short vowel sounds (such as cat).

### ***Intermediate Stage of Reading and Writing***

In the intermediate children are in stage end of second grade or the beginning of third grade and they still in the consolidated alphabet stage (Ehri and McCormick, 2004), and matured an awareness of syllables and affixes (i.e., prefixes, suffixes, and other types of inflectional endings) (Bear et al., 2004). These children can read faster silently than they can orally, and they can spell most single-syllable words correctly. Children in the transitional stage could also spell single-syllable words but only words containing short vowel sounds. So the difference is the level of sophistication found in the syllable. In multisyllable words, children in this stage may still “make errors at syllable juncture and in unaccented syllables” (Bear et al., 2004, p. 29).

### ***Advanced Stage of Reading and Writing***

Readers and writers at the advanced stage, or *automatic stage*, of word reading have “highly developed automaticity and speed in identifying unfamiliar as well as familiar words” (Ehri and McCormick, 2004, p. 384). A characteristic of readers is that they read accurately and recognize words automatically (Kuhn and Stahl, 2004). The corresponding stage of spelling

development is known as the stage of *derivational relations*, because children understand that they can derive related words from a basic root word by adding prefixes and suffixes (Bear et al., 2004). Children at this stage benefit from using the literature circles format.

#### **1.6.4 Development of friendship**

Very young children don't understand that other people have different feelings and experiences from their own. But this perspective-taking ability and perspective of children's friendship develops over time until it is quite sophisticated in adults. Robert Selman, developed a five-stage model to describe the development of perspective-taking. Selman's methods are similar to those of Piaget (and his moral stories) and Kohlberg (with his dilemmas). Selman views that social awareness develops in a series of stages and each of these stages involves reorganization of mental elements by the child (Rubin, 1980). Typically Selman reads such a story and asks questions. One such story is that of Holly:

*"Holly is an 8-year old girl who likes to climb trees. She is the best tree climber in the neighbourhood. One day while climbing a tree she falls off the bottom branch but does not hurt herself. Her father sees her fall, and is upset. He asks her to promise not to climb trees anymore, and Holly promises. Later that day, Holly and her friends meet Sean. Sean's kitten is caught up in a tree and cannot get down. Something has to be done right away or the kitten may fall. Holly is the only one who climbs trees well enough to reach the kitten and get it down, but she remembers her promise to her father."*

If children of different ages are presented with this situation and asked such questions as, "If Holly climbs the tree, should she be punished?" "Will her father understand if she climbs the tree?" "Will Sean understand why Holly has trouble deciding what to do?" the children will give answers relevant to their age group.

### **Undifferential perspective-taking (age: 3-6)**

**Description:** Children recognize that the self and others can have different thoughts and feelings, but they frequently confuse the two.

**Response:** The child predicts that Holly will save the kitten because she does not want it to get hurt and believes that Holly's father will feel just as she does about her climbing the tree: "Happy, he likes kittens." Friendship: Momentary physicalistic playments (Momentary physical playmates).

**Friendship:** A close friend is one who may live nearby and who the child is playing with at that moment (Asher & Gottman, 1981). There is no clear conception of an enduring relationship other than specific encounters. (Rubin, 1980)

### **Social-informational perspective-taking (Age: 5-9)**

**Description:** Children understand that different perspectives may result because people have access to different information.

**Response:** When asked how Holly's father will react when he finds out that she climbed the tree, the child responds, "If he didn't know anything about the kitten, he would be angry. But if Holly shows him the kitten, he might change his mind."

**Friendship:** One-way assistance - A friend is someone who does something that pleases you. A close friend is someone that you know better than other people (Asher & Gottman, 1981).

### **Self-reflective perspective-taking (Age: 7-12)**

**Description:** Children can "step in another person's shoes" and view their own thoughts, feelings, and behavior from the other person's perspective. They also recognize that others can do the same.

**Response:** When asked whether Holly thinks she will be punished, the child says, "No. Holly knows that her father will understand why she climbed the tree." This response assumes that Holly's point of view is influenced by her father being able to "step in her shoes" and understand why she saved the kitten.

**Friendship:** Fair-weather cooperation - There is a new awareness of interpersonal relationships. (Asher & Gottman, 1981). Friendship becomes reciprocal, but is still focusing on specific incidents rather than an enduring relationship (Rubin, 1980).

### Third-party perspective-taking (Age: 10-15)

**Description:** Children can step outside a two-person situation and imagine how the self and other are viewed from the point of view of a third, impartial party.

**Response:** When asked whether Holly should be punished, the child says, "No, because Holly thought it was important to save the kitten. But she also knows that her father told her not to climb the tree. So she'd only think she shouldn't be punished if she could get her father to understand why she had to climb the tree." This response steps outside the immediate situation to view both Holly's and her father's perspectives simultaneously.

**Friendship:** In the transformation from stage 2 to this stage, children reflect on intimacy and mutuality within a continuing relationship (Rubin, 1980)

### Societal perspective-taking (Age: 14-Adult)

**Description:** Individuals understand that third-party perspective-taking can be influenced by one or more systems of larger societal values.

**Response:** When asked if Holly should be punished, the individual

responds, "No. The value of humane treatment of animals justifies Holly's action. Her father's appreciation of this value will lead him not to punish her."

**Friendship:** Perspectives can be shared between two people on common interests and deeper feelings. Perspectives among people form a network, which in turn become generalised (Asher & Gottman, 1981).

So there is a difference in friendships of children from about six to nine years and children about ten and twelve years. In children six to nine of the friends usually live close to one another and are of the same sex and similar in age, social status, and social maturity. They spend most of their time together in physical activities (skating, biking, sports), make-believe games related to domestic or work situations, fantasized athletic accomplishments, and "adventures" modeled after favorite fictional heroes. Children at this age still tend to describe their friends according to physical characteristics and possessions, but sometimes think of them in more relational terms, such as showing liking and supportiveness in different ways, they feel that friends should share points of view. Thus, at this stage, friendships are on-and-off relationships that are largely self-oriented and opportunistic.

Between the ages of roughly nine and twelve years, children increasingly respond to others in terms of internal characteristics (attitudes, beliefs, values). They learn to infer these characteristics by observing the ongoing acts of others, and they are aware that others can, in turn, infer internal characteristics in the same way. With this cognitive ability, a child can "step outside" of the self and take the perspective of the other, including the perceptions the other has of her or him. This enables them to form friendships that Rawlins (1992) labels *reciprocal and equal*. At this stage, children usually choose friends whose beliefs agree with their own. To the degree that their perspectives differ, however, friends at this age are able to

accommodate some of the differences and arrive at a shared outlook. Although the children still tend to be self-oriented and opportunistic. That is, the child provides benefits when the friend has a need for them because that is what friends are supposed to do. That friend, of course, is expected to return the benefits for the same reason. Thus, friends are people who share ideas, interests and feelings, and who provide rewards on a broadly reciprocal basis. In the reciprocity and equality phase, then, children are on the fringes of a conception of friendship as a relatively stable relationship that transcends occasional disagreements and periods of separation.

### **1.7 Sense of agency (SA), sense of ownership (SO) and awareness of action**

Compare the action of intentionally moving your own arm and the passive movement of your arm moved by somebody else. The *sense of agency* (SA) refers to the subjective awareness that one is initiating, executing, and controlling one's own volitional actions in the world (Jeannerod, M. 2003). It is the pre-reflective awareness or implicit sense that it is me who is presently executing bodily movement(s) or thinking thoughts.

The *sense of ownership* (SO) is present in active and passive movements. The sense of ownership and the sense of agency are associated in the normal experience of voluntary action, whereas they are dissociated in passive movements. The sense of ownership is implicated in the sense of agency but not viceversa, because the sense of agency needs self-generated movements (Tsakiris et al 2007). If someone else were to move your arm (while you remained passive) you would certainly have sensed that it were your arm that moved and thus a sense of ownership (SO) for that movement. However, you would not have felt that you were the author of the movement; you would not have a sense of agency (SA). Normally SA and SO are tightly integrated, but in patients suffering from certain forms of pathological experience (i.e., schizophrenia) the integration of

SA and SO may become disrupted in some manner. In this case, movements may be executed or thoughts made manifest, for which the schizophrenic patient has a sense of ownership, but not a sense of agency. The distinction between self-generated action and actions generated by others, and also the corresponding ability to attribute an action to its proper agent, are key functions for the self-other distinction. *Awareness of action* (references) is the awareness about the goal of action, the agent controlling the action. Action is not only bodily movement or a simple reaction to external or internal stimulus; rather it has a goal, end point, or effect.

### **1.7.1 Central Monitoring Theory**

The sense of agency is not only the experience of act of will that it is distinct from bodily movements: it is the experience of the continuous control of action execution.

The prevalent explanation of the sense of agency of our own action is “The Central Monitoring Theory” (Blakemore, Frith, & Wolpert, 2001; Blakemore, Wolpert, & Frith, 1998). Figure 1.1 explain the theory holds that the comparison between efferent signals at the origin of an action and those which arise from its execution (the reafferent signals) provides cues about where the action originates. The original idea is that each time the motor centers generate an outflow signal for producing a movement, a copy of this command (the ‘efference copy’) is retained. In the simplest form of the model, the reafferent inflow signals generated by the movement (e.g. visual, kinesthetic) are compared with the efference copy. A predictive component can be added to the model, which predicts the sensory consequences of the movement. In the case of a self-produced movement, the actual sensory feedback will match the prediction. In contrast, signals arising in the absence of a self-produced movement will be referred to an external event. Otherwise a sensory signal will be perceived differently whether it arises from a self-

produced movement or it is externally produced (Wolpert et al. 1995; Blakemore et al. 1998). This model of the control of action can be directly applied to the problem of self-identification.

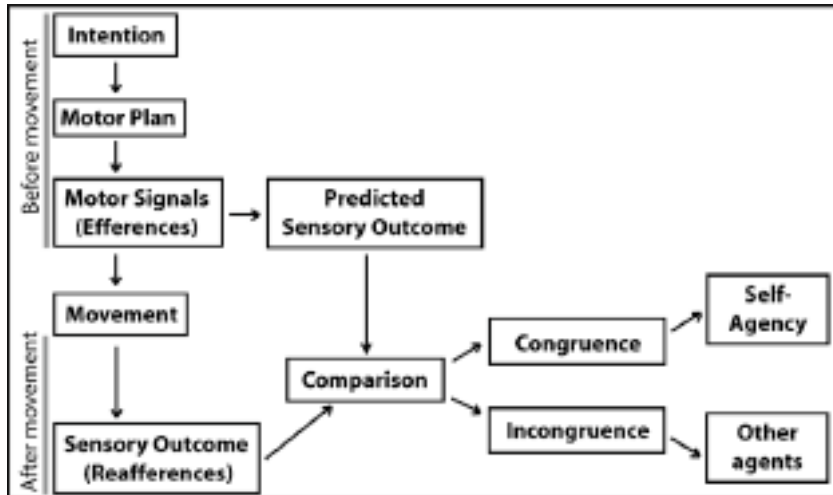


Figure 1.1 Central monitoring theory or comparator model.

A classical experiment was conducted by Nielsen (1963): the task for subjects was to draw a line on a paper. They could either see their own or, unbeknown to the subject, an “alien hand”. The alien hand’s movements spatially deviated from the subject’s own movement. So, subjects adjusted their own actual movement to the false visual feedback without being aware of the adjustment. Many manipulation experiment of this have evolved (Daprati et al., 1997; Farrer, Franck, Paillard, & Jeannerod, 2003b; Farrer & Frith, 2002; Fink et al., 1999; Fournieret & Jeannerod, 1998; Sirigu, Daprati, Pradat-Diehl, Franck, & Jeannerod, 1999).

Farrer and others (2003) create an experimental situation where the visual feedback showed to the subjects about their own movements could be either congruent with the execution or distorted to a variable degree. The subjects were instructed to move a joystick with their right hand. Distortions were introduced: the movements seen by the subjects were rotated with respect to those they actually performed by 25° and 50°, or were completely non-correlated with them. Subjects were instructed to concentrate on their own

feelings of whether they felt in control of the movements they saw. The task of observing one's own movements in this unusual situation activated the posterior parietal lobe, with higher activation in the right hemisphere. A peak activation was located in the inferior parietal lobule. The important point, was that the less the subjects felt in control of their own movements, due to larger and larger degrees of distortion, the more the right inferior parietal lobule was activated (Farrer et al. 2003).

This experiments indicated that the processes underlying the sense of agency are not all-or-none: but, person rely on continuous monitoring of the different movement-related signals, from sensory (kinesthetic, visual) and central (motor command) origin. However, this also suggests that the mismatch between these normally congruent signals requires an increased level of processing, hence the progressive increase in activity .

Research thereby indicated that visual signals so vision is the dominant modality or motor signals (Van Beers, Wolpert, & Haggard, 2002). However, the sense of agency cannot be considered as being solely influenced by visual reafferences (Tsakiris & Haggrad, 2005; Tsakiris et al., 2007).

The comparator model has also been associated with abnormalities of action awareness. For example, patients with schizophrenia may suffer from delusions of control, in which they experience others' actions as a consequence of their own intentions or attribute their own actions to external sources (Daprati et al., 1997; Franck et al., 2001; Jeannerod, & Franck, 2003). Several authors have explained such delusions as a breakdown of central monitoring mechanisms (Blakemore et al., 2002; Gallagher, 2004).

### **1.7.2 Simulation Model**

However, the general validity of the comparator model was recently reexamined. The "simulation theory, similar to the comparator model, also proposes a functional role of the motor system is. This theory consider that in understanding or predicting other people's behavior we use our own experiences to simulate those of others (Goldman, 1989). The simulation

model invokes a functional role of the motor system and offers an alternative to the comparator model. The discovery of “mirror neurons” in the macaque brain, which discharge both during action execution and observation (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fogassi, & Gallese, 2001), support to simulation theory (Saxe, 2005) but direct neurophysiological evidence from the human brain has yet to be delivered (Keysers & Perrett, 2004). Nonetheless, in the simulation theory if we assuming shared representations for self and other cannot explain why we normally do not confuse our own and others’ actions. This is in line with Sebanz and Frith (2004) who argued that “the mirror neuron system does not provide an explicit representation of other agents” and that “an additional mechanism must be assumed” (Schütz-Bosbach, Mancini, Aglioti, & Haggard, 2006, Farrer & Frith, 2002; Farrer et al., 2003a).

In the literature, in opposition with the mirror neuron system, this has also been referred to as a “‘Who’ system” (de Vignemont & Fournieret, 2004; Georgieff & Jeannerod, 1998) the core of the ability to distinguish self from other or the development and integrity of human self awareness.

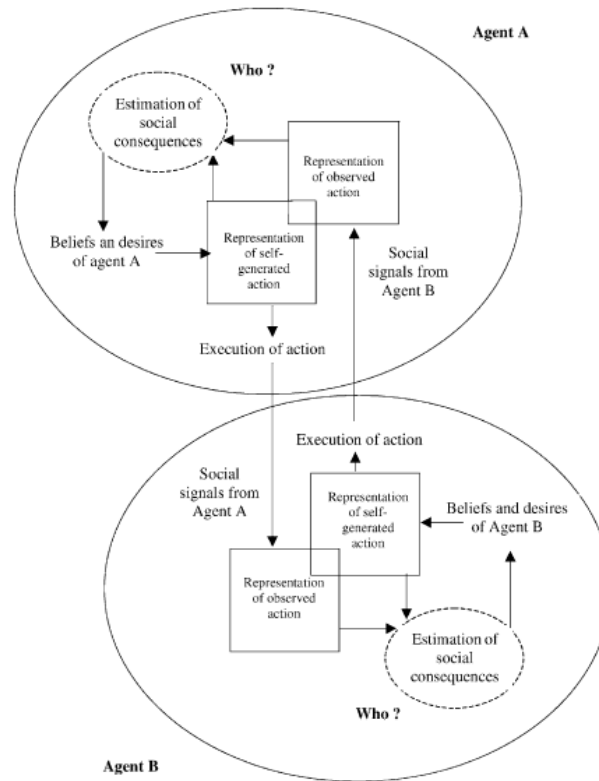
Decety and Sommerville (2003) suggested that self-awareness and agency (a Who system) are implicated in exploration within shared representations. But it is not clear if for the execution of this system which signals or mechanisms mainly contribute and whether they need to be conscious. The comparator and predictor mechanism of the simulation model add information to this issue but, clearly, cannot be the only relevant mechanism. The importance of simulation for the sense of agency may be sustained by a population with simulation deficits such as autism spectrum disorders or Asperger syndrome (Dapretto et al., 2006; Oberman et al., 2005 David et al., 2007b). Subjects performed comparably to healthy control subjects without evidence for an agency impairment. However, Autistic subjects did show deficits in perspective taking which has been explicitly linked to simulation (Langdon & Coltheart, 2001). This finding is in accordance with the fact that

subjects within the autism spectrum did not show deficits in representing another person's action but exhibited mentalizing deficits.

### **1.7.3 Self-Other Distinction and Who System**

Social situations imply the presence of two person, two potential agents, social attributes derive from the presence of the other, who is both a spectator and likewise an agent. An action could attribute to ourselves or to others and this is a result of self-other differentiation. Georgieff and Jeannerod (1998) suggested that the discrimination between one's own actions and other's actions is associated with the activation of non-overlapping brain areas. The prefrontal and parietal cortex, supplementary motor area, and cerebellum seem to be deeply involved in action attribution processes (Grèzes J, Decety J 2001), with the activity of the anterior insula and the right inferior region of the parietal lobe then modulated by the processing of performance feedback discrepancies (Balconi M, Crivelli D 2010). Therefore the self-attribution of action is associated with greater activation of the anterior insula, and the attribution of agency to others activates the inferior right parietal cortex, and self-monitoring mechanisms related to error detection and feedback evaluation are associated with activation of rostral and caudal regions of the cingulate cortex. *Who system* was introduced by the cognitive and neural overlap between self and other action representations. The who system theory represents a cognitive model of agency that includes the peripheral perception information from vision and proprioceptive system of the moving body and the relation between movement or action and their consequences, afterwards it isn't only a mere control of central signals, but is related to all the capacity to plan an action: goal, intending and executing, and feeling of controlling the results (Wolpert DM, Ghahramani Z (2000), Balconi M, 2010). This process would thus be the basis for correctly attributing a representation (or the

corresponding action) to its proper agent for answering the question of “Who” is the author of an action.



The flow chart Jeannroad (2002) illustrated of the many interactions between two agents. Each agent builds in his brain a representation of both his own intended actions, using internal cues like his own beliefs and desires, and the potential actions of the other agent with whom he interacts. The overlapping part in representations are used by every agent to build a set of predictions and estimates about the social consequences of the represented actions. In fact, other agent as a set of social signals which confirm (or not) his predictions and possibly modify his conviction when an action comes to execution. In this view there is different pathological condition wherein the nature of the dysfunction are responsible for misattribution of actions. A specific configuration of symptoms appearing in schizophrenic patient where the manifest “positive” symptoms, including verbal hallucinations, insertion

of thought, and delusion of influence, which should represent mechanisms which normally specify the boundaries between the self and other people. Patients with positive symptoms tend to over attribute to themselves actions performed by others and to attribute their own actions or thoughts to the influence of others. This patients in experimental were found to systematically misattribute their movements or those of the experimenter (Daprati 1997, Farrer 2001). Weiberger 1996 suggest that an explanation of this failure to recognize one's own actions and to correctly attribute actions to their agents could be implicated the role of prefrontal cortex. Prefrontal cortex is known to be hypoactive in many schizophrenic patients (Weinberger 1996, Goldman-Rakic 1997). Indeed, neuroimaging studies have revealed that patients presenting verbal hallucinations (e.g. "voices" whereby inner speech is erroneously attributed to external agents) show abnormal activation of primary auditory areas in their left temporal lobe, as if they were processing an external auditory stimulus (Dierks et al, 1999). Such increased activation could likely be related to the loss of frontal inhibition on the corresponding areas.

However, for person are very important to distinguish between self and other in agency attribution, and requirements for acting in the world and with the external world. Despite, the active or passive role of an agent, during an interaction we need to be able to perceive our body, our acting space, and our causal power.

#### **1.7.4 Action Recognition in Handwriting**

Only few studies investigated whether individuals are able to identify past actions. Wolff (1931) conducted the first study on identification of past action, he used a filmed of people while they walking in a room. They were all dressed in the same clothing to disguise anatomical cues. Participants

recognize themselves much better than they could recognize other persons whom they all knew well.

Neuro-physiological evidence supports the action simulation assumption. First, there are mirror neurons in the monkey premotor cortex that discharge when the monkey carries out certain hand actions but also when the monkey observes the experimenter perform the same action (Gallese et al., 1996; Gallese & Goldman, 1998). Several regions in the human brain are activated during action generation, action simulation, and action observation. These areas include the premotor cortex, the posterior parietal cortex, and the cerebellum (Ruby & Decety, 2001). Orliaguet, Kandel, and Boé (1997) demonstrated that when a person observe the kinematics of an handwriting trajectories can generate accurate anticipations about the identity of following letters. In a recent study, Kandel, Orliaguet, and Viviani (2000) extended these results by demonstrating a correct predictions were possible only if the movement observed was biologically plausible. This study support that people can use action-related representations to simulate the outcomes of an action. The authorship effects are explained by the fact that action perception is followed by concurrent action simulation (Blakemore & Decety, 2001; Knoblich & Flach, 2001). Representations of distal events as postulated in the common coding assumption, that prove a stage where perceptual input and the simulation results could be integrated, but to complete this is important underline that the activation of motor codes results in turn in a prediction of future events (Knoblich & Jordan, 2002). Probabbily the self-recognition is related on a comparison between observed and simulated events and this interpretation evidenced that people can recognize their own drawing kinematics (Knoblich & Prinz, 2001). In an experiment of Knoblic 2002, authors isolated kinematics information from handwriting samples and investigated whether participants can still identify their own handwriting. The participants produced writing samples of a

number of familiar symbols, like numbers and letters from the Latin script, and unfamiliar symbols, like letters from Thai and Mongolian scripts. The kinematics of their writing with a writing pad was recorded. The result indicated that persons are able to recognize own handwriting based on information provided in the kinematic displays. Similar, results were obtained when participant have to discriminate between the self- and other-handwriting. But they found also a role of velocity when that information was change participants could not identify their own handwriting anymore. The accuracy of self-other-judgments was not higher for writing samples reproducing familiar symbols. So the past actions can be identified, and velocity changes seemed to be crucial for self-identification. This supports the claim that self-recognition is informed by the action system, because velocity changes are clearly an action-related parameter. In other experiments Knoblich (2002) investigated that if the actions are simulated while being observed when one observes one's own actions, it might be easier to predict the future outcomes of actions. The participants observed parts of self and other produced trajectories and judged whether another stroke would follow or not. Using the handwriting domain, participants were asked to write different versions of the digit "2". The task was to decide whether the observed stroke had been produced in isolation or as a part of the digit "2." Authors found that when participants decide on strokes made by other the response was near chance level. However, when they observed their own past strokes, their predictions were significantly above chance level. Hence, it seems that such integration is not necessary to predict future strokes. The ability to predict letters and strokes from earlier parts of a trajectory is quite similar to phenomena in the domain of speech perception where the same phoneme is perceived differently depending on the context created by the preceding phoneme (Liberman & Whalen, 2000). All this results are in line with the action simulation in the motor system because an action observation is related to activation of common events.

Authorship effects not only are interesting in themselves but also provide a way to address the issue of whether the action system contributes to action perception. Considering that the predictions for others were as accurate as for self, it is not possible explain that without assuming the presence of an action simulation mechanism.

# Chapter 2

## Experiment 1: Handwriting discrimination in adults and the self/other dichotomy

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### 2.1 Introduction

The aim of my first experiment was to evaluate a possible superiority of self-using handwriting stimuli in discrimination tasks (AB-X and X-AB). Chen et al. (2008) reported an experiment where participants were shown examples of Chinese handwriting. They used an explicit identification task. The task was to judge whether the handwriting, that they saw, was their own. The result showed prominent differences in event-related potentials elicited by own and other handwriting condition. The temporal sequence in event-related potentials in own handwriting condition was different from other. Differently in my experiment I chose to use an implicit task, because I think that is relative simple recognize directly own handwriting for an adult. The participant was a psychology student because their handwriting is stable and represent a traits of them. The hypothesis of this experiment was to understand if is simpler discriminate between two handwriting if there is own handwriting in the stimuli than discriminate only between other handwriting. For this reason I chose an AB-X and X-AB task and all participant judge condition where was present own handwriting and were was only extraneous handwriting that I called other handwriting.

## 2.2 Methods

### 2.2.1 Participants

Eight native Italian graduate students participated in the study (4 males, 4 females; age in the 21-24 yr. range). All participants were physically and mentally healthy, right-handed, and had normal or correct to normal vision.

### 2.2.2 Stimuli

I chose 65 Italian words balanced for length (4,5,6,7 letters) and frequency that was calculated as the number of occurrences in a corpus of written Italian (<http://dev.sslmit.unibo.it/corpora/corpora.php>). Each participant copied 30 of such words (each shown as a bold original s printed on an A4 sheet) using her/his own cursive handwriting. These 30 words included 20 comparison words identical for all participants, to be used in AB pairs, and 10 target words to be used as X, 5 identical for all participants (*mela, sedia, tavola, portata, fratello*) and 5 specific to each participant. Stimuli were scanned and saved as high resolution image files after resizing, to make sure that the average height of each handwriting sample was equal.

### 2.2.3 Tasks

Both AB-X and X-AB presentation orders were used in a within-subjects design. The task was where AB was comparison word and X target. In AB-X task each participant was shown: the same comparison word (A-B) written by two participants with different A B handwritings; after a short interval a target word (X) different from A B , with the same handwriting as either A or B. The participant should press either the left or right button. Left button if target matched with A, right button if target matched with B in comparison pair. The temporal sequence for AB-X task (fig. 2.1a) was fixed point (1000 ms), AB (1500 ms), white slide (300 ms) and X (time to response). The temporal sequence for X-AB task (fig. 2.1b) was fixed point (1000 ms), X (1000 ms), white slide (300 ms) and AB (time to response). The task presentation was made with SuperLab program used to record reaction time and response.

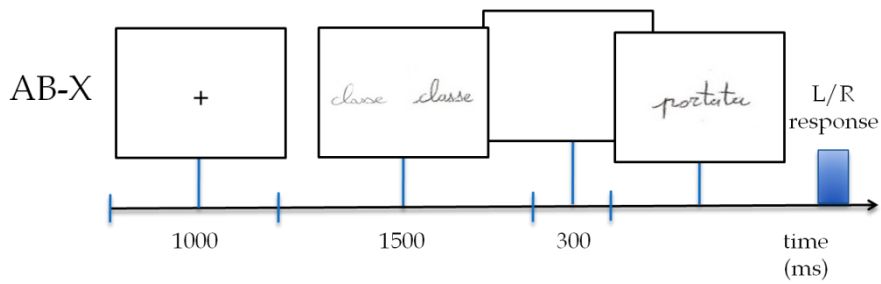


Figure 2.1 Example of task and time sequence (AB-X)

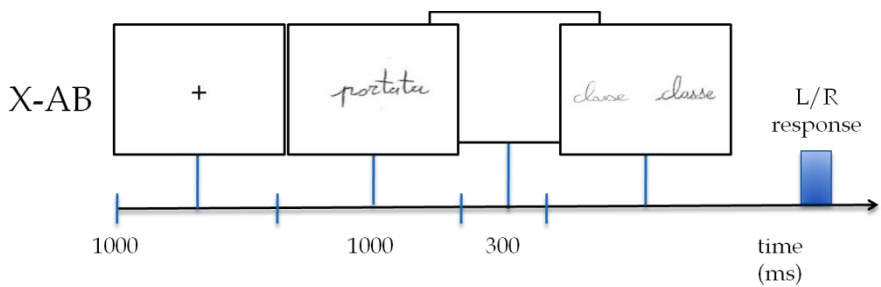


Figure 2.1b Example of task and time sequence (X-AB)

## 2.2.4 Experimental Design

The temporal sequence of the experiment was:

- **session 1:** each participant read instructions and wrote 30 words
- **session 2:** first test after one month
- **session 3:** second test after one month from session 2

In this experiment I used a within subject design. Each participant judged a total of 112 trials of which 56 AB-X and 56 X-AB. Each set of 56 trials was balanced for left and right correct match positions and resulted from the sum of two subsets: 7 trials including the self handwriting – either once, like in a (1,2)-2 AB-X trial for participant 1, or twice, like in a (1,2)-1 AB-X trial for participant 1 – and 21 trials that never included the self handwriting – like in a (2, 3)-2 for participant 1.

From the point of view of the participant, there were three types of trials:

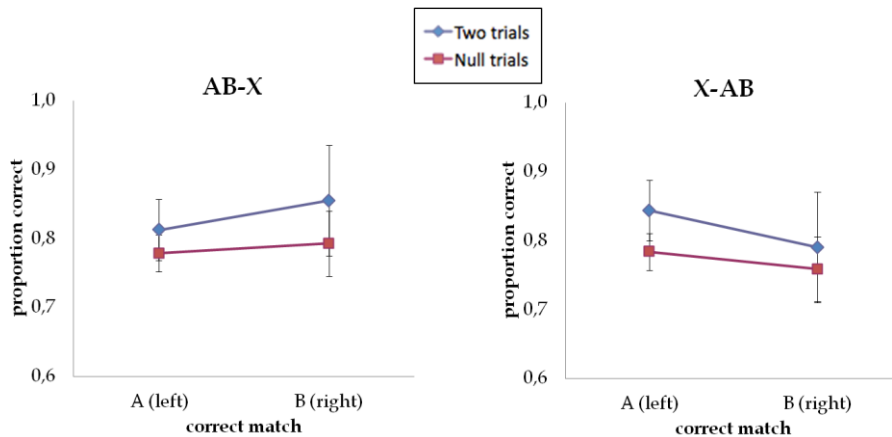
1. *Null*, when neither the target word X nor the comparison words (AB) belonged to the set of 30 words written by the participant;
2. *One*, when the target word X and one comparison word (either A or B) have been written by a person different from the participant, while the other comparison word belonged to the set of 30 words written by the participant;
3. *Two*, when the target word X and one comparison word (either A or B) belonged to the set of 30 words written by the participant, while the other comparison word has been written by another person.

## **2.3 Results**

### **2.3.1 Proportion of correct responses**

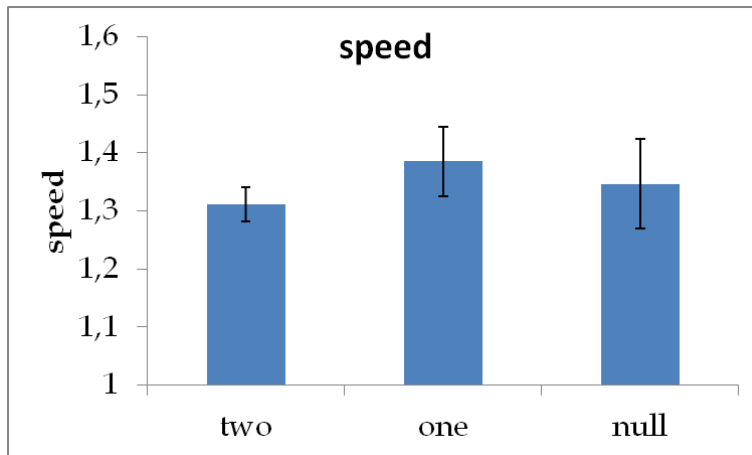
In the first step to analyze data I calculated the proportion of correct response. I divided the response in null, one and two trials and also in AB-X and X-AB type for each subject and calculated the proportion of correct response since the task was to identify the correct match.

In this experiment I used two type of stimuli's presentations AB-X and X-AB and the correct response was also balanced in left and right position so in first analysis I want consider if there is a difference between this two type of presentation and if there isn't in the future analysis I can consider together the data.



**Figure 2.1 Global mean of proportion of correct response for Trials (Two, Null) in position of correct match (A left, B right); divided in AB-X and X-AB task.**

The Figure 2.1 show the distribution of data with arcsen of proportion correct response in trials Null and Two, position of correct match left and right and for type of presentation AB-X and X-AB. The figure shows a superiority of self, performance is better in two trials where self is target (mean AB-X= 1.12 X-AB= 1.07) then null trials (mean AB-X= 0.93 X-AB= 0.88) in both type and position. An ANOVA on Position (2) x Trial (2) x Type (2) with a within-subject design confirmed the main effect of self is ( $F_{1,7} = 7.38$   $p < 0.05$ ) where the performance in two is better than null; for participant there is no difference if correct response is left or right ( $F_{1,7} = 0.047$   $p < 0.83$ ) and also no difference between AB-X and X-AB ( $F_{1,7} = 0.508$   $p < 0.49$ ). All interactions weren't significant Trials X Type ( $F_{1,7} = 0.01$   $p < 0.92$ ). Trials X Position target ( $F_{1,7} = 0.01$   $p < 0.92$ ). Position target X Type ( $F_{1,7} = 1.72$   $p < 0.23$ ), Trials X Position target X Type ( $F_{1,7} = 1.67$   $p < 0.23$ ).



**Figure 2.2 Mean of speed (1/RT) in all trials: Two, One, Null. Show no difference between condition**

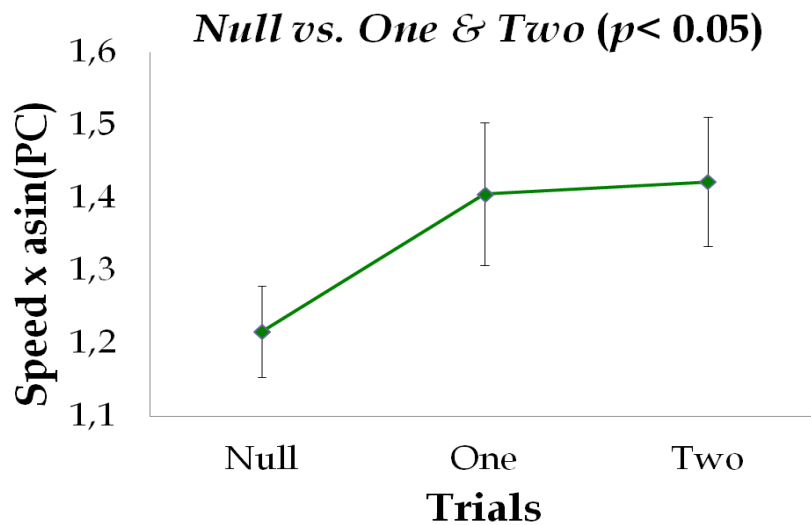
### 2.2.2 Reaction times

In order to represent better the time I used speed measure  $1/rt$ . Figure 2.2 show that there isn't difference in the distribution of reaction times with mean in two: 1.31, one:1.38 and null: 1.34. The absence of different in each condition is confirmed by ANOVA within subject Trials (3), ( $F_{1,7}= 0.58$   $p<0.56$ ).

### 2.3.3 Global performance

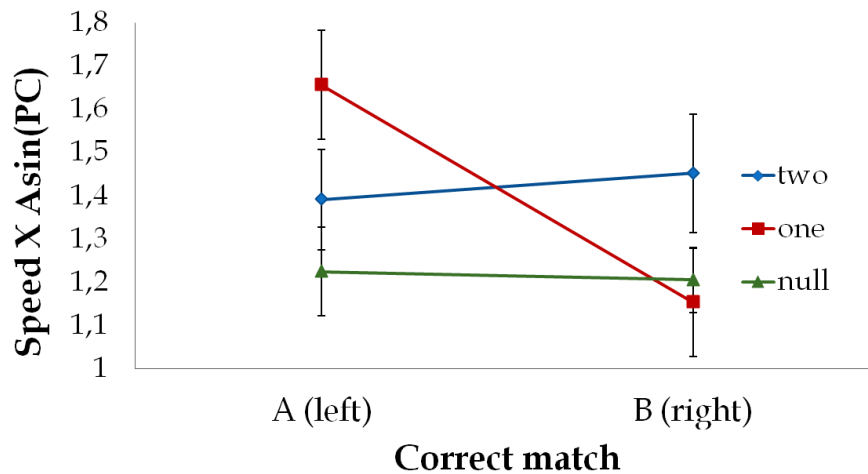
For further analysis I used an index of global performance corresponding a product between arcsen of proportion of correct response and the mean of speed of correct response.

Figure 2.3 shows how the global performance index varies in the different type of trials (Null, One, Two). Performance is better in One (mean 1.40) and Two (mean 1.42) trials than null (mean 1.21).



**Figure 2.3 Global performance accuracy (Speed X asinPC) for all trials Two, One, Null. Show a difference between Two and Null trials.**

An ANOVA within subject one factor Trials (Null, One, Two) shows the self superiority effect performance in One and Two trials was similar. and better than in null trials ANOVA: Design 1 Within Subject Factor ( $F_{2,14} = 2.77$   $p < 0.09$ ). The comparison between Two and Null ( $t_7 = 2.15$   $p < 0.06$ ). Two and One ( $t_7 = 0.17$   $p < 0.86$ ) One and Null  $t_7 = 1.94$   $p < 0.09$ . And considering the comparison One-Two vs Null  $t_7 = 2.38$   $p < 0.04$ .



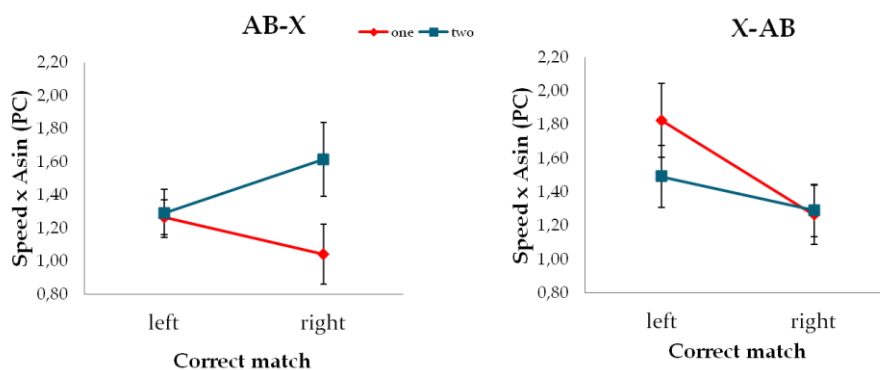
**Figure 2.4** Global performance accuracy (Speed X asinPC) for all trials (Two, One, Null) in Position of correct match (A left, B right). Show the interaction between One and Two trials, and the superiority of Two trials on Null trials.

Figure 2.4 shows how the global performance index for the left and right correct match varies in the three trial types (Null, One, Two). Performance is not affected by the position of the correct match in Null (1.23 for both left and right positions) and Two (1.39 vs. 1.45 for left/right positions) trials; whereas performance with the left correct match is clearly better than with the right (1.36 vs. 1.15) for the One type of trial. Furthermore, performance was better in Two (1.42 on the average) over Null (1.23) trials, independent of the correct match position. Anova on the Position (2) x Trial (3) within-subjects design confirmed that the two-way interaction was significant ( $F_{2,14} = 8.28, p < 0.005$ ). Neither the main effect of Position ( $F_{1,7} = 3.13, p < 0.12$ ) nor the main effect of Trial ( $F_{2,14} = 2.77, p < 0.09$ ) were significant. The interpretation of the significance of the Position x Trial interaction must take into account the different spatial positions of the three elements involved in AB-X and X-AB trials.

Null Trials. Both A and B are “other” handwritings. The absence of a difference between the two correct match positions is consistent with the fact that correct and incorrect matches always involve “other” handwritings.

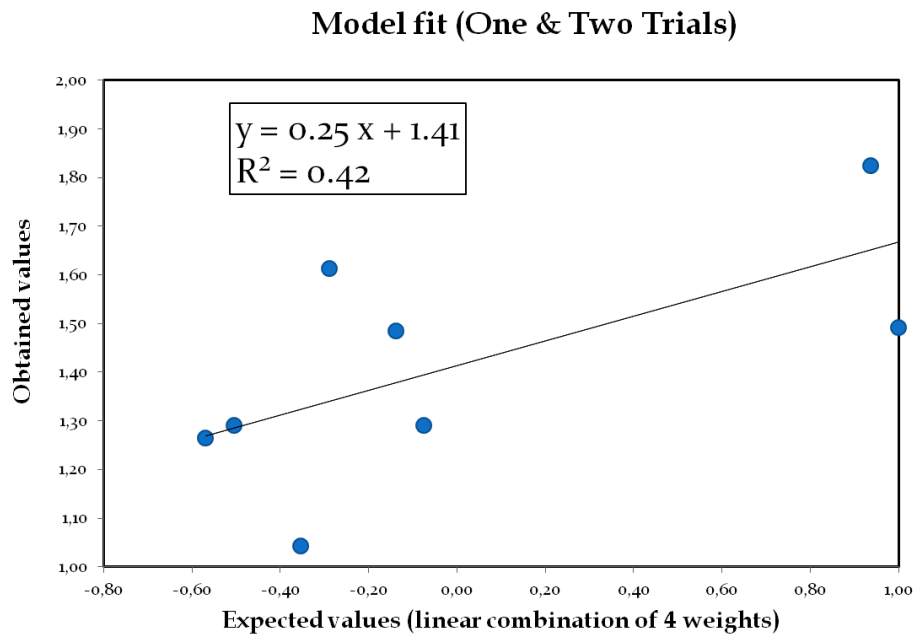
Two Trials. The correct match is always the own handwriting. The absence of a difference between the two correct match positions is consistent with the fact that response is probably influenced by own handwriting as target

One Trials. In one trials when the correct match is on left participant in AB saw “other-own” when is on the right participant saw “own-other”. The performance is worse in right position probably because the participant first saw his/her own handwriting and then should inhibit own handwriting.



**Figure 2.5** Global performance accuracy (Speed X asinPC) for all trials (Two, One, Null) in Position of correct match (A left, B right), divided in AB-X and X-AB task.

In light of this results I considered the same data without the null trials, but I considered the data also for type of presentation AB-X and X-AB (figure 2.5). In both AB-X and X-AB in one trials the performance is better in left (with average of 1.03 AB-X, 1.28 X-AB) then right (with average of 0.79 AB-X. 0.96 X-AB). It is different in two trials where in AB-X is better in left than right (with average of 1.00 vs 1.23) and in X-AB the difference between left and right is minimal ( 1.15 vs 0.89).



**Figure 2.6 Model fit (One & Two Trials) with a combination of four weights ( X-Match Distance, Position, Task, Trial), this model explain the 42% of variance.**

Considering the distance between target and correct match for example in AB-X near is other own – own and far own other – own; the performance is worse when the correct match is far. Furthermore, I calculated a linear 4-variable model, including a new factor: target-match distance. The model is obtain from the correlation between obtained values and expected variable linear combination of 4 weights:

- X-Match Distance (Near= 0.14 vs. Far= -0.14)
- Position (Left = 0.56 vs. Right= -0.56)
- Task (X-AB= 0.10 vs. AB-X= -0.10)
- Trial (Two= 0.21 vs. One= -0.21 )

As the figure 2.6 show this model explain the 42% of variance and the most relevant weight is position of correct match.

### 2.3.4 Perceived dissimilarity of handwriting samples

Finally, I tried to evaluate the effect of ownership on the perceived dissimilarity of handwriting pairs shown as AB stimuli. As a baseline measure of dissimilarity, not influenced by ownership, I computed the mean value of discrimination accuracy in Null trials for each of the 28 AB pairs, as shown in Table 2.2.

**Table 2.1 Raw matrix of accuracy values for the 28 AB pairs and 8 participants. Each value is the proportion correct on the basis of a maximum of 4 AB-X and 4 X-AB trials for each participant. Yellow cells refer to one and Two trials, which included the participant's own handwriting.**

participant handwriting		pair	participants							
A	B		AB-BA	1	2	3	4	5	6	7
1	2	1	0,750	0,875	0,750	0,620	0,875	1,000	1,000	0,620
1	3	2	0,500	0,625	0,875	0,750	0,750	0,500	0,750	0,620
1	4	3	1,000	0,750	1,000	0,875	0,750	0,750	0,750	1,000
1	5	4	0,500	0,750	0,875	1,000	1,000	1,000	0,875	0,750
1	6	5	0,620	1,000	0,620	0,710	0,875	1,000	0,875	0,620
1	7	6	0,750	0,625	0,875	0,620	0,620	0,750	0,750	0,420
1	8	7	0,875	1,000	0,875	0,875	0,875	0,850	0,620	0,710
2	3	8	0,875	0,750	0,875	0,620	0,875	0,875	0,750	0,750
2	4	9	0,875	1,000	0,875	0,875	0,875	0,875	0,820	0,875
2	5	10	0,750	0,875	0,875	0,620	1,000	0,750	1,000	0,750
2	6	11	0,625	0,625	0,620	0,500	0,620	0,750	0,620	0,250
2	7	12	1,000	0,750	0,250	0,620	0,620	0,875	1,000	0,875
2	8	13	0,750	1,000	1,000	0,620	0,875	0,630	0,875	0,500
3	4	14	0,875	0,875	1,000	0,750	1,000	0,750	0,820	0,370
3	5	15	0,750	0,875	1,000	0,875	0,620	0,750	0,620	0,750
3	6	16	0,500	0,710	0,875	0,850	0,750	1,000	0,370	0,620
3	7	17	0,750	0,750	0,875	0,750	0,500	0,620	0,620	0,500
3	8	18	0,625	0,750	0,750	1,000	0,370	1,000	0,500	0,875
4	5	19	0,710	0,850	1,000	0,875	1,000	0,875	1,000	0,750
4	6	20	0,750	0,820	1,000	0,875	1,000	1,000	1,000	0,750
4	7	21	0,857	1,000	1,000	1,000	0,850	1,000	0,570	0,850
4	8	22	0,750	1,000	0,875	0,750	1,000	0,750	0,875	0,875
5	6	23	0,625	0,875	0,875	0,620	0,875	0,875	0,850	0,420
5	7	24	0,625	0,500	0,875	0,750	1,000	0,750	1,000	0,750
5	8	25	1,000	0,750	0,370	0,750	1,000	0,750	0,875	0,875
6	7	26	0,250	0,375	0,750	0,500	0,370	0,620	0,500	0,370
6	8	27	0,625	0,500	0,620	0,875	0,250	0,620	0,750	0,620
7	8	28	0,500	0,625	1,000	0,875	0,620	0,620	0,875	0,750

Every mean value was obtained by averaging the individual accuracy values of 6 participants, shown in the white cells of Table 2.1. Every individual accuracy value shown in Table 2.1 (which includes One and Two trials) was

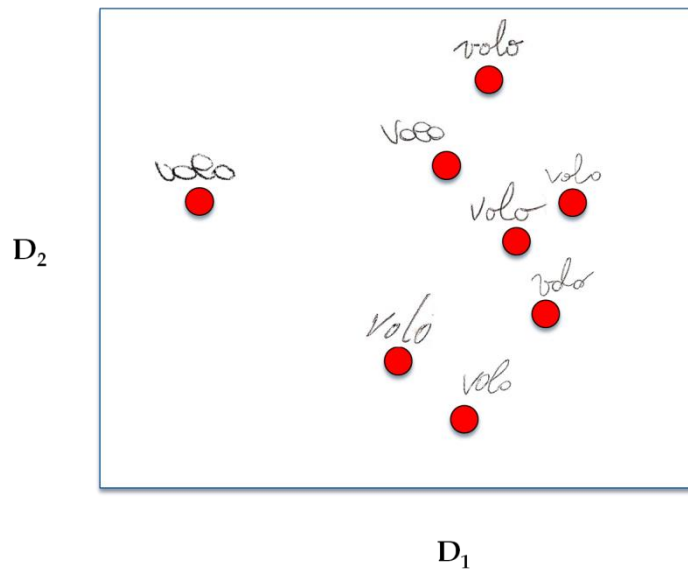
the proportion correct on a maximum of 8 trials. A few trials were randomly lost, due to violations of the time limit or to technical problems.

Table 2.2. includes the mean accuracy value for each of the 28 handwriting pairs, based only on Null trials, irrespective of AB-X vs. X-AB order and session.

**Table 2.2. Mean accuracy values for the 28 handwriting pairs. Every mean is based on Null trials for the 6 participants shown in Table 2.1.**

	1	2	3	4	5	6	7	8
1		0,802	0,666	0,833	0,857	0,765	0,643	0,822
2	0,802		0,772	0,828	0,782	0,539	0,688	0,773
3	0,666	0,772		0,772	0,752	0,633	0,645	0,708
4	0,833	0,828	0,772		0,855	0,887	0,926	0,857
5	0,857	0,782	0,752	0,855		0,693	0,699	0,740
6	0,765	0,539	0,633	0,887	0,693		0,436	0,594
7	0,643	0,688	0,645	0,926	0,699	0,436		0,698
8	0,822	0,773	0,708	0,857	0,740	0,594	0,698	

The arcsin transformed values of proportions in Table 2.2. were the input for a Multidimensional Scaling (MDS) procedure that aimed at obtaining the average distances among the 8 handwritings in 2D space. MDS is a statistical technique often used in information visualization for exploring similarities or dissimilarities in data. processes A matrix of item-item dissimilarities (like the one in Table 2.2) is processed by the MDS algorithm to assign a location in N-dimensional space to all items.



**Figure 2.7** Distribution in a 2D space of the 8 handwriting samples, based on Null trials only.

Figure 2.7 includes all handwriting samples for the 8 individuals and represents their distribution in a two dimensional space which accounts for 61% of the variance of the scaled data (stress value: 0.25).

Finally, I tested if the correlation with MDS distances was larger for empirical dissimilarity values on based on Null trials ( $r= 0.41$ ) than for One and Two trials that included the self ( $r= 0.29$ ). The difference between the two correlations is in the expected direction (since reference to the self should perturb the dissimilarities between different handwritings) but did not reach a significance level ( $z= -0.87$ ; one-tailed,  $p= 0.19$ ).

## 2.4 Discussion

This experiment reveals that one's own handwriting is special and influences discrimination performance in AB-X and X-AB tasks. I found that discrimination performance is better for the self vs. other handwriting (figure

2.3). This is one type of self-reference effect, confirmed by the MDS analysis (figure 2.7).

However, seeing his/her own handwriting does not always constitute an advantage for the participant. In first part of experiment, when the own handwriting is in the first position (it is the first word that they see) and the target is other the accuracy is lower (figure 2.4). A possible explanation could be that own handwriting cause more attraction then other and participant are distracts for the correct match. The results are in line with Chen et al. (2008) who found that the perception of own handwriting is special and related to the self. The results show that the response to own handwriting are different from response to other handwriting. Which implies that implicit self – related processing could be elicited by handwriting stimuli. In this experiment I consider only the aspect of handwriting discrimination between own and other. However, it is possible that these results are only conditioned by high familiarity with own handwriting. In future experiments I will explore differential effects of agency and familiarity.

# Chapter 3

## Experiment 2: Development in Children of Self Reference Effects in Handwriting Recognition

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### 3.1 Introduction

I conducted the experiment with children of 3<sup>rd</sup> and 5<sup>th</sup> grade respectively 8 and 10 years. The aim of this study was to investigate the self reference effect and how the sense of ownership development in children. In addition I suppose that the discrimination between familiarity and own was simpler for 5<sup>th</sup>-grade children than for 3<sup>rd</sup>-grade. I compared own, familiar and other handwriting in order to eliminate the variable of familiarity with own handwriting, that in previous experiment could be objectionable. I used the best friend handwriting as familiar stimuli, every children says to me who was his/her best friend. I thought that best friend handwriting for children is very familiar almost as own. In this experiment the participant had 8 and 10 years respectively 3<sup>rd</sup>-grade and 5<sup>th</sup>-grade. I choose this range of ages because there are a difference in friendships of children and self-other understanding from about six to nine years and children about ten and twelve years. In children six to nine of age follows a pattern that Rawlins (1992) describes as opportunity and activity. The friends usually live close to one another and are of the same sex and similar in age, social status, and social maturity. They spend most of their time together in physical activities (skating, biking, sports), make-believe games related to domestic or work situations, fantasized athletic accomplishments, and "adventures" modeled after

favorite fictional heroes. Thus, at this stage, friendships are on-and-off relationships that are largely self-oriented and opportunistic. Between the ages of roughly nine and twelve years a child can "step outside" of the self and take the perspective of the other, including the perceptions the other has of her or him. This enables them to form friendships that Rawlins (1992) labels reciprocal and equal. At this stage, children usually choose friends whose beliefs agree with their own. In the reciprocity and equality phase, then, children are on the fringes of a conception of friendship as a relatively stable relationship that transcends occasional disagreements and periods of separation.

In this age, there is also a development of handwriting children at 3<sup>rd</sup>-grade and children in 5<sup>th</sup>-grade children. In third grade children are in intermediate stage still in the consolidated alphabet stage (Ehri and McCormick, 2004), but they also move into an awareness of syllables and affixes (i.e., prefixes, suffixes, and other types of inflectional endings) (Bear et al., 2004). These children can read faster silently than they can orally, and they can spell most single-syllable words correctly. Children in the transitional stage could also spell single-syllable words correctly – but only words containing short vowel sounds. So the difference is the level of sophistication found in the syllable. In multisyllable words, children in this stage may still “make errors at syllable juncture and in unaccented syllables” (Bear et al., 2004, p. 29). Then between fourth and fifth children are at the advanced stage, or automatic stage, of word reading have “highly developed automaticity and speed in identifying unfamiliar as well as familiar words” (Ehri and McCormick, 2004, p. 384). A characteristic of proficient readers is that they read accurately and recognize words automatically (Kuhn and Stahl, 2004). The corresponding stage of spelling development is known as the stage of derivational relations, because children understand that they can derive related words from a basic root word by adding prefixes and suffixes (Bear et al., 2004).

Children at this stage benefit from using the literature circles format. (Ehri and McCormick, 2004, p. 384).

## **3.2 Experiment 2a: Implicit recognition**

### **3.2.1 Methods**

#### **3.2.1.1 Participants**

Sixteen children of 8-yr (3<sup>rd</sup>-grade) divided in eight best-friend pairs (5 F, 5 M) and Sixteen children of 10-yr (5<sup>th</sup>-grade) divided eight best-friend pairs (5 F, 5 M). The participants was chose from four different school so that they was strangers. All subjects were physically and mentally healthy, right-handed and had normal or correct to normal vision, and Italian mother tongue, and without learning disability. I chose children from different elementary school.

#### **3.2.1.2 Stimuli**

I chose 30 true Italian words balanced for length and frequency. Words were: *cara, neve, pane, sole, volo, latte, parco, sasso, sogno, volto, chiave, classe, esatto, salato, argento, cartone, portata, ricordo, salmone, cane, mela, rosa, gatto, sedia, tappo, attimo, colore, tavola, albergo, confine, ragazza*. Each participant in class wrote the words copying them from bold printed originals shown on an A4 sheet, using their own cursive handwriting. Each stimulus was insert in a power point presentation, every stimulus was enlarged in the same way; this is the only transformation operated. I did this to make clearer the word on computer screen.

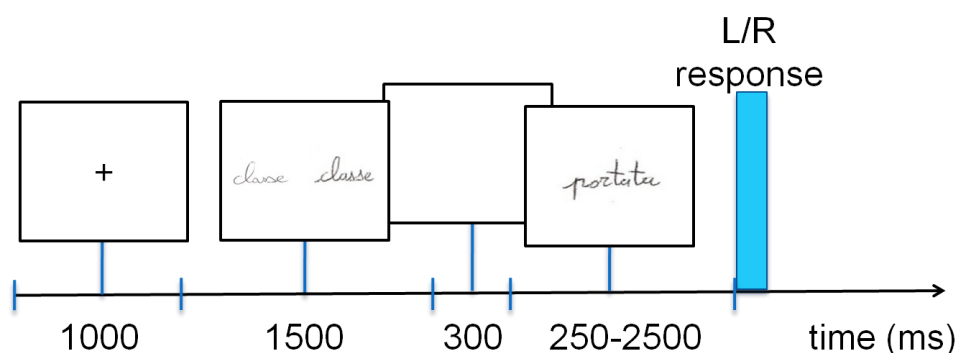
#### **3.2.1.3 Experimental Design: Implicit Task successive matching**

In this experiment I used a mixed subject design. Each participant judged a total of 528 experimental trials, after a training of 15 trials. The experimental phase was made after one month of the writing phase, in individual session. In the implicit AB-X task each participant was shown: the same comparison

word (A-B) written by two participants with different A B handwritings; after a short interval a target word (X) different from A B, with the same handwriting as either A or B. The participant should press either the left or right button, the left button if target matched with A, right button if target matched with B in comparison pair. The temporal sequence for AB-X task (fig. 2.1a) was fixed point (1000 ms), AB (1500 ms), white slide (300 ms) and X (time to response) (figure 3.2). In all sessions the presentation of familiar handwriting in AB was balanced for the position. The task presentation was made with SuperLab program used to record reaction time and response.

For each condition participants judged (table 3.1):

- 30 trials where the comparison pair was self-other and target was self
- 30 trials where the comparison pair was self-other and target was other
- 30 trials where the comparison pair was friend-other and target was friend
- 30 trials where the comparison pair was friend-other and target was other
- 408 trials where the comparison pair was other-other and target was other



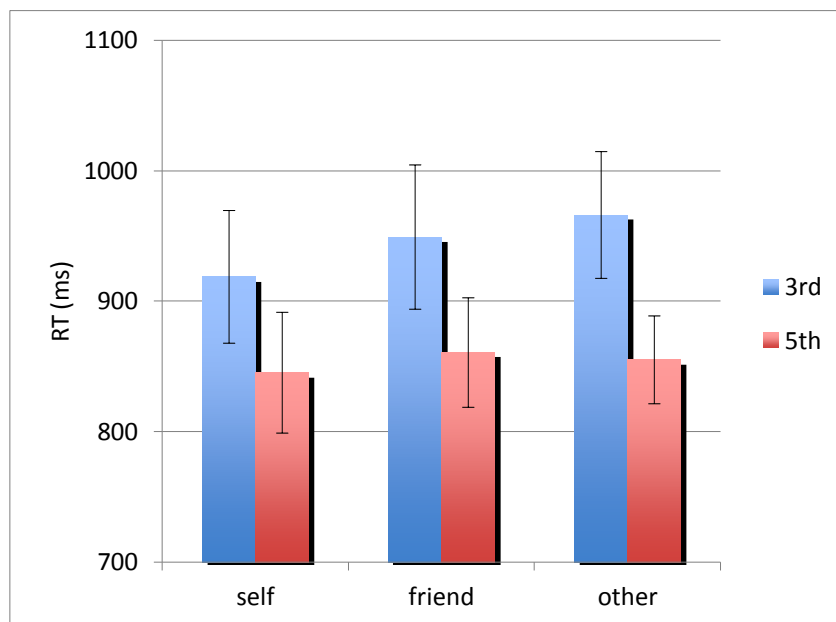
**Figure 3.1** Example of task sequence (AB-X)

**Table 3.1** Number of trials in each condition

Trials (N)		AB		
		self-other	friend-other	other-other
X	self	30		
	friend		30	
	other	30	30	408

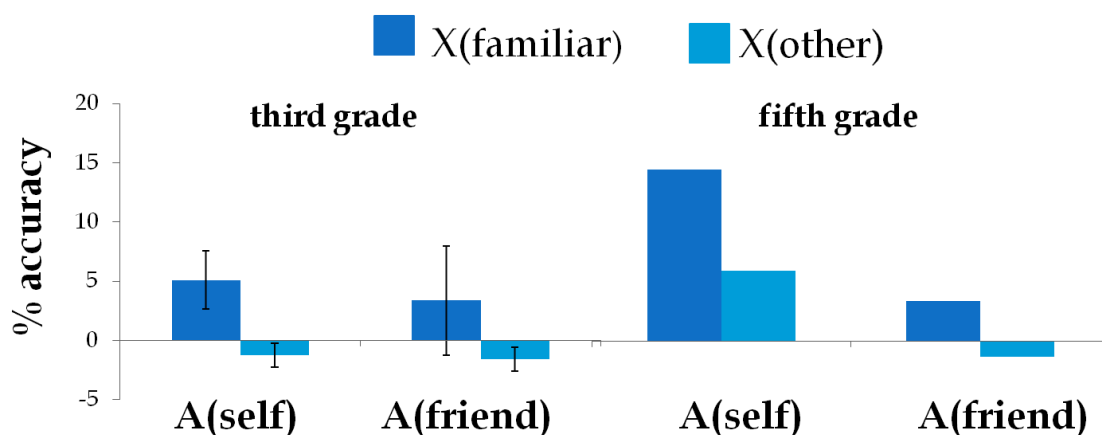
### 3.2.2 Results

Before to consider the analysis it is important to clear that one couple in 3<sup>rd</sup> grade and one in 5<sup>th</sup> grade was eliminated because was outlier both in reaction time and in correct response with Z-score = -3.5.



**Figure 3.2** Mean of reaction time for Class group (3<sup>rd</sup> , 5<sup>th</sup> ) in Trials (Self, Friend, Other)

*Reaction time:* in the analysis conducted on the reaction time I considered  $1/RT_{\text{sec}}$  only for correct response. I computed the mean of reaction time for participants in five level (*self-other/self*) vs. (*self-other/other*) vs. (*friend-other/other*) vs. (*friend-other/other*) vs. (*friend-other/other*) vs. (*other-other/other*) and the two groups third and fifth. Then I made the mean between (*self-other/self*) and (*self-other/other*), (*friend-other/other*) and (*friend-other/other*). The means in all group was very similar in third grade was self= 918.60, friend=949.08 and other 966.02; in fifth grade was self= 845.21, friend=860.56 and other 854.95. In the end analysis was made with ANOVA mixed design with two factors Class (2 *third grade* vs. *fifth grade*) X Trial (3 *self*, *friend* and *other*) that indicated the tendency in 5<sup>th</sup>-grade was faster than 3<sup>rd</sup>-grade ( $F_{1,26} = 1.90$   $p < 0.17$ ). But there isn't effect in handwriting condition ( $F_{1,26} = 2.06$   $p < 0.13$ ).



**Figure 3.3** Distributions of mean of %gain in condition for Target (Familiar, Other) in condition AB type: A(self) where AB is (self other), A(friend) where AB is (friend other). Divided for Class (3<sup>rd</sup>, 5<sup>th</sup>).

*Accuracy:* I counted the correct response of each condition: (*self-other/self*), (*self-other/other*), (*friend-other/other*), (*friend-other/other*), (*other-other/other*). After I did the proportion of correct response and I calculated the percentage of gain. In order to calculate the gain I used trials where AB was the combination of self-other, friend-other that I called familiar-other, and the baseline was the accuracy (proportion of correct response) in [(other-other)-

other]. In this way the gain was the percentage increment in [(familiar-other)-X] trials, relative to the baseline.

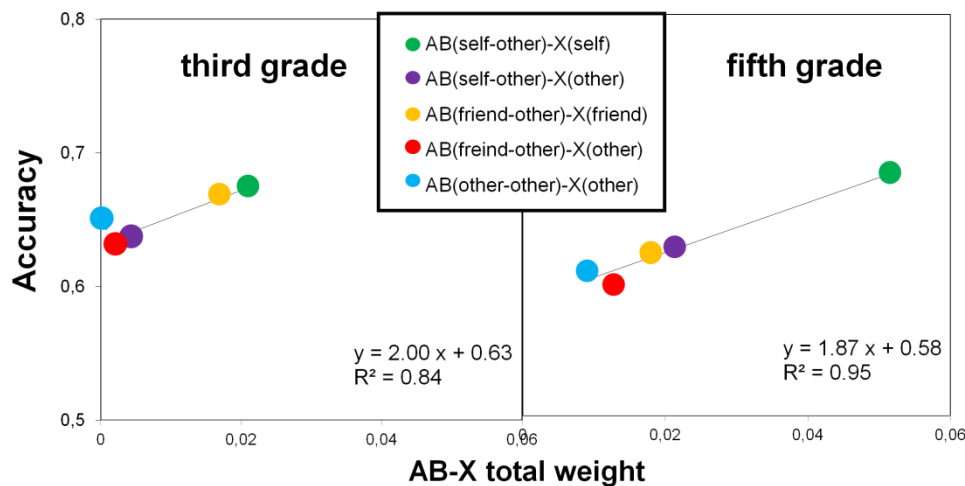
Data in figure 3.3 illustrated the distribution of the percentage of gain in each condition. The mean of %gain in third grade in condition is similar: target familiar and self handwriting (5.09) and target familiar and friend handwriting (3.37), the same trend analysis is showed in: target other and self handwriting (-1.25) and target other and friend handwriting (-1.57). The trend analysis is different in fifth grade that show an higher accuracy for target familiar and self handwriting (15.19) than target familiar and friend handwriting (3.68), the same trend analysis is showed in target other and self handwriting (6.29) and target other and friend handwriting (-1.34).

ANOVA mixed design with three factor: Group (third vs. fifth), A (self vs. friend) and Target X (familiar vs. other) confirmed that in both class self is better than friend with familiar handwriting in "A" ( $F_{1,26}=5.68$   $p<0.05$ ), the main effect Target is also relevant because both class are more accurate in familiar target then other ( $F_{1,26}=6.54$   $p<0.05$ ). The Class main effect isn't significant but show a trend where 5<sup>th</sup>-grade is more accurate then 3<sup>rd</sup>-grade ( $F_{1,26}=3.55$   $p<0.07$ ). The interaction Class x A ( $F_{1,26}=6.54$ ,  $p<0.06$ ) indicated no difference between self and friend in 3<sup>rd</sup>-grade children but the different come out in 5<sup>th</sup>-grade children pointing out a self superiority. There isn't interaction in Class x Target ( $F_{1,26}=0.06$   $p<0.79$ ), in familiar Writing x Target ( $F_{1,26}=0.41$   $p<0.5$ ) and Class x Target x Familiar writing ( $F_{1,26}=0.09$   $p<0.76$ ). The hypothesis that in fifth grade there is difference between self and friend but this difference there isn't in third grade is also confirmed by the comparison between *self-other/familiar* and *friend-other/familiar* there is no difference in third grade ( $T_{13}=0.44$   $p<0.44$ ) instead of in fifth grade where children discriminate better own handwriting then friend ( $T_{13}=2.30$ ,  $P<0.05$ ). Fifth grade children showed better competence in comparison *self-*

*other/familiar* then in 3<sup>rd</sup>-grade ( $T_{26}=2.3$   $p<0.05$ ), better than *friend-other/friend* in 3<sup>rd</sup>-grade ( $T_{26}=2.01$   $p<0.05$ ) and also better than *self-other/other* in 5<sup>th</sup>-grade.

**Table 3.2 Value of weights in each condition in 3<sup>rd</sup> grade and 5<sup>th</sup> grade**

3 <sup>rd</sup> grade		AB			5 <sup>th</sup> grade		AB		
		self-other 0,48*0,09= 0,043	friend-other 0,43*0,09= 0.038	other-other 0,09*0,09=0,0081			self-other 0.5*0.21= 0.1	friend-other 0.29*0.21= 0.05	other-other 0.21*0.21=0.04
X	self <b>0.48</b>	0,043*0,48= 0,02			X	self <b>0.5</b>	0.1*0.5= 0.05		
	friend <b>0.43</b>		0,038*0,43= 0,01			friend <b>0.29</b>		0.5*0.29= 0,017	
	other <b>0.09</b>	0,043*0,09= 0,003	0,038*0,09= 0,003	0,0081*0,09= 0,0007		other <b>0.21</b>	0.1*0.21= 0.2	0.5*0.21= 0.012	0.04*0.21= 0.008



**Figure 3.4 Fit of AB-X total weight for 3<sup>rd</sup>-grade children is  $y = 2.00x + 0.63$   $R^2 = 0.84$ , for 5<sup>th</sup>-grade children is  $y = 1.87x + 0.58$   $R^2 = 0.95$**

*Model:* At last I computed analysis creating a model based on the accuracy. The average obtained values of accuracy (percentage of gain) were fitted to predictions of the following multiplicative model: Accuracy AB-X =  $f(w_A \times w_B \times w_X)$ . Then I calculated the relative weights for self, friend and other were searched to optimize the fit for each age group (table 3.2). As the figure

3.4 shows the model for 3<sup>rd</sup>-grade children is  $y = 2.00x + 0.63$  and explain a variance of  $R^2 = 0.84$ , for 5<sup>th</sup>-grade children is  $y = 1.87x + 0.58$  and explain a variance of  $R^2 = 0.95$ . In the in 3<sup>rd</sup>-grade children there isn't difference between AB(friend other)-X (friend) and AB (self other) - X (self) with respectively weighs 0.01 and 0.02, instead in 5<sup>th</sup>-grade children only AB (self other) - X (self) is different from everything else with a weighs of 0.05.

### **3.2.3 Discussion**

Results showed the trend in reaction time where fifth grade children was faster than third grade and not particular difference between condition. Instead both ANOVA and the multiplicative model indicate two effects. One is that in 3<sup>rd</sup>-grade children is present only a familiarity effect but no SRE (self reference effect) but in 5<sup>th</sup> grade children are present both SRE and familiarity effects.

## **3.3 Experiment 2b : identification**

### **3.3.1 Methods**

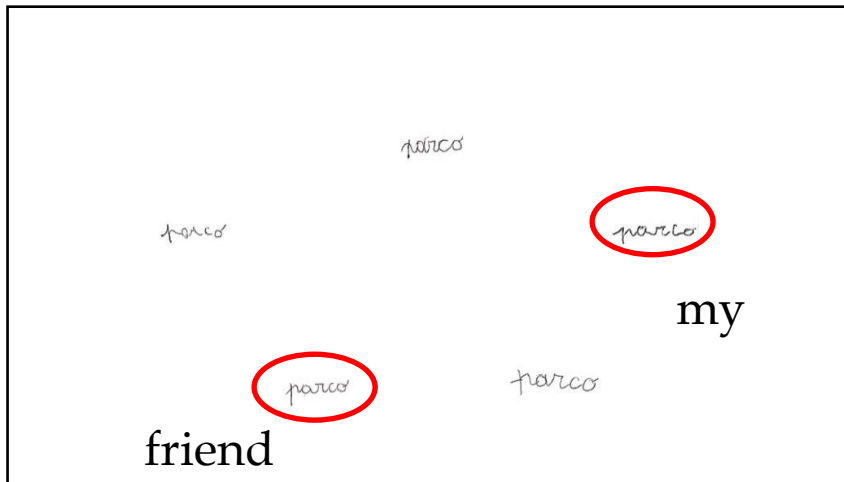
#### **3.3.1.1 Participants**

Sixteen children of 8-yr 3<sup>rd</sup>-grade divided in eight best-friend pairs (5 F, 5 M) and sixteen children of 10-yr 5<sup>th</sup>-grade divided eight best-friend pairs (5 F, 5 M). All subjects were physically and mentally healthy, right-handed and had normal or correct to normal vision, and Italian mother tongue, and without learning disability. I chose children from different elementary school.

#### **3.3.1.2 Stimuli and Task**

I chose thirty true Italian words balanced for length and frequency. Each participant wrote the words copying them from bold printed originals shown on an A4 sheet, using their own cursive handwriting. The word was scanned. I choose five different handwriting of the same word and arranged on an A4 sheet in order to create a pentagon (figure 3.5). For each

presentation there was handwriting for one children, his/her best friend and other.



**Figure 3.5** Example of task stimuli

## **Experimental Design**

### **3.3.1.3 Explicit Task: identification and recognition**

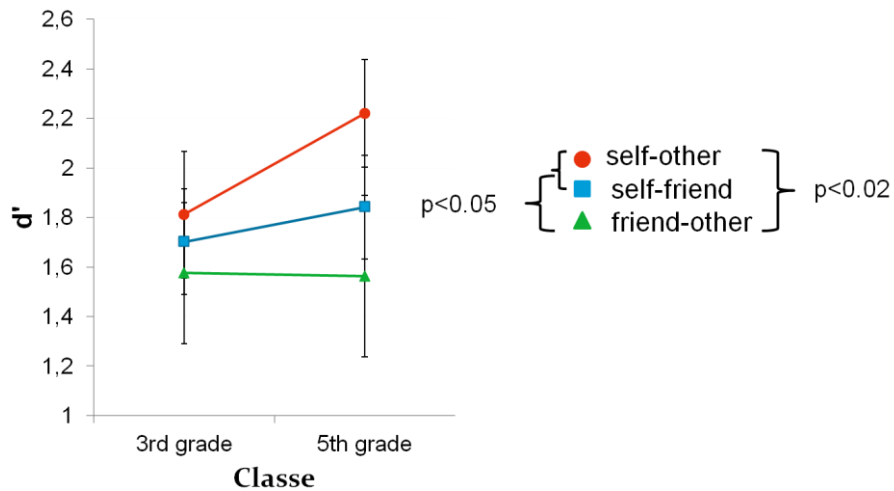
The task was double: children had to identify own handwriting and best friend handwriting between 5 handwriting. Each children judged six different trials.

### **3.3.2 Results**

In this experiment I explored if children were able to indentify own handwriting and best friend handwriting, so I investigated the ability of identification and discrimination. I computed the analysis considering "signal detection theory" (SDT). SDT assumes that the decision maker is not a passive receiver of information, but an active decision-maker who makes difficult perceptual judgments under conditions of uncertainty. SDT attributes responses to a combination of sensitivity and bias. Sensitivity is what we are interested in and refers to how hard or easy it is to detect that a

target stimulus is present from background events. For example, in a recognition memory paradigm, having longer to study to-be-remembered words makes it easier to recognize previously seen or heard words. In contrast, having to remember 30 words rather than 5 make the discrimination harder. One of the most commonly used statistics for computing sensitivity is the so-called sensitivity index, or  $d'$ . While bias is what we have to take into account to recover sensitivity so the extent to which one response is more probable than another. That is, a receiver may be more likely to respond that a stimulus is present or more likely to respond that a stimulus is not present. Bias is independent of sensitivity. For example, if there is a penalty for either false alarms or misses, this may influence bias. If the stimulus is a bomber, then a miss (failing to detect the plane) may increase deaths, so a liberal bias is likely. In contrast, crying wolf (a false alarm) too often may make people less likely to respond, grounds for a conservative bias (Wikipedia, Pat Keating).

I computed the proportion of correct response both in self and friend in each group. Then I calculated "hit" and "false alarm" both self and friend, in the end I obtained  $d'$  for self-other, friend-other and self-friend.



**Figure 3.5 Discrimination Accuracy ( $d'$ ) in AB pairs (Self Other, Self Friend, Friend Other) for Class group (3<sup>rd</sup>, 5<sup>th</sup>).**

The figure 3.5 shows that in both class there is a superiority of self (with a mean in 3<sup>rd</sup> grade of 1.67 and in 5<sup>th</sup> grade of 2.07) respect other (with a mean in 3<sup>rd</sup> grade of 1.47 and in 5<sup>th</sup> grade of 1.56), and also that the performance in fifth grade (mean 1.8) is better than third grade (mean 1.56).

The comparison pair showed in line with previous experiment 3<sup>rd</sup>-grade children no difference between AB(self-other) and AB (self friend) ( $T_{13}=0.14$   $p<0.89$ ). On the other hand 5<sup>th</sup>-grade children showed a significant difference between AB (self other) and AB (self friend) with ( $T_{13}=2.73$   $p<0.02$ ), and also between AB (self other) and AB (friend other) ( $T_{13}=1.97$   $p<0.07$ ). The ANOVA mixed design with two factors: Group (third vs. fifth) and AB pairs (self-other vs. friend-other vs. self-friend) confirm that the AB “friend other” is the most difficult comparison instead the simpler is comparison “self other” ( $F_{2,26}= 2.64$   $p<0.08$ ).

The main effect in Class showed no difference between third and fifth grade in this task ( $F_{1,26}= 0.047$   $p<0.83$ ) although children in fifth class were more able to discriminate than third. Also the interaction Group x AB was not significant ( $F_{2,26}= 0.89$   $p<0.45$ ).

### **3.3.3 Discussion**

These results show that if I consider contrast self-friend as a the self effect that is stronger than the contrast friend-other and friend self that I called familiarity effect. And also results are in line with the previous experiment the self effect is better in fifth grade than third grade.

### **3.4 Conclusion**

Results of both experiments indicated that in 3<sup>rd</sup> grade is present only the familiar effect, children at this age were able to discriminate between self/friend and other but not between self and friend. This ability grows up in 5<sup>th</sup> grade children where I found familiar effect and self reference effect. However, performance is better with own handwriting than friend in both group (figure 3.3 and 3.5). The difference in friendship between children of 8 age and 10 age is also explain by Rawlins (1992). He described that friend at 8 age usually live close to one another and are of the same sex and similar in age, social status, and social maturity. And only after nine or ten years a child can "step outside" of the self and take the perspective of the other, including the perceptions the other has of her or him and the friendships become reciprocal and equal. Also the handwriting change in this year like McCorminck said. It is also important to observe the trend in both experiments and in both analysis (accuracy and reaction time), I found that fifth grade children showed a better performance that third grade in line with normal cognitive development of child. These results supported the previous experiment because I found a clear distinction between familiar effect and self reference effect, confirming that handwriting contain information about self and not only about familiarity.

# Chapter 4

## Behavioral and fMRI evidence for a Self-Reference Effect on the Recognition of Dynamic Handwriting Traces

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### 4.1 Introduction

The third experiment, conducted in collaboration with Professor Erik Chang of the Institute of Cognitive Neuroscience of the National Central University, Taiwan, was focused on the recognition and identification of handwriting dynamic traces.

Only few studies investigated whether individuals are able to identify past actions. Persons browsing in an old diary, or looking at an old drawing one usually recognized the handwriting as her/his own. However, in other situations it is less obvious whether one perceives the products of one's own past actions. Biological motion refers to the unique visual phenomenon of a moving, animate object. Often, the stimuli used in biological motion experiments are just a few moving dots that reflect the motion of some key joints of the moving organism. Gunnar Johansson invented point light displays, visualizing the positions of the main joints of a walking human body by dots against dark background (Johansson 1973) yields information from biological motion with reduced interference from non-kinematic cues.

Behavioral experiments in support of common-coding theory show that, participants drew familiar and unfamiliar characters on a tablet in the

absence of visual feedback (Knoblich & Prinz, 2001). In recognition task, participants had to identify own draw between two kinematic displays reproducing drawings. Authors concluded that motor processes influenced perception because participants accurately recognized their own previously unseen drawings. Different results was obtained with familiar and unfamiliar characters, suggesting that previous experience producing particular characters may not play a significant role in character recognition. Jokisch et al (2006) found an advantage of frontal view in comparison to profile in face perception. For recognition of other familiar persons, the reverse pattern emerged: person identification does not vary with angle in faces, whereas there is a clear frontal-view advantage for biological-motion perception. For recognition of familiar persons, the viewing angle plays an important role. Identity information can be extracted more reliably from frontal and half-profile view. Finally, recognition of one's own movements is independent of the viewing angle. They hypothesise that it is a consequence of a common coding of visual and motor representations according to the common-coding theory (Prinz 1997) and the direct-matching hypothesis (Rizzolatti et al 2001).

In this study I tried to explain if the action is self related knowledge and contributes to recognize one's own past action or their products. I used the handwriting domain because the product of handwriting is a simple trajectory with two spatial dimensions and one temporal dimension. Nevertheless, drawing is a complex skill and action planning ought to play an important role in drawing productions (Van Sommers, 1984). I used also normal view of handwriting and backward in order to consider viewpoint-dependent recognition for own and other handwriting, I can't change the view point but only present the trace in backward like face in different angle.

## **4.2 Experiment 3a: Lexical Decision Task**

### **4.2.1 Methods**

#### **4.2.1.1 Participants**

Thirteen native Taiwanese graduate students participated in the study (6 male, 7 female). With their ages ranging from 23 to 24. All subjects were physically and mentally healthy, right-handed and had normal or correct to normal vision, and Chinese mother tongue.

#### **4.2.1.2 Stimuli and Task**

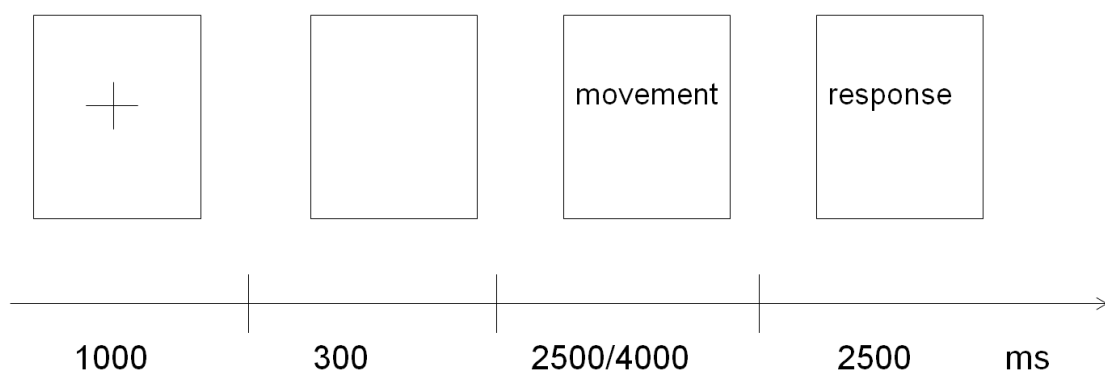
I chose sixteen true Chinese characters and sixteen Chinese non characters (combination of legal and illegal Chinese radicals). Each subject was given a list of characters to be copied, and they wrote these characters and non-characters on a digital tablet (Wacom Intuos4, A4 format). The 2D coordinates were of the writing traces were saved for each character for further processing to create animated writing stimuli for the experiment. In the actual experiment, only the dynamic traces of writing were displayed on a computer screen. The trajectories were presented in both forward and backward directions in different trials.

In the first session after one week from the writing each subject performed a lexical decision task on own and others dynamic writing traces. Then after another week in fMRI session each subject made an authorship judgment while being scanned.

### **4.2.2 Experimental Design: Lexical Decision Task**

I used a within subject design. Each participant judged a total of 192 stimuli that were a combination of eight different types. Indeed in task I inserted three independent variables: authorship (own/other), meaning (word /nonword), direction (forward /backward). The factor of authorship referred at the ability of discriminate if the action was produced by own self or other. To investigate the self recognition in past action, I decided to use an implicit task in these case the lexical decision task, so I introduced the factor

of meaning with word and nonword. The participants had to distinguish word from nonword. To control the distortion effect like velocity (Knoblich & Prinz, 2001) I introduced the direction factor all stimuli were presented in correct direction in half of the trials, and in backward direction in the other half of trials. The participants saw the following sequence: blank screen, fixation point, writing trace, blank screen (as is show in figure 2.1). They answer pressing the right or left button in the end or during the presentation. The trace interval is in the range of 6-12 seconds.



**Figure 4.1** Temporal sequence of task

## 4.2.3 Results

### 4.2.3.1 Signal Detection Theory

Data obtained in lexical decision task (LDT) was analyzed according to the Signal Detection Theory. The sensitivity index  $d'$  is reported in figure 4.1. This indicated that for participants it was easier to judge word/nonword when they viewed their own handwriting in correct direction (mean: own 1.12, other 0.65) than in backward direction (mean: own 0.27, other -0.02). Only the average  $d'$  in the other-backward condition is not significantly different from zero.

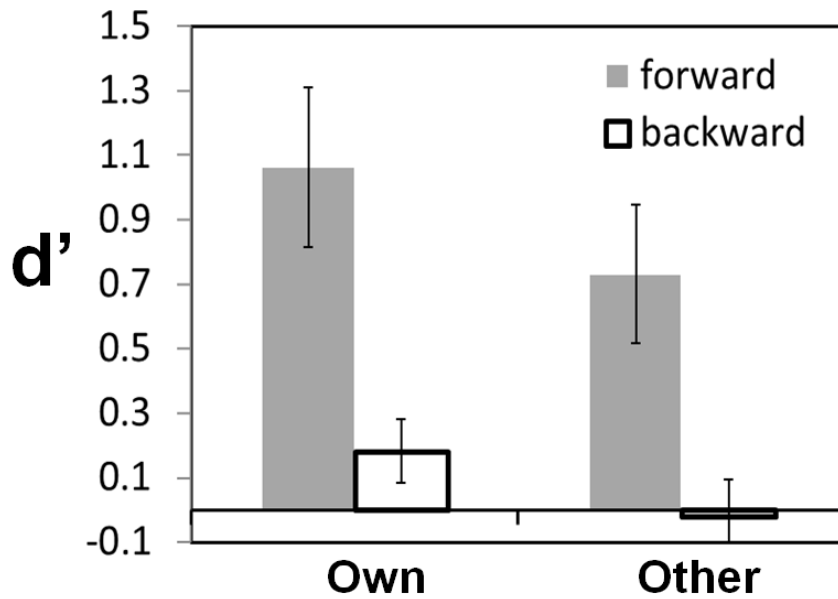


Figure 4.2 LDT Discrimination ( $D'$ ) in Direction (forward, backward) for Handwriting (Own, Other)

The ANOVA of Direction (2)  $\times$  Handwriting (2) within-subjects design (figure 4.2) calculated with a  $d'$  confirm the main effect of authorship ( $F_{1,12} = 5.78 p < 0.05$ ): performance is better with own than other handwriting. Also a main effect of Direction is significant: it is easier for participant to judge forward traces than backward ones ( $F_{1,12} = 17.1 p < 0.001$ ). But the interaction Authorship  $\times$  Direction is not significant ( $F_{1,12} = 0.25, p < 0.62$ ). Considering only the comparison in pairwise between own-forward vs. own-backward ( $t_{12}=3.27 p < 0.05$ ), other-forward vs. other-backward ( $t_{12}=3.84 p < 0.05$ ), performance is better in forward than in backward and own-backward vs other-forward ( $t_{12}=1.37 p < 0.04$ ). Indicated that it is easier to make a LDT in forward presentation than in backward presentation. The comparisons between own-forward vs other-forward ( $t_{12}=1.74 p < 0.107$ ) and own-backward vs other-backward ( $t_{12}=1.37 p < 0.19$ ) showed that is easier when the stimuli were own handwriting than other. In authorship there was an

advantage for own handwriting than other and in direction the advantage is for forward traces than backward traces.

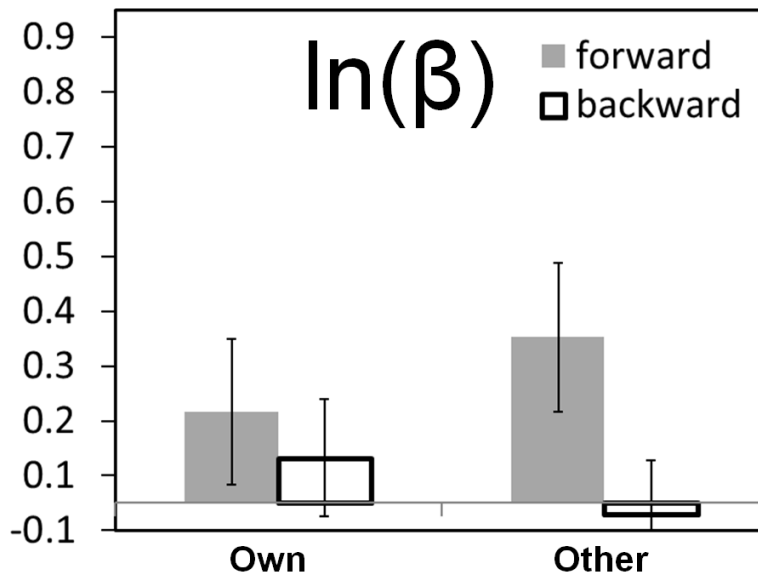


Figure 4.3 LDT Bias in Direction (forward, backward) for Handwriting (Own, Other)

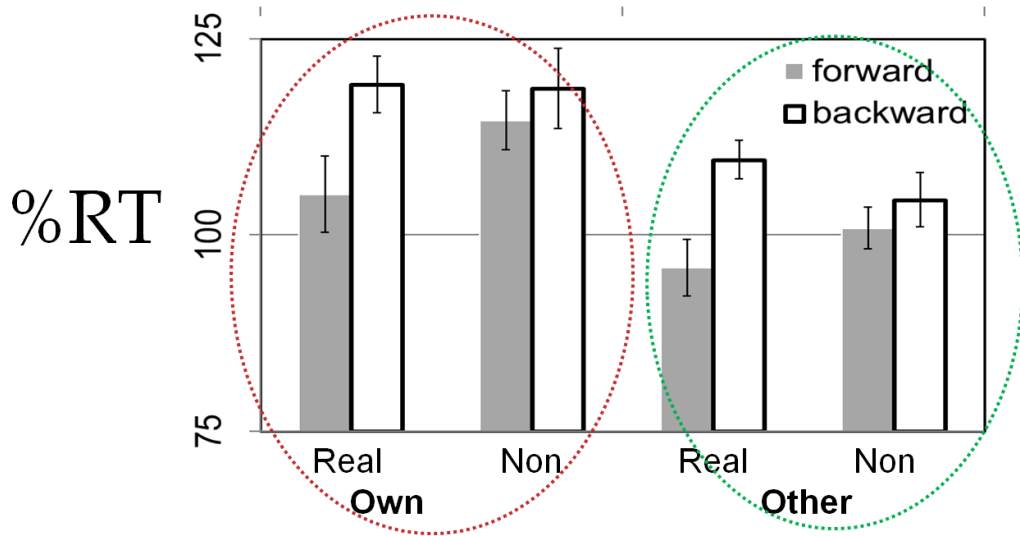
Further analysis considering the bias to response word in LDT (with  $\ln \beta$ ) is showed in figure 4.3. The figure showed that the bias in condition indicated that participants are unbiased with backward traces (mean own= 0.08 other= -0.02) and they are moderately conservative with forward traces (mean own= 0.16 other= 0.30), in forward traces participants tend to response more nonword than word. This is confirmed by the comparison pairwise between other-forward vs. other-backward ( $t_{12}=2.25$   $p<0.05$ ).

The ANOVA of Direction (2) x Handwriting (2) within-subjects design with  $\ln \beta$  in figure 4.3 show that there is not a response bias, neither Handwriting ( $F_{(1,7)} = 0.163$   $p<0.69$ ) nor Direction  $F_{(1,7)} = 0.270$   $p<0.61$  was significant.

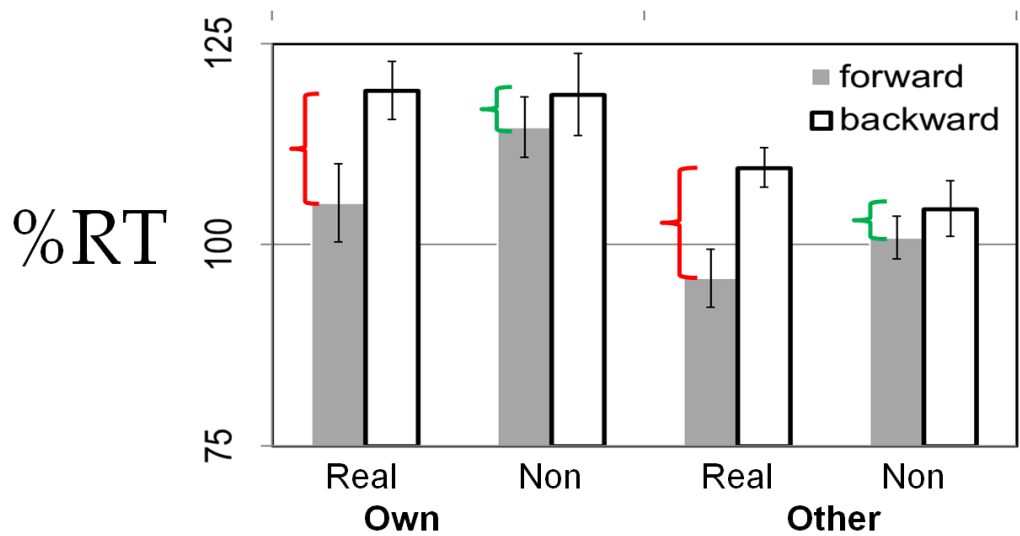
#### 4.2.3.2 Reaction Time

*Reaction time* (RT): the analysis on RT of correct response is showed in figure 4.3, in this analysis the dependent measure is not simple RT but the percentage of the traces duration that participant used to produce the response (%RT). The data indicated that in the %RT was faster for other (other-forward-word 95.85, other-forward-nonword 100.86, and for other-backward-word 109.62, other-backward-nonword 104.49) than own handwriting (own-forward-word 105.19, own-forward-nonword 114.63, own-backward-word 119.2, own-backward-nonword 118.67). And also faster for forward (mean 104.13) than backward (mean 113.17).

The main effect resulted from ANOVA (within subject Handwriting (2) x Direction (2) x Word (2)) in handwriting and direction is significant. The self attraction is underlined in the main effect of authorship (figure 4.3) because participants spent more time on characters written by themselves than by others ( $F_{1,12} = 14.3$   $p < 0.005$ ). In the direction effect the participants spent less time when characters were traced in the forward direction than in the backward direction ( $F_{1,12} = 11.7$   $p < 0.01$ ). With respect to the meaning factor, there isn't a significant difference between word and nonword ( $F_{1,12} = 1.45$   $p < 0.25$ ). The trend in interaction between handwriting and direction is faster response in other than self but is not significant ( $F(1,12) = 0.036$   $p < 0.8$ ). In interaction between handwriting and meaning participant are faster in other than own but is not significant ( $F_{1,12} = 3.05$   $p < 0.10$ ). In the end the interaction between direction and meaning (figure 4.4) the time cost of backward vs. forward tracing was larger for true than false characters ( $F_{1,12} = 17.2$   $p < 0.005$ ).



**Figure 4.3** %RT distribution for Direction (forward, backward) in Word (real, non real) divided in Handwriting (Own, Other). Evidence faster %RT for Other than Own handwriting ( $F_{1,12} = 14.3$   $p < 0.005$ ).



**Figure 4.4** %RT distribution for Direction (forward, backward) in Word (real, non real) divided in Handwriting (Own, Other). Evidence faster %RT for Forward than Backward direction ( $F_{1,12} = 11.7$   $p < 0.01$ ).

### 4.3 Experiment 3b: fMRI and identification task

Experiment 3b was made after one month from experiment 3a with same participants and stimuli.

As the previous experiment I used a within subject design. Each participant judged a total of 112 stimuli that were a combination of five different types. Indeed in task I inserted three independent variables: authorship (own/other), meaning (word /nonword), as the control baseline I chose backward words. The participants saw the following sequence: blank screen, fixation point, writing trace, blank screen. The task was to judge if the trace was own handwriting or written by someone else (the “other” condition). Participants answered by pressing the right or left button during the period between the start and the end of the handwriting trace animation. The trace interval is in the range of 6-12seconds.

*fMRI parameters:* I used the 3T Siemens MAGNETOM Trio Tim System at National Yang-Ming University, Taipei. A T1 structural scan was acquired for every participant at the beginning of the experiment. EPI parameters: TR=2000 ms, TE=30 ms, FOV=220 mm (64 x 64 in-plane matrix), 4.0 mm thickness, flip angle=90 deg.

### **4.3.2 Results**

**fMRI data analysis:** Neuroimaging data were preprocessed and analyzed with preprocessing, 1<sup>st</sup> GLM analysis (duration modulated HRF), and 2<sup>nd</sup> level mixed-effect group analysis on beta weights. Analysis was then performed on regression ANOVA: Authorship (2 self / other) x Lexicality (2 word / no word) were carried out in AFNI.

The result of Anova indicated that viewing writing traces elicited bilateral medial frontal, parietal, insula, ventral parietal activations and right superior frontal gyrus and temporal gyrus (figure 4.5), these areas were implicated in handwriting elaboration.

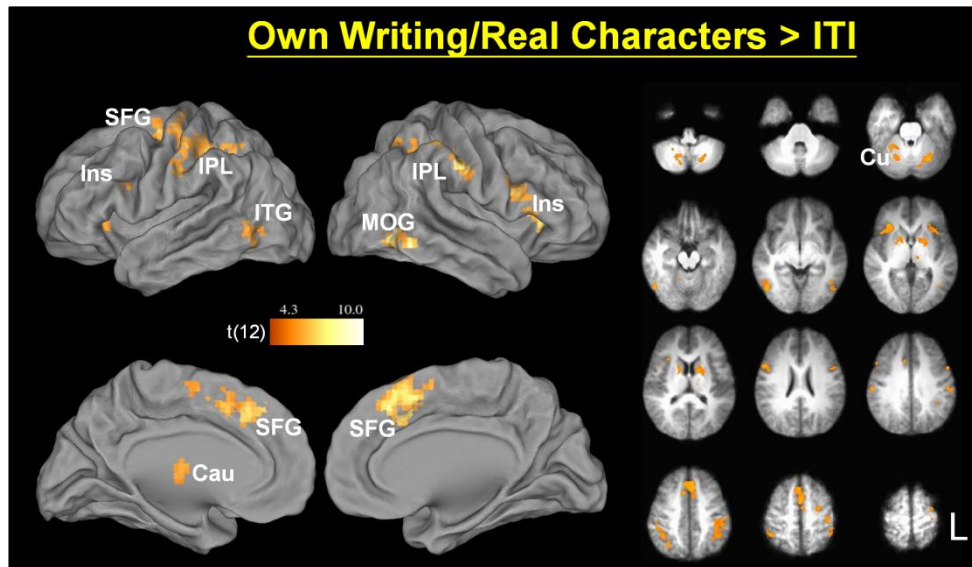
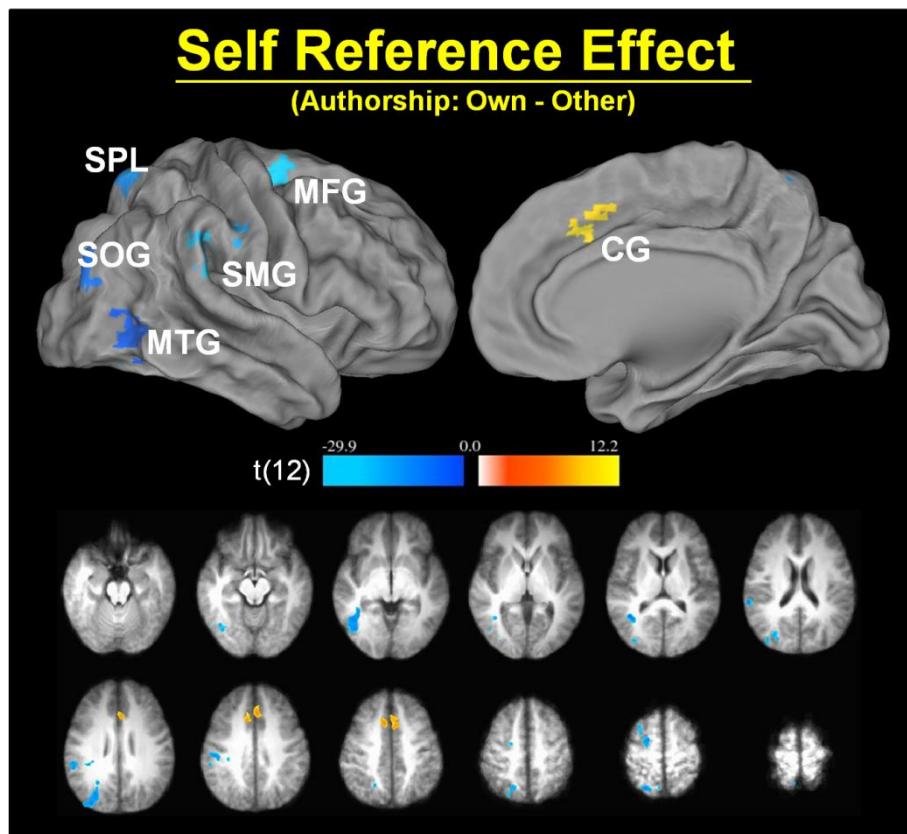


Figure 4.5 Voxels activated during observation of Own Writing/ Real Characters.

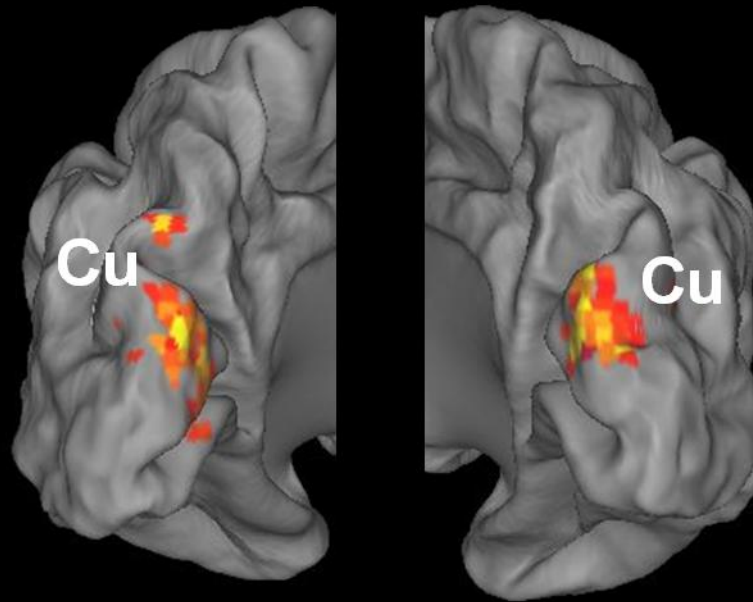
Table 4.1 Information of significant clusters (alpha levels: \*\*\* .001, \*\* .01, \* .05, and † .10. )

Region	Talairach Coordinates			Volume (mm <sup>3</sup> )	alpha
	x	y	z		
Authorship: $t(12) = 3.056, p < .01$ , cluster threshold 1350 mm <sup>3</sup>					
Right middle temporal gyrus (MTG)	42	-57	-1	3888	***
Right superior occipital gyrus (SOG)	31	-74	25	3159	**
Cingulate gyrus (CG)	1	21	40	2457	**
Right superior parietal lobule (SPL)	16	-64	58	1890	**
Right supramarginal gyrus (SMG)	40	-28	34	1512	**
Right inferior parietal lobule (IPL)	55	-35	28	1485	**
Right middle frontal gyrus (MFG)	21	-4	62	1404	*
Lexicality: $t(12) = 3.056, p < .01$ , cluster threshold 1350 mm <sup>3</sup>					
Left Insula/Basal Ganglia (Ins/BG)	-26	15	10	5319	†
Authorship × Lexicality: $F(1,12) = 9.319, p < .01$ , cluster threshold 1350 mm <sup>3</sup>					
Bilateral cuneus (Cu)	-1	-84	19	7749	***



**Figure 4.6** Voxels activated during observation of SRE (Authorship: Own-Other). Results of Authorship were summed in Table 1 and figure 4.6: others' writing induced higher activation than one's own in the right visuospatial as well as motor network. Unfamiliar writing animation may require more resources in the right to carry out spatiotemporal analysis.

# SRE × Lexicality



F(1,12) 9.3 26.7

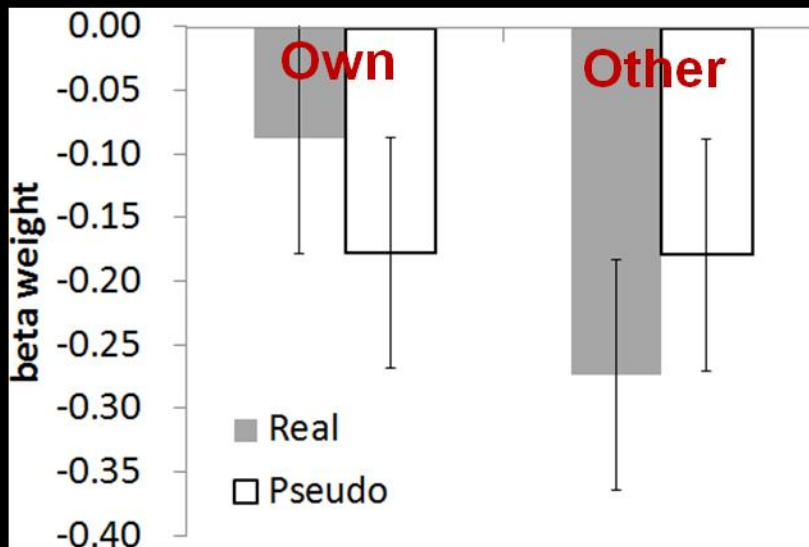


Figure 4.8 Voxels activated during observation of SRE X Lexicality

Figure 4.8 showed Interaction SRE X Word: non-character did not elicit different level of (de)activation in bilateral cuneus, where as real characters elicit more deactivation in others' than in own writing.

#### **4.4 Discussion**

In the lexical decision task results showed an implicit manifestation of SRE. According to Knoblich and Flach (2003) people not only recognize their “action style” but they can also generate more accurate predictions of future actions outcomes when observing their own past actions. Experiment confirms that handwriting stimuli is related to self and contains also information about agency. The result show that handwriting traces could reveals information about authorship. The sensitivity measure ( $d'$ ) reveals a significant effect of “authorship” (figure 4.1), and also an higher sensitivity for forward than backward traces also validates the procedure.

The result showed in (figure 4.5) indicated that viewing writing traces elicited bilateral medial frontal, parietal, insula, ventral parietal activations and right superior frontal gyrus and temporal gyrus. These activations were in line with literature, considering the activation in insula, it is impaired in patient with agraphia following a unique infarction, restricted to the left anterior insula and the adjacent part of the intrasylvian frontal opercular cortex. This patient had a severe apraxia of speech completely receded after one year and highly selective disturbance of the spelling system (phonological agraphia). The data not only seem to enrich current insights in the anatomical locus for phonological agraphia, they also seem to contribute to a further delineation of the insular role in phonologically mediated aphasic manifestations (Marien P 2001). Lin et al. (2007), in a study of Chinese writing, described that activations in temporal gyrus and parietal lobule were implicated in central processes for writing Chinese characters. Otherwise is important underline that neuroimaging evidence has shown

that Chinese character processing recruits differential activation from alphabetic languages due to its unique linguistic features. Activations in the left parietal lobule and the right superior temporal gyrus were specialized for phonological processing, while the left middle temporal gyrus was involved in semantic processing. Functional dissociation was identified in the left inferior frontal gyrus, with the posterior dorsal part for phonological processing and the anterior ventral part for semantic processing. Moreover, bilateral involvement of the ventral occipito-temporal regions was found for both phonological and semantic processing (Wu Cy 2012, Dong Y 2000). All these results provide that this area (left middle frontal gyrus and the right fusiform gyrus) were implicated in Chinese orthographic, phonological, and semantic processing. And also that Chinese character processing as compared with the universal language network that has been based on alphabetic languages.

Others' writing induced higher activation than one's own in the right visuospatial as well as motor network. Unfamiliar writing animation traces could require more resources in the right hemisphere to carry out spatiotemporal analysis. The results are in line with biological motion perception, motion comport activation in temporo-parietal-occipital junction (Peelen et al., 2006, Peuskens et al., 2005). In these experiment participant saw the dynamic traces last for quite a long time (a few seconds) and require lots of efforts to be integrated across time. In this case, the visuospatial processing areas (SOG/SPL), visual pattern memory (MTG), and motor areas (MFG/SMG) need to work synchronously for a relative long period, especially for unfamiliar character traces. Interestingly, Matthys et al (2009) found activation in SOG and STS in a study of hand movement. The right superior occipital gyrus is located in the V2 and lies within the dorsal visual stream; this area is connected with the PPC, a large associative cortical region, where afferents from different sensory modalities are integrated to

provide the basis for perceptual processes. Activation of MTG could be also explained considering handwriting traces as a movement made from a manipulation object like tools and utensils. Beauchamp et al (2002) found a larger activation in MTG comparing observed action for tool's motion compared with human motion. However, Beauchamp found a greater distinction because he used also both image of tools and movement, instead my experiment where I used only kinematic traces of handwriting. Thus the initial higher activation in the right self-reference network may explain the advantage of self processing. A behavioral study conducted on split brain patients reported that both hemisphere are capable on face recognition but the left shows a bias for self, and the right shows a bias for familiar others (Turk et al., 2002). The relation between temporo-parietal junction and self was suggesting also in patient whit Out of Body Experience (Blanke and Arzy, 2005). Literature also converge that the right hemisphere is implicated in self recognition (Plateck & Gallup 2002, Sugiura 2005).

# Chapter 5

## Gender Effects in Handwriting Gender Classification

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### **5.1 Introduction**

The aim of this experiment was to study the effects of participant's gender and grammatical gender of the word whose handwriting should be classified on the classification of writer's gender. The only specific hypothesis was referred to the own sex bias, according to which participants' responses in a yes/no task are biased towards the same-sex response (Wright & Sladden, 2003). In other respects the study was exploratory, in the sense that no specific hypotheses were formulated in advance.

Various studies in biological motion found that people are able to classify the human walker gender (Troje, 2002a). Also the voice gender identification and the discrimination between familiar and unfamiliar voice is possible (Sheffert et al., 2002).

### **5.2 Methods**

#### **5.2.1 Participants**

Thirty-four native Italian graduate students participated in the study (17 male, 17 female; age 21-24 yr.). All subjects were physically and mentally healthy, right-handed and had normal or correct to normal vision.

### **5.2.2 Stimuli**

I selected two words: one grammatically feminine (*collana*, necklace) and one masculine (*martello*, hammer). Both are lexically regular object nouns, terminating in “a” for the feminine and “o” for the masculine, and also evocating feminine vs. masculine concepts. Each participant wrote these words copying them from bold printed originals shown on separate sheets, using their own cursive handwriting. Stimuli were inserted in a power point presentation, resizing them to make them approximately equal in size. This is the only transformation operated.

### **5.2.3 Experimental design**

The experimental design was mixed, with one between-subjects factor, Participant (male, female), and two within-subjects factors: Handwriting (male, female) and Word (masculine “martello”, feminine “collana”).

### **5.2.4 Task**

I used a very simple task: words written by every participant were *randomly* projected on the screen for 3 s in a classroom presentation. Participants evaluated every word after presentation, filling in a questionnaire where they indicated the perceived writer gender on a scale of 5 grades (feminine, rather feminine, neither masculine nor feminine, rather masculine=and clearly masculine) and if it is own or not. Overall every participants judged 68 trials and for each of four condition (“male handwriting-male word”, “male handwriting-female word”, “female handwriting-male word” and “female handwriting-female word”) 17 trials.

### 5.3 Results

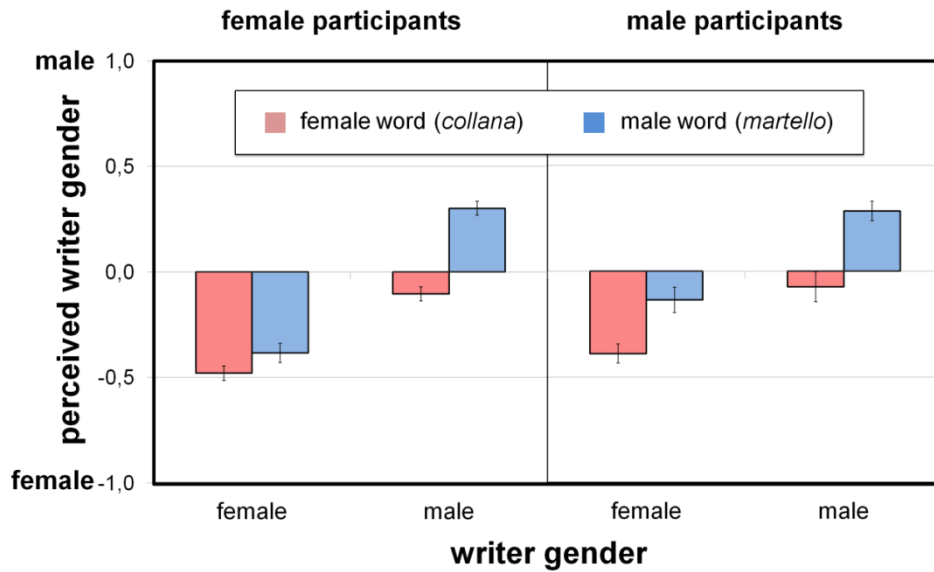
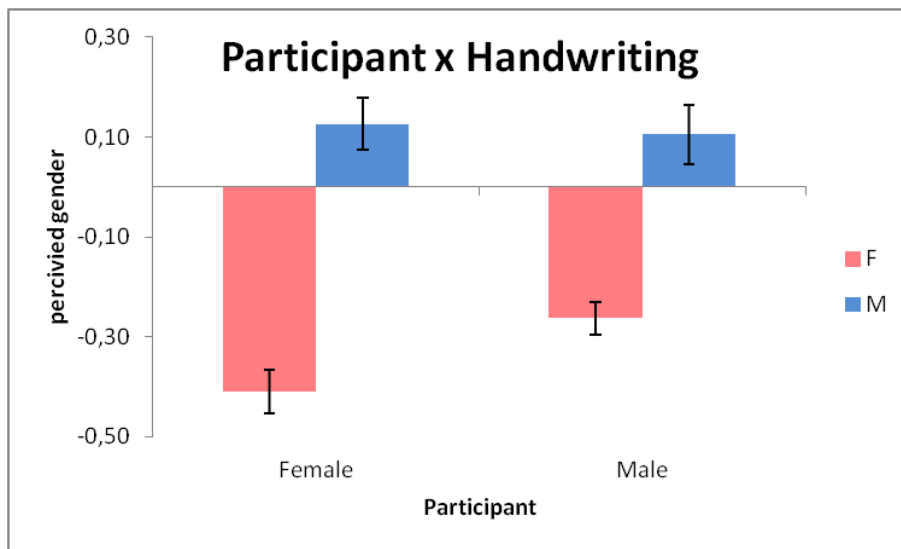


Figure 5.1 Distribution of perceived writer gender mean where -1 is clearly female and +1 clearly male, in female and male participants, for Words (female “collana”, male “martello”) as a function of Writer Gender (female and male)

First, I considered the perception of gender in handwriting. Participants' responses on the 5-point scale were coded as follows: clearly feminine= -1, rather feminine= -0.5, neither masculine nor feminine= 0, rather masculine=0.5 and clearly masculine= +1 .

For every participant I calculated the mean of gender judgments on the -1/+1 scale for each condition of the Handwriting (male, female) x Word (male, female) design. Figure 5.1 shows the four means and s.e.m. for male and female participants. The ANOVA on the mixed design Participant (2) x Handwriting (2) x Word (2) showed that words written by males were judged more masculine ( mean= 0) than those written by females (mean=-0.33) (main effect of Handwriting:  $F_{1,32} = 215.00$ ,  $p < 0.001$ ). The main effect of Word was also significant: the grammatically male word *martello* (mean=0.02) was judged as more masculine than the grammatically female word *collana* (mean=-0.25)( $F_{1,32} = 114.00$ ,  $p < 0.001$ ). The main effect of

Participant was not significant ( $F_{1,32} = 1.34$   $p < 0.22$ ). The interaction Participant X Handwriting showed in figure 5.2 underline that for male handwriting both male and female participant judge that male in the same way but for female handwriting female participant judge it more feminine than female participants ( $F_{1,32} = 7.42$   $p < 0.05$ ); in Word X Handwriting female word is judge more feminine in female handwriting and male word is judge more masculine in male handwriting ( $F_{1,32} = 21.9$   $p < 0.0001$ ). Whereas the interaction Participant x Word is no significant ( $F_{1,32} = 1,85$   $p < 18$ ).



**Figure 5.2 Interaction between Participant and Handwriting**

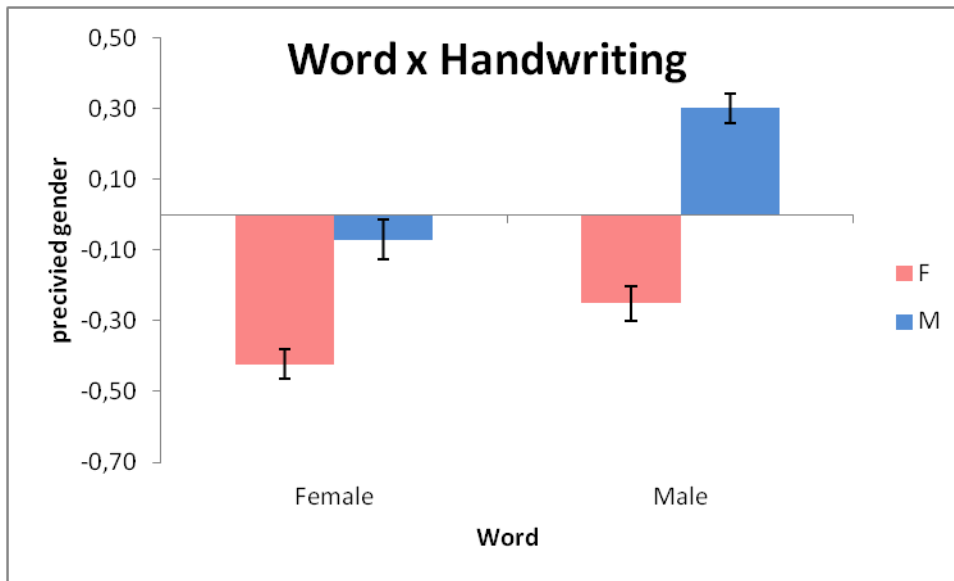


Figure 5.3 Interaction between Word and Handwriting

### 5.3.1 Signal Detection Theory Analysis

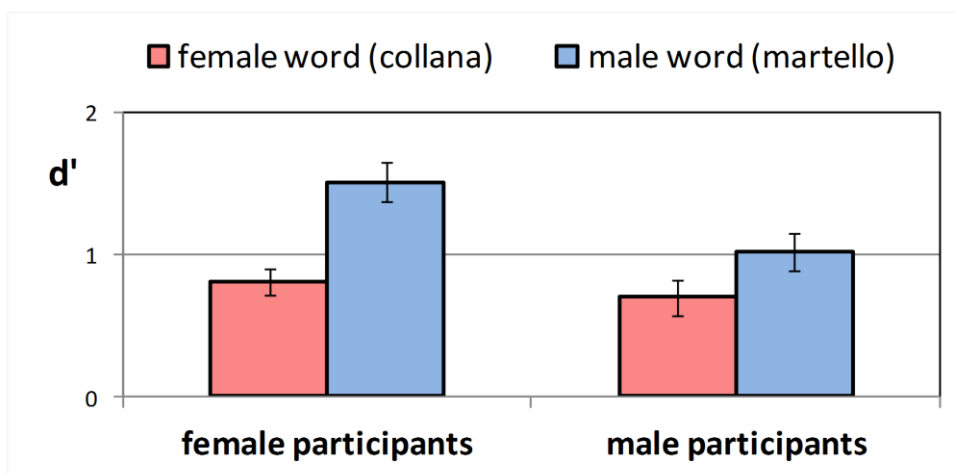


Figure 5.4 Discrimination accuracy ( $D'$ ) for Word (female, male). as a function of Participants (female, male)

**$D'$  Analysis:** Data obtained during the experimental phase were analyzed according the Signal Detection Theory. Figure 5.4 shows the distribution of data using the  $d'$  measure of sensitivity (taking the female handwriting as signal). The discrimination between female and male handwritings was

better with the masculine word "martello" (mean 1.29) than with the feminine word "collana" (mean 0.75). Female participants (mean 1.17) were more sensitive than male participants (mean 0.88). The mixed design ANOVA for the design Participant (2) x Word (2) confirmed the significance of the main effects of Word ( $F_{1,32} = 19.3$   $p < 0.001$ ) and Participant ( $F_{1,32} = 4.93$ ,  $p < 0.05$ ); the interaction Participant x Word did not reach the significance level ( $F_{1,32} = 2.97$ ,  $p < 0.094$ ), though suggesting that the grammatical gender effect (the advantage for the masculine word) was stronger in female participants.

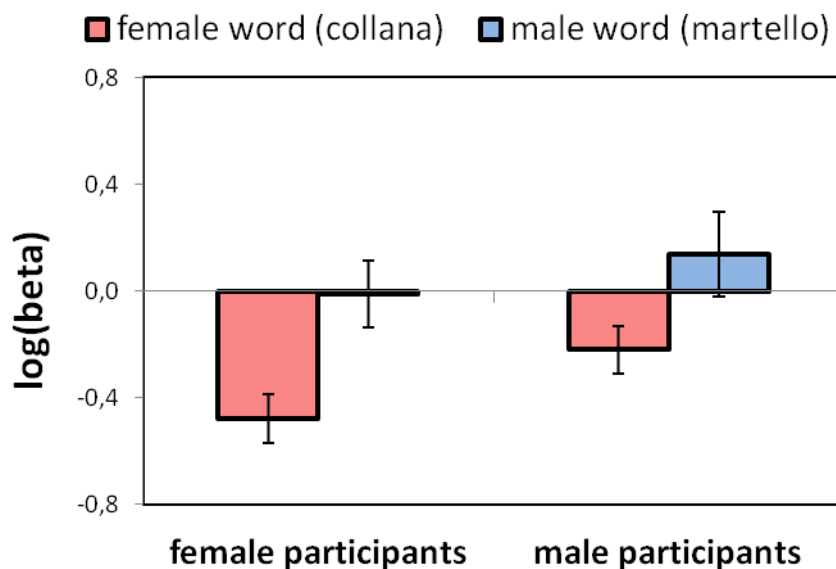


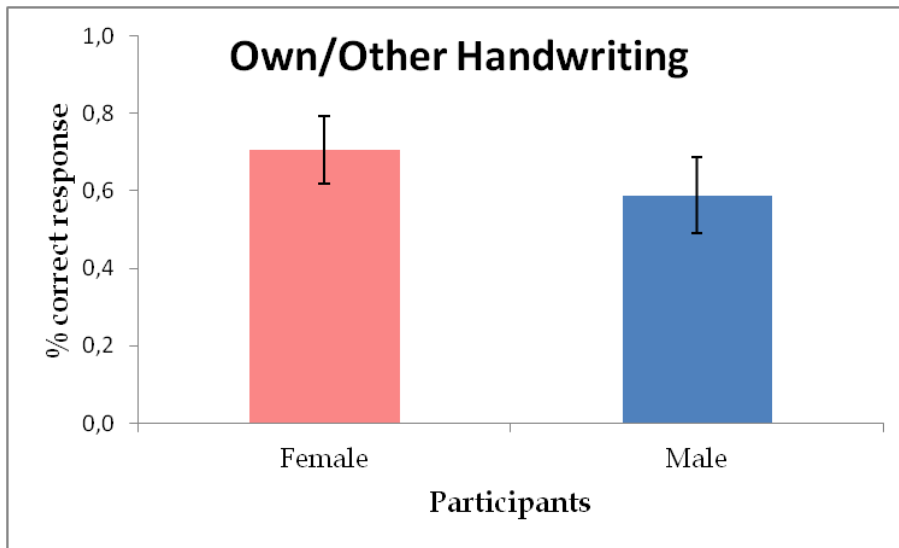
Figure 5.5 Mean of  $\ln \beta$ , for Word (female, male) in Participants (female, male)

**$\beta$  Analysis:** Further analysis considering the bias to response female in female handwriting (with  $\ln \beta$ ) is showed in figure 5.5. The figure showed that there is a bias in female word (mean female -0.28, male -0.04), and female response in female participants (female -0.47, male -0.21). The ANOVA mixed design analysis between Participants (2) x Word (2) on  $\ln \beta$  showed that the response were biased consistently with word gender participant was liberal showing a trend to response more female handwriting

( $F_{1,32}=18.6$   $p<0.001$ ) whereas the main effect in participants were no significant ( $F_{1,32}=2.15$   $p<0.15$ ). The interaction Word x Participants show that male participants was more conservative in male word than female participants, male participants response more male handwriting but it isn't significant ( $F_{1,32}=0.32$   $p<0.5$ ). The figure show also a strong bias towards the "female" response in female participants this is confirmed by ANOVA within design Word (2), analyzing only female word in female participants with ( $F_{1,16} = 12,2$   $p<0,005$ ). Female participants were more conservative in male word than female word, showing the tendency to answer more "female" on a female word.

### **5.3.2 Was this word written by**

In the end I analyze the part of questionnaire that investigate the ability to discriminate own handwriting from other. Each participants in a presentation of 68 stimuli saw own handwriting only two times, one with female word and one with male word. The figure 5.6 show that that girls (mean= 0.76) are more able than boys (mean= 0.58) to recognize own handwriting, but this difference is not important. In fact, the results of ANOVA (Between subject) Participants (2) was not significant ( $F_{1,32}= 0.81$   $p<0.37$ ).



**Figure 5.6 Mean of % correct response in owns handwriting recognition for Participants (female, male)**

## 5.4 Conclusion

This last experiment could be consider as a addition to previous experiment on SRE, because the purpose was not only the recognition of own handwriting but if gender of word and of handwriting can influence of in discrimination of handwriting. I explored the presence of an own sex bias towards word gender and writer gender.

I found:

- Two effect of grammatical gender of word: the handwriting of male word is judge more masculine than the handwriting of female word (figure 5.1), also discrimination between female and male handwritings was better with the masculine word "martello" than with the feminine word "collana" (figure 5.4), and there is a bias for female response to feminine word "collana" (figure 5.5).
- An effect on handwriting gender showed that male handwriting is evaluated more masculine than female handwriting (figure 5.1).

- An effect on participant indicated that female participants were more sensitive in discrimination than male participants (figure 5.4).
- An interaction between Participant and Handwriting (figure 5.2) underline that for male handwriting both male and female participant judge that male in the same way but for female handwriting female participant judge it more feminine than female participants, in interaction between Word and Handwriting (figure 5.3) female word is judge more feminine in female handwriting and male word is judge more masculine in male handwriting.

These results confirmed the presence of own sex bias described in study with face stimuli (Wright D.B., Sladden B., 2003; Cellerino, 2004), the own sex bias regards both word gender and writer gender.

# Chapter 6

## General discussion

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In my thesis I investigated the role of handwriting in self referential processing. The first reference point was if the presence of own handwriting in discrimination task could improve the performance. In first the experiment, I found that in an implicit task the discrimination performance is better when own handwriting was present in stimuli. This result was also confirmed by the fact that reference to the self could perturb the dissimilarities between different handwritings. There Remains an uncertain explanation that seeing his/her own handwriting does not constitute an advantage for the participant when it is in the first position and isn't the target. The results are in line with Chen et al. (2008) who found that the perception of own handwriting is special and related to the self. The results show that the response to own handwriting is different from response to another condition.

However, the first experiment could be questionable because persons have confidence with their own handwriting, and it is possible that the results do not depend on a self processes but were only conditioned by high familiarity with own handwriting. For this reason I made two other experiment, one where participants were children and their best friend and one with kinematic traces as stimuli.

The second experiment not only confirmed the previous results but also added a development of self related processes, that these findings was the same in both sessions of implicit discrimination and explicit identification tasks. Interestingly, 3<sup>rd</sup> grade children manifest only a familiar effect because they were able to discriminate between self/friend and other but not

between self and friend. This ability grows up in 5<sup>th</sup> grade children where I found familiar effect and self reference effect.

It is also important to observe the trend in both experiments and in both analysis response correct and reaction time, I found that fifth grade children showed a better performance than third grade which is in line with normal cognitive development of a child.

This difference in friendship development between children of 8 ages and 10 ages is also explained by Rawlins (1992). He describes that friend at the age of 8 usually live close to one another and are of the same sex and similar in age. It is after nine or ten years at the age that friendships become reciprocal and equal, a child can "step outside" of the self and take the perspective of the other, including the perceptions the other has of her or him.

These results showed a clear distinction between familiar effect and self reference effect, and handwriting contain information about self and is not only special because it is familiar.

Further investigations were made with handwriting's kinematic traces. The experiment was made in collaboration with the Institute of Cognitive Neuroscience of the National Central University, Taiwan, for this reason the traces was Chinese characters. The study confirms that handwriting traces are related to self and contain also information about authorship. This was in agreement with the Knoblich (2003) findings where people not only recognize their "action style" but they can also generate more accurate predictions of future action outcomes when observing their own past actions. Indeed, the lexical decision task reveals a significant effect of "authorship", and also a higher sensitivity for forward than backward traces also validates the procedure. In addition in children I found longer reaction time for own than others, which suggests that one's own writing may have "captured" attention for more detailed processing, which in turn enhanced sensitivity.

The results of an fMRI experiment indicated that viewing traces elicited bilateral medial frontal, parietal, insula, ventral parietal activations and right superior frontal gyrus and temporal gyrus.

These activations were in line with literature, considering the activation in insula this is impaired in patient with agraphia following a unique infarction. The data not only seem to enrich current insights in the anatomical locus for phonological agraphia, they also seem to contribute to a further delineation of the insular role in phonologically mediated aphasic manifestations (Marien P 2001). Temporal gyrus and parietal lobule were implicated in central processes for writing Chinese characters (Lin et al., 2007). Activations in the left parietal lobule and the right superior temporal gyrus were specialized for phonological processing, while the left middle temporal gyrus was involved in semantic processing. Functional dissociation was identified in the left inferior frontal gyrus, with the posterior dorsal part for phonological processing and the anterior ventral part for semantic processing. Moreover, bilateral involvement of the ventral occipito-temporal regions was found for both phonological and semantic processing (Wu Cy 2012, Dong Y 2000). Considering all these results, it provide that this area (left middle frontal gyrus and the right fusiform gyrus) were implicated in Chinese orthographic, phonological, and semantic processing.

Others' writing induced higher activation than one's own in the right visuospatial as well as motor network. Unfamiliar writing animation traces could require more resources in the right to carry out spatiotemporal analysis. The results are in line with biological motion perception, that comport activation in temporo-parietal-occipital junction (Peelen et al 2006, Peuskens 2005). In the experiment participants saw the dynamic traces for quite a long time (a few seconds) and require lots of efforts to be integrated across time. In this case, the visuospatial processing areas (SOG/SPL), visual pattern memory (MTG), and motor areas (MFG/SMG) need to work

synchronously for a relative long period, especially for unfamiliar unfamiliar character traces. Furthermore SOG and STS areas were implicated in hand movement (Matthys et al (2009)). Another consideration is that the handwriting traces could be compared a movement made from a manipulation object like tools and utensils, Beauchamp et al (2002) in a study found a larger activation in right MTG comparing observed action for tool motion compared with human motion. Thus the initial higher activation in the right self-reference network may explain the advantage of self processing. Relation between in right hemisphere and self was support by a patient with split brain patients (Turk et al., 2002); while relation between temporo-parietal junction and self was suggesting also in patient whit Out of Body Experience (Blanke and Arzy, 2005). Literature also converge that the right hemisphere is implicated in self recognition (Plateck & Gallup 2002, Sugiura 2005). Further investigation could compare dynamic and static written traces, and see if the direction of difference in activation between self vs. other reverses between static and dynamic traces.

I decided to conduct one further type of experiment where the effects of participant's gender and grammatical gender of the word whose handwriting should be classified on the classification of writer's gender were investigate. It was interesting that the participant's response was biased by gender of word and handwriting. Indeed the handwriting of male word is judge more masculine than the handwriting of female word, and the inverse trend was showed for female word, there is a bias for female response to feminine word "collana". There is also a role of handwriting gender because male handwriting is evaluated more masculine than female handwriting. These results confirmed the presence of own sex bias described in a study with face stimuli (Wright D.B., Sladden B., 2003; Cellerino, 2004), a own sex bias in regards to both word gender and writer gender.

In conclusion, all experiments confirm that handwriting could be considered a good method to investigate self related processing. The results indicated that handwriting contains information about self, familiarity and authorship. Self referential is a complex system to investigate and this is only an aspect of a greater topic. Future investigation could be with aphasic, autistic and dyslexia patients.

# Appendix

## Chapter 2

### Experimental Design

	subject	1	2	3	4	5	6	7	8
cond	1	X- AB	X- AB	X- AB	X- AB	AB- X	AB-X	AB- X	AB- X
cond	2	AB- X	AB- X	AB- X	AB- X	X- AB	X-AB	X- AB	X- AB

Words:

Comparison: *cara, confine, evento, martello, volo, cartone, classe, partenza, pane, caviglia, dizione, sole, volto, gatto, parco, esatto, ricordo, immagine, elogio, saldo.*

Target:

for all subject (*mela, sedia, tavola, portata, fratello*).

Subject 1 (*attimo, sasso, cervello, cane, albergo*)

Subject 2 (*muto, latte, ragazza, galleria, colore*)

Subject 3 (*cercato, cucina, neve, naturale, tappo*)

Subject 4 (*cartone, punta, sagoma, telefono, telefono*)

Subject 5 (*cura, chiave, cassa, salmone, tempesta*)

Subject 6 (*tribuna, collante, rosa, critica, somma*)

Subject 7 (*grigio, opzione, pericolo, viso, cuore*)

Subject 8 (*argento, salto, miracolo, sofno, foto*)

Data: mean values for each subject

	pc											
	Two				One				Null			
	left		right		left		right		left		right	
subj	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X
1	0,75	0,70	0,88	0,50	0,670	0,880	0,800	0,630	0,82	0,84	0,77	0,88
2	1,00	0,80	0,75	0,84	0,670	0,860	0,670	0,880	0,810	0,75	0,78	0,77
3	1,00	0,80	0,75	1,00	1,000	0,880	0,830	0,750	0,82	0,81	0,77	0,94
4	1,00	0,90	0,50	1,00	1,000	0,850	0,630	0,500	0,76	0,69	0,81	0,77
5	0,50	0,90	0,86	1,00	1,000	0,880	1,000	0,620	0,72	0,81	0,76	0,83
6	0,75	1,00	1,00	1,00	0,800	0,750	0,670	0,880	0,82	0,9	0,8	0,61
7	1,00	0,80	0,72	1,00	1,000	0,880	0,670	0,880	0,75	0,68	0,8	0,94
8	0,75	0,60	0,86	0,50	1,000	0,880	0,670	0,380	0,77	0,75	0,58	0,6

asin PC											
Two				One				Null			
left		right		left		right		left		right	
X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X
0,848	0,775	1,076	0,524	0,734	1,076	0,927	0,682	0,961	0,997	0,879	1,076
1,571	0,927	0,848	0,997	0,734	1,035	0,734	1,076	0,944	0,848	0,895	0,879
1,571	0,927	0,848	1,571	1,571	1,076	0,979	0,848	0,961	0,944	0,879	1,223
1,571	1,120	0,524	1,571	1,571	1,016	0,682	0,524	0,863	0,761	0,944	0,879
0,524	1,120	1,035	1,571	1,571	1,076	1,571	0,669	0,804	0,944	0,863	0,979
0,848	1,571	1,571	1,571	0,927	0,848	0,734	1,076	0,961	1,120	0,927	0,656
1,571	0,927	0,804	1,571	1,571	1,076	0,734	1,076	0,848	0,748	0,927	1,223
0,848	0,644	1,035	0,524	1,571	1,076	0,734	0,390	0,879	0,848	0,619	0,644

speed											
Two				One				Null			
left		right		left		right		left		right	
X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X
1,004	1,834	1,510	1,522	1,388	1,627	1,326	1,954	1,450	1,469	1,371	1,342
1,118	1,383	1,291	1,478	1,283	1,749	1,771	1,270	1,287	0,720	1,309	1,577
1,324	1,223	1,362	1,385	1,417	1,372	1,579	1,090	2,174	1,980	1,371	1,290
0,989	1,231	1,010	1,471	1,386	1,413	1,219	1,050	1,211	1,133	1,764	0,853
1,610	1,212	1,511	1,056	1,501	1,067	1,495	1,112	1,052	0,604	1,473	0,937
1,464	1,323	1,258	1,120	1,398	1,518	1,380	1,067	1,361	0,983	1,333	1,570
1,421	1,136	1,362	1,355	1,480	1,738	1,414	1,796	1,748	1,912	1,435	1,299
1,632	0,971	1,244	1,160	1,442	1,033	1,113	0,886	1,456	1,222	1,418	0,988

asin PC * speed											
Two				One				Null			
left		right		left		right		left		right	
X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X	X-AB	AB-X
0,851	1,422	1,624	0,797	1,019	1,751	1,229	1,332	1,394	1,465	1,205	1,444
1,756	1,282	1,095	1,474	0,942	1,811	1,300	1,366	1,215	0,611	1,172	1,386
2,080	1,134	1,155	2,175	2,226	1,476	1,546	0,925	2,090	1,870	1,205	1,578
1,553	1,379	0,529	2,311	2,177	1,436	0,831	0,550	1,045	0,862	1,665	0,749
0,843	1,357	1,564	1,659	2,358	1,148	2,348	0,744	0,845	0,570	1,271	0,918
1,241	2,077	1,976	1,760	1,296	1,287	1,013	1,148	1,308	1,101	1,236	1,030
2,233	1,054	1,095	2,128	2,325	1,870	1,038	1,932	1,483	1,430	1,331	1,588
1,384	0,625	1,288	0,607	2,264	1,111	0,817	0,345	1,279	1,037	0,877	0,636

## Chapter 3

Words: *cara, neve, pane, sole, volo, latte, parco, sasso, sogno, volto, chiave, classe, esatto, salato, argento, cartone, portata, ricordo, salmone, cane, mela, rosa, gatto, sedia, tappo, attimo, colore, tavola, albergo, confine, ragazza.*

Speed: mean values for each subject

Third			Fifth		
self-other	friend-other	other-other	self-other	friend-other	other-other
self	friend	other	self	friend	other
1005	1069	1089	673	699	619
1199	1194	1130	935	1029	955
682	742	690	994	942	1016
752	837	920	760	779	734
729	575	728	1301	1210	1116
954	927	936	767	744	772
960	868	927	666	792	766
971	1064	1045	1004	1113	898
776	837	822	942	919	938
784	809	835	862	870	897
1169	1243	1174	834	794	873
712	932	939	680	744	835
865	827	891	753	735	840
1301	1364	1399	662	676	711

Percentage of gain mean values for each subject

Third				Fifth			
% GAIN				% GAIN			
A(self)		A(friend)		A(self)		A(friend)	
sel	other	friend	other	sel	other	friend	other
13,862	1,390	-2,318	-25,021	23,771	6,262	17,982	-3,439
6,872	-3,361	9,957	13,392	47,013	12,095	22,308	-5,151
5,615	-3,652	-2,372	3,403	14,810	29,525	14,810	-4,559
4,631	1,390	9,241	-5,317	24,328	-0,521	11,130	7,130
-15,935	10,761	-28,267	9,334	26,517	20,828	-8,210	-14,286
7,403	-16,703	-3,611	10,836	0,450	-3,223	-10,074	-11,093
-8,214	6,909	-0,950	6,909	16,600	5,436	-10,025	16,600
12,268	2,060	7,648	-15,231	0,285	0,285	-17,552	-10,533
8,805	-5,384	36,743	-1,434	20,406	3,752	11,656	7,625
15,862	-3,774	25,812	3,563	-0,671	6,133	2,136	7,744
6,263	3,175	-19,019	-12,240	-1,400	13,260	17,692	12,187
1,216	-20,515	1,216	1,978	20,957	-6,824	-13,903	3,045
-1,089	1,459	16,269	-9,039	22,794	0,688	-9,394	-7,453
13,792	8,680	-3,059	-3,059	-3,123	0,494	22,083	-16,699

SDT- D' mean values for each subject

Third			Fifth		
d' self/o	d' friend/	d' self/f	d' self/o	d' friend/	d' self/f
2,502	1,618	2,432	3,297	3,297	2,766
0,244	1,498	1,825	3,297	3,297	2,766
1,857	-0,300	1,150	1,862	-0,894	0,842
1,965	2,028	1,992	-0,760	1,466	0,253
3,217	0,967	2,350	2,028	1,965	1,992
1,187	2,816	1,935	3,273	2,561	2,665
1,932	1,182	1,825	2,028	1,965	1,992
-0,244	-0,231	-0,431	3,246	1,651	2,533
3,297	3,297	2,766	2,561	3,273	2,665
1,187	2,816	1,935	2,770	0,511	1,712
3,217	0,967	2,350	3,273	2,561	2,665
0,498	2,783	1,642	2,502	1,618	2,432
3,246	1,651	2,533	0,792	-0,659	0,000
2,857	2,875	2,249	1,857	-0,300	1,150

## Chapter 4

### Lexical decision task SDT transformation

D' mean values for each subject

self				other				d'			
forward= 1		backward= 2		forward= 1		backward= 2		self		other	
Hit	FA	Hit	FA	Hit	FA	Hit	FA	forward	backward	forward	backward
0,167	0,333	0,083	0,042	0,583	0,292	0,042	0,167	-0,537	0,349	0,759	-0,764
0,708	0,208	0,375	0,250	0,708	0,375	0,417	0,375	1,361	0,356	0,867	0,108
0,583	0,167	0,333	0,083	0,250	0,208	0,167	0,083	1,178	0,952	0,138	0,416
0,750	0,708	0,958	0,875	0,292	0,375	0,292	0,375	0,126	0,581	-0,230	-0,230
0,667	0,083	0,542	0,500	0,625	0,125	0,500	0,292	1,814	0,105	1,469	0,549
0,667	0,458	0,550	0,733	0,217	0,333	0,438	0,409	0,535	-0,497	-0,350	0,073
0,917	0,125	0,458	0,375	0,625	0,292	0,292	0,458	2,533	0,214	0,867	-0,444
0,875	0,208	0,667	0,625	0,708	0,125	0,417	0,375	1,963	0,112	1,699	0,108
0,667	0,083	0,167	0,125	0,583	0,042	0,333	0,208	1,814	0,183	1,942	0,381
0,875	0,833	0,750	0,750	0,667	0,667	0,333	0,542	0,183	0,000	0,000	-0,535
0,583	0,500	0,500	0,458	0,458	0,500	0,250	0,375	0,210	0,105	-0,105	-0,356
0,500	0,083	0,250	0,333	0,500	0,083	0,417	0,417	1,383	-0,244	1,383	0,000
0,667	0,208	0,292	0,250	0,542	0,167	0,292	0,167	1,243	0,126	1,072	0,419

B mean values for each subject

ln(beta)			
self		other	
forward	backward	forward	backward
-0,375	0,543	0,128	-1,031
0,179	0,177	-0,100	0,029
0,446	0,864	0,102	0,488
-0,077	-0,838	-0,100	-0,100
0,864	-0,005	0,611	0,150
-0,087	0,186	-0,212	0,014
-0,295	0,045	0,100	-0,145
-0,332	-0,042	0,511	0,029
0,864	0,194	1,477	0,237
-0,194	0,000	0,000	-0,087
-0,022	0,005	-0,005	-0,177
0,956	-0,135	0,956	0,000
0,237	0,077	0,462	0,318

Reaction time: mean values for each subject

self				other			
forward= 1		backward= 2		forward= 1		backward= 2	
W	NW	W	NW	W	NW	W	NW
110,75	113,25	116,50	90,83	117,79	106,29	106,00	89,35
88,88	104,21	98,11	100,06	96,53	106,40	114,50	113,67
134,14	121,65	142,00	129,64	101,67	106,74	120,75	116,73
119,14	121,00	110,27	118,00	106,00	109,54	111,00	107,33
114,81	131,59	123,15	132,75	87,80	103,00	99,33	107,35
122,38	135,62	138,91	158,00	108,00	102,19	128,14	122,85
77,77	88,24	101,64	92,47	82,33	92,35	98,29	97,85
101,52	107,32	115,38	113,89	94,65	111,19	115,30	104,33
99,63	110,82	131,50	125,14	85,36	90,65	102,50	107,32
97,24	105,00	110,78	109,00	90,50	92,13	107,75	80,36
125,71	132,17	122,17	135,08	109,55	107,17	113,33	113,93
93,67	113,18	121,00	119,25	96,00	105,09	107,10	109,86
81,88	106,11	118,14	118,67	69,85	78,40	101,00	87,40

## Chapter 5

Perceived writer gender: mean values for each subject

Participant Female				Participant male			
word female		word male		word female		word male	
handwriting feminine	handwriting male	handwriting feminine	handwriting male	handwriting feminine	handwriting male	handwriting feminine	handwriting male
-0,525	0,000	-0,400	0,559	-0,275	0,118	-0,075	0,235
-0,600	-0,118	-0,650	-0,029	-0,350	0,088	0,075	0,324
-0,575	-0,176	-0,275	0,324	-0,325	0,353	-0,275	0,441
-0,650	-0,206	-0,475	0,324	-0,525	-0,353	-0,125	0,176
-0,275	0,059	-0,275	0,441	-0,475	-0,059	0,100	0,441
-0,500	-0,118	-0,650	0,176	-0,650	-0,706	-0,075	0,088
-0,250	-0,088	-0,350	0,441	-0,275	0,118	-0,125	0,382
-0,650	-0,088	-0,550	0,324	-0,350	-0,088	-0,600	0,059
-0,575	-0,294	-0,525	0,118	-0,125	-0,176	-0,150	0,147
-0,275	-0,176	-0,174	0,265	-0,375	-0,029	0,330	0,226
-0,203	0,088	-0,075	0,382	-0,775	-0,353	-0,575	0,265
-0,275	-0,059	0,100	0,088	-0,550	-0,324	-0,233	-0,029
-0,450	0,088	-0,350	0,294	-0,200	-0,059	-0,250	0,588
-0,625	0,000	-0,550	0,441	-0,650	-0,412	-0,425	0,118
-0,450	-0,147	-0,425	0,441	-0,200	0,353	0,163	0,402
-0,400	0,000	-0,050	0,412	-0,300	-0,059	-0,150	0,294
-0,450	0,118	-0,525	0,412	-0,225	0,324	0,075	0,676

For SDT analysis D' mean values for each subject

risposte F+M				proporzioni				z(p)				d'		ln(beta)	
female handwriting		male handwriting		Hit		FA		Hit		FA		d'		ln(beta)	
female word	male word	female word	male word	female word	male word	female word	male word	female word	male word	female word	male word	female word	male word	female word	male word
19	13	13	12	0,842	0,923	0,462	0,083	-1,003	-1,426	0,097	1,383	1,100	2,809	-0,498	-0,061
19	20	14	14	0,842	0,850	0,500	0,571	-1,003	-1,036	0,000	-0,180	1,003	0,856	-0,503	-0,521
15	16	13	13	0,933	0,750	0,615	0,231	-1,501	-0,674	-0,293	0,736	1,208	1,411	-1,084	0,044
17	18	9	13	0,941	0,778	0,778	0,231	-1,565	-0,765	-0,765	0,736	0,800	1,501	-0,932	-0,021
15	17	12	14	0,667	0,706	0,417	0,143	-0,431	-0,541	0,210	1,068	0,641	1,609	-0,071	0,423
20	19	13	13	0,800	0,842	0,615	0,385	-0,842	-1,003	-0,293	0,293	0,548	1,297	-0,311	-0,460
15	18	15	14	0,667	0,722	0,667	0,143	-0,431	-0,589	-0,431	1,068	0,000	1,657	0,000	0,396
17	16	9	15	0,882	0,875	0,667	0,400	-1,187	-1,150	-0,431	0,253	0,756	1,404	-0,612	-0,630
19	15	15	16	0,895	0,933	0,667	0,438	-1,252	-1,501	-0,431	0,157	0,821	1,658	-0,691	-1,114
14	9	10	10	0,857	0,778	0,800	0,200	-1,068	-0,765	-0,842	0,842	0,226	1,606	-0,216	0,062
9	9	9	9	0,778	0,667	0,333	0,056	-0,765	-0,431	0,431	1,593	1,195	2,024	-0,200	1,176
15	18	13	14	0,600	0,333	0,538	0,429	-0,253	0,431	-0,097	0,180	0,821	1,658	-0,251	-0,027
13	16	14	13	0,923	0,813	0,357	0,231	-1,426	-0,887	0,366	0,736	1,792	1,623	-0,950	-0,122
19	19	11	14	0,842	0,842	0,545	0,143	-1,003	-1,003	-0,114	1,068	0,889	2,071	-0,497	0,067
20	19	14	13	0,700	0,737	0,571	0,154	-0,524	-0,634	-0,180	1,020	0,344	1,654	-0,121	0,320
15	10	14	12	0,933	0,600	0,500	0,167	-1,501	-0,253	0,000	0,967	1,501	1,221	-1,127	0,436
18	20	16	11	0,778	0,850	0,438	0,182	-0,765	-1,036	0,157	0,908	0,922	1,945	-0,280	-0,124
16	14	12	13	0,750	0,643	0,417	0,231	-0,674	-0,366	0,210	0,736	0,885	1,102	-0,205	0,204
18	14	13	14	0,833	0,429	0,385	0,286	-0,967	0,180	0,293	0,566	1,261	0,386	-0,425	0,144
16	18	15	13	0,750	0,667	0,267	0,231	-0,674	-0,431	0,623	0,736	1,297	1,167	-0,033	0,178
15	11	12	7	0,933	0,636	0,833	0,286	-1,501	-0,349	-0,967	0,566	0,534	0,915	-0,659	0,099
19	19	16	16	0,842	0,421	0,500	0,125	-1,003	0,199	0,000	1,150	1,003	0,951	-0,503	0,642
18	14	14	16	0,944	0,571	0,929	0,375	-1,593	-0,180	-1,465	0,319	0,128	0,499	-0,196	0,035
14	13	12	13	0,786	0,615	0,417	0,231	-0,792	-0,293	0,210	0,736	1,002	1,030	-0,291	0,228
16	18	15	11	0,813	0,944	0,533	0,455	-0,887	-1,593	-0,084	0,114	0,803	1,707	-0,390	-1,263
16	17	10	11	0,563	0,647	0,700	0,364	-0,157	-0,377	-0,524	0,349	-0,367	0,726	0,125	-0,010
15	15	13	9	0,800	0,200	0,538	0,222	-0,842	0,842	-0,097	0,765	0,745	-0,077	-0,350	-0,062
19	18	13	14	0,947	0,889	0,846	0,357	-1,620	-1,221	-1,020	0,366	0,600	1,587	-0,792	-0,678
17	17	13	17	0,882	0,706	0,769	0,529	-1,187	-0,541	-0,736	-0,074	0,451	0,468	-0,433	-0,144
13	15	13	13	0,615	0,667	0,462	0,077	-0,293	-0,431	0,097	1,426	0,390	1,857	-0,038	0,924
18	16	11	15	0,944	0,875	0,909	0,467	-1,593	-1,150	-1,335	0,084	0,258	1,234	-0,378	-0,658
14	13	11	10	0,643	0,385	0,091	0,100	-0,366	0,293	1,335	1,282	1,701	0,988	0,824	0,778
16	18	11	14	0,688	0,556	0,636	0,214	-0,489	-0,140	-0,349	0,792	0,140	0,931	-0,059	0,304
16	16	15	14	0,688	0,500	0,267	0,036	-0,489	0,000	0,623	1,803	1,112	1,803	0,075	1,625

# Bibliography

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- Anderson, J. R. (1984). The development of self-recognition: A review. *Developmental Psychobiology*, 17, 35–49.
- Asendorpf, J. B., & Baudonniere, P.-M. (1993). Self-awareness and other-awareness: Mirror self-recognition and synchronic imitation among unfamiliar peers. *Developmental Psychology*, 29, 88-95.
- Asendorpf, J. B., Banse, R., & Mücke, D. (2002). Double dissociation between implicit and explicit personality self-concept: The case of shy behavior. *Journal of Personality and Social Psychology*, 83, 380–393.
- Balconi, M., Crivelli, D. (2010) FRN and P300 ERP effect modulation in response to feedback sensitivity: the contribution of punishment-reward system (BIS/BAS) and behaviour identification of action. *Neuroscience Res*, 66,162-172
- Barclay, C.D., Cutting, J.E., Kozlowski, L T, (1978). Temporal and spatial factors in gait perception that influence gender recognition. *Perception & Psychophysics*, 23 145-152
- Bear, D.R., Invernizzi, M., Templeton, S., Johnston, F. (2004). *Words their way: Word study for phonics, vocabulary, and spelling instruction (3rd ed.)*. Upper Saddle River, Pearson Prentice Hall.
- Beauchamp, M.S., Lee, K.E., Haxby, J.V., Martin, A. (2002). Parallel visual motion processing streams for manipulable objects and human movements. *Neuron*, 34(1):149-59.
- Biederman, I., Gerhardstein, P.C., 1993. Recognizing depth-rotated objects: evidence and conditions for three-dimensional viewpoint invariance. *Journal of Experimental Psychology: Human Perception and Performance*, 19 1162-1182
- Bischof-Köhler, D. (1994). Self-objectification and other-oriented emotions: Self-recognition, empathy, and prosocial behavior in the second year. *Zeitschrift für Psychologie*, 202, 349–377.
- Blakemore, S.J., Frith, C. Wolpert, D. (1999). Spatio-temporal prediction modulates the perception of self-produced stimuli. *Journal of Cognitive Neuroscience*, 11, 551–559.

- Blakemore, S.J., Frith, C.D. and Wolpert, D. (2002) Abnormalities in the awareness of action. *Trends in Cognitive Science*, 6, 237-42.
- Blakemore, S.J., Smith, J., Steel, R., Johnstone, E.C. and Frith, C.D. (2000). The perception of self-produced sensory stimuli in patients with auditory hallucinations and passivity experiences: evidence for a breakdown in self-monitoring. *Psychological Medicine*, 30, 1131-9.
- Blakemore, S.J., Wolpert, D. and Frith, C. D. (1998). Central cancellation of self-produced tickle sensation. *Nature Neuroscience*, 1, 635-40.
- Buccino, G., Binkofski, F., Fink, G. R., Fadiga, L., Fogassi, L., Gallese, V., Seitz, R.J., Rizzolatti, G., Freund, H.J., (2001). Action observation activates premotor and parietal areas in a somatotopic manner: an fMRI study. *European Journal of Neuroscience* 13 400 - 404
- Butterworth, B. (1992). "Disorders of phonological encoding". *Cognition* 42 (1-3): 261-286
- Cellerino, A., Borghetti, D., & Sartucci, F. (2004). Sex differences in face gender recognition in humans. *Brain Research Bulletin*, 63 443-449
- Chen A, Weng X, Yuan J, Lei X, Qiu J, Yao D, Li H. (2008). The temporal features of self-referential processing evoked by Chinese handwriting. *Journal of Cognitive Neuroscience*, 20, 816-827.
- Conway, M. A. (2005). Memory and the self. *Journal of Memory and Language*, 53, 594-628.
- Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, 107(2), 261-288.
- Cutting, J. E., & Kozlowski, L. T. (1977). Recognizing friends by their walk: Gait perception without familiarity cues. *Bulletin of the Psychonomic Society*, 9, 353-356.
- Daprati, E., Franck, N., Georgieff, N., Proust, J., Pacherie, E., Dalery, J., Jeannerod, M. (1997). Looking for the agent. An investigation into consciousness of action and self-consciousness in schizophrenic patients. *Cognition*, 65:71-86.
- Daprati, E., Sirigu, A., Pradat-Diehl, P., Franck, N. and Jeannerod, M. (2000). Recognition of self produced movement in a case of severe neglect. *Neurocase*, 6, 477-86.

- Dapretto, M., Davies, M. S., Pfeifer, J. H., Scott, A. A., Sigman, M., Bookheimer, S. Y., et al (2006). Understanding emotions in others: Mirror neuron dysfunction in children with autism spectrum disorders. *Nature Neuroscience*, 9(1), 28–30.
- David, A. S. (1994). *The neuropsychological origin of auditory hallucinations*. In *The neuropsychology of schizophrenia*, pp. 269–313. Lawrence Erlbaum, Hove, UK.
- David, N., Bewernick, B. H., Cohen, M. X., Newen, A., Lux, S., Fink, G. R., et al (2006). Neural representations of self versus other: Visual-spatial perspective taking and agency in a virtual balltossing game. *Journal of Cognitive Neuroscience*, 18, 898–910.
- David, N., Cohen, M. X., Newen, A., Bewernick, B. H., Shah, N. J., Fink, G. R., et al (2007a). The extrastriate cortex distinguishes between the consequences of one's own and others' behavior. *NeuroImage*, 36(3), 1004–1014.
- De Renzi, E., Liotti, M., & Nichelli, P. (1987). Semantic amnesia with preservation of autobiographic memory: A case report. *Cortex*, 23, 575–597.
- De Vignemont, F., & Fourneret, P. (2004). The sense of agency: A philosophical and empirical review of the “who” system. *Consciousness and Cognition*, 13(1), 1–19.
- Decety J., Jeannerod M., Prablanc, C. (1989). The timing of mentally represented actions. *Behavior Brain Research*, 34:35–42.
- Decety J., Jessica A. (2003). Sommerville Shared representations between self and other: A social cognitive neuroscience view. *Trends in Cognitive Sciences*, Vol. 7, No. 12. pp. 527-533
- Dierks, T., Linden, D.E.J., Jandl, M., Formisano, E., Goebel, R., Lanferman, H., et al. (1999). Activation of the Heschl's gyrus during auditory hallucinations. *Neuron*, 22:615–21.
- Dittrich, W. H., (1993) Action categories and the perception of biological motion. *Perception*, 22 15- 22
- Dong, Y., Fukuyama, H., Honda, M., Okada, T., Hanakawa, T., Nakamura, K., Nagahama, Y., Nagamine, T., Konishi, J., Shibasaki, H.(2000). Essential role of the right superior parietal cortex in Japanese kana mirror reading: An fMRI study. *Brain*, 790-9.
- Ehri, L.C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading*, 9(2), 167–188

- Ehri, L., & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading and Writing Quarterly*, 14, 135-163.
- Fadiga, L., Fogassi, L., Pavesi, G., Rizzolatti, G. (1995). Motor facilitation during action observation: a magnetic stimulation study. *Journal of Neurophysiology*, 73, 2608 - 2611
- Farrer, C., Franck N., Georgieff, N., Tiberghien, G., Marie-Cardine, M., Daléry, J., et al. (2001). Confusing the self and the other. Impaired attribution of actions in patients with schizophrenia, *Schizophrenia Bulletin*
- Farrer, C., & Frith, C. D. (2002). Experiencing oneself vs another person as being the cause of an action: The neural correlates of the experience of agency. *NeuroImage*, 15(3), 596-603.
- Farrer, C., Franck, N., d'Amato, T., and Jeannerod, M. (2004). Neural correlates of action attribution in schizophrenia. *Psychiatry Research: Neuroimaging*, 131, 31-44.
- Farrer, C., Franck, N., Georgieff, N., Frith, C. D., Decety, J. and Jeannerod, M. (2003). Modulating the experience of agency: a PET study. *Neuroimage*, 18, 324-33.
- Farrer, C., Franck, N., Paillard, J., & Jeannerod, M. (2003b). The role of proprioception in action recognition. *Consciousness and Cognition*, 12(4), 609-619.
- Farrer, C., Frey, S. H., Van Horn, J. D., Tunik, E., Turk, D., Inati, S., et al (2007). The angular gyrus computes action awareness representations. *Cerebral Cortex*.
- Feinberg, I. (1978) Efference copy and corollary discharge: Implications for thinking and its disorders. *Schizophrenic Bull*, 4, 636-640
- Feinberg, T. E., Haber, L. D. M., & Leeds, N. E. (1990). Verbal asomatognosia. *Neurology*, 40, 1391-1394.
- Fink, G. R., Marshall, J. C., Halligan, P. W., Frith, C. D., Driver, J., Frackowiack, R. S. J. And Dolan. R J. (1999). The neural consequences of conflict between intention and the senses. *Brain*, 122, 497-512.
- Fourneret P, Franck N, Slachewsky A, Jeannerod M.( 2001). Self-monitoring in schizophrenia revisited. *NeuroReport*, 12:1203-8.
- Fourneret, P. and Jeannerod, M. (1998). Limited conscious monitoring of motor performance in normal subjects. *Neuropsychologia*, 36, 1133-40.
- Frith, C. (1992) *The Cognitive Neuropsychology of Schizophrenia*, Erlbaum

- Gallagher S (2000) Philosophical conceptions of the self: implications for cognitive science. *Trends Cognitive Science*, 4:14-21
- Gallagher, S. (2004). Neurocognitive models of schizophrenia: A neurophenomenological critique. *Psychopathology*, 37(1), 8-19.
- Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain*, 119(Pt 2), 593-609.
- Gallup, G. G. (1970, January 2). Chimpanzees: Self-recognition. *Science*, 167, 86-87.
- Gangitano M, Mottaghy F M, Pascual-Leone A, (2001). Phase-specific modulation of cortical motor output during movement observation. *NeuroReport* 12 1489 - 1492
- Gazzaniga, M. (1995) Consciousness and the cerebral hemispheres. *Cognitive Neurosciences* pp. 1391-1400
- Gazzaniga, M. and Gallagher, S. (1998) The neuronal Platonist. *J. Conscious*, 706-717
- Georgieff, N., Jeannerod, M. (1998) Beyond consciousness of external reality: a "Who" system for consciousness of action and self-consciousness. *Conscious Cognitive*, 7:465-477.
- Gillihan, S., Farah, M. (2005). Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience. *Psychological Bulletin*, vol 131, n1, 76-97.
- Goldman-Rakic, P.S., Selemon, L.D. (1997). Functional and anatomical aspects of prefrontal pathology in schizophrenia. *Schizophrenic Bull*, 23:437-58.
- Grèzes, J., Decety, J. (2001) Functional anatomy of execution, mental simulation, observation, and verb generation of actions: a meta-analysis. *Hum Brain Mapp* 12:1-19
- Hill, H., Bruce, V., (1996). Effects of lighting on the perception of facial surfaces. *Journal of Experimental Psychology: Human Perception and Performance*, 22 986-1004
- Hill, H., Schyns, P.G., Akamatsu, S., (1997). Information and viewpoint dependence in face recognition. *Cognition*, 62 201- 222
- Hodges, J. R., & McCarthy, R. A. (1993). Autobiographical amnesia resulting from bilateral paramedian thalamic infarction. *Brain*, 116 921-940.
- Jeannerod, M (2006) *Motor cognition*. Oxford University Press, United Kingdom Oxford
- Jeannerod, M. (1999). To act or not to act: perspectives on the representation of actions. *Q J Exp Psychol*, 52A:1-29.

- Jeannerod, M. (1997). *The cognitive neuroscience of action*. Cambridge, MA: Blackwell.
- Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception & Psychophysics*, 14(2), 201-211.
- Jokisch, D., Daum, I., & Troje, N. F. (2006). Self recognition versus recognition of others by biological motion: Viewpoint-dependent effects. *Perception*, 35, 911-920.
- Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An event-related fMRI study. *Journal of Cognitive Neuroscience*, 14, 785-794.
- Keysers, C., & Perrett, D. I. (2004). Demystifying social cognition: A Hebbian perspective. *Trends in Cognitive Sciences*, 8(11), 501-507.
- Knoblich G, Flach R. (2003). Action identity: evidence from self-recognition, prediction, and coordination. *Conscious Cognition*, 12(4):620-32.
- Knoblich, G., & Prinz, W. (2001). Recognition of self-generated actions from kinematic displays of drawing. *Journal of Experimental Psychology: Human Perception and Performance*, 27, 456-465.
- Krashen, S. (2001). More smoke and mirrors: A critique of the National Reading Panel report on fluency.
- Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology*, 95,3-22
- Langdon, R., & Coltheart, M. (2001). Visual perspective-taking and schizotypy: Evidence for a simulation-based account of mentalizing in normal adults. *Cognition*, 82(1), 1-26.
- Leedham, G. Sumit Chachra Writer (2003). Identification using Innovative Binarised Features of Handwritten Numerals, Document Analysis and Recognition,
- Leedham, G., (1999). Image analysis tools for authentication and enhanced classification of handwritten script using forensic techniques - *Final Report (RG25/95)*, Nanyang Technological University.
- Legrand, D., Ruby, P. (2009). What is self specific? Theoretical investigation and critical review on neuroimaging results. *Psychological Review*, Vol 116. N. 1. 252-282.
- Lewin, C., & Herlitz, A. (2002). Sex differences in face recognition ± Women's faces make the difference. *Brain and Cognition*, 50, 121-128.

- Lewis, M., Sullivan, M. W., Stanger, C., & Weiss, M. (1989). Self development and self-conscious emotions. *Child Development*, 60, 146-156.
- Lewis, M., Brooks-Gunn, J. (1979). *Social cognition and the acquisition of self*. New York: Plenum.
- Lewis, M., Brooks-Gunn, J., & Jaskir, J. (1985). Individual differences in visual self-recognition as a function of mother-infant attachment relationship. *Developmental Psychology*, 21, 1181-1187.
- Lin, C.-Y., Xiao, Z.-W., Shen, L., Zhang, J.X., & Weng X.-C. (2007). Similar brain activation patterns for writing logographic and phonetic symbols in Chinese. *Neuroreport*, 18(15):1621-5.
- Marcel A.J. (2003) *The sense of agency: awareness and ownership of action*. In: Roessler J, Eilan N (eds) *Agency and self-awareness: issues in philosophy and psychology*. Oxford University Press, Oxford, pp 48-93
- Marien, P., Pickut, B.A., Engelborghs, S., Martin, J., De Deyn, P.P. (2001) Phonological agraphia following a focal anterior insulo-opercular infarction. *Neuropsychologia*, 1;39(8):845-55.
- Mather, G., Murdoch, L., (1994). Gender discrimination in biological motion displays based on dynamic cues *Proceedings of the Royal Society of London*, 258 273-279
- Matthys, K., Smits, M., Van der Geest, J.N., Van der Lugt, A., Seurinck, R., Stam, H.J., Selles, R.W. (2009). Mirror-induced visual illusion of hand movements: a functional magnetic resonance imaging study. *Arch Phys Med Rehabil*. 90(4):675-81.
- McBride-Chang, C. (2004). *Children's Literacy Development*. Texts in Developmental Psychology Series. London: Edward Arnold/Oxford Press.
- Meltzoff, A. N., & Gopnik, A. (1993). The role of imitation in understanding persons and developing a theory of mind. In S. Baron, *Understanding Other minds: Perspectives from autism* (pp. 335-366). New York: Oxford University Press.
- Michela Balconi (2010). *Neuropsychology of the sense of Agency: from consciousness to action*. Springer
- Kuhn, M.R., Schwanenflugel P.J., Morris R.D. (2006). Teaching children to become fluent and automatic readers. *Journal of Literacy Research*, 38: 357.
- Neisser, U. (1988) Five kinds of self-knowledge. *Philos. Psychol.* 1, 35-59

- Neisser, U. , Fivush, R. (1994) *The Remembering Self : Construction and Accuracy in the Self-Narrative*, Cambridge University Press
- Nielsen, T. I. (1963). Volition: a new experimental approach. *Scandinavian Journal of Psychology* 4, 225–30.
- Peelen, M.V., Wiggett AJ., Downing PE. (2006). Patterns of fMRI activity dissociate overlapping functional brain areas that respond to biological motion. *Neuron*. 16;49(6):815-22.
- Peuskens, H., J. Vanrie, K. & Verfaillieand G. A.(2005). Orban Specificity of regions processing biological motion. *European Journal of Neuroscience*, Vol. 21, pp. 2864–2875.
- Platek, S. M., & Gallup, G. G. (2002). Self-face recognition is affected by schizotypal personality traits. *Schizophrenia Research*, 57, 81–85.
- Preilowski, B. (1979) Self-recognition as a test of consciousness in left and right hemisphere of 'split-brain' patients. *Act. Nerv. Super. Praha*. 19 343–344
- Prinz, W., (1997) Perception and action planning" *European Journal of Cognitive Psychology* 9 129 – 154
- Rawlins, W. K. (1992). *Friendship matters: Communication, dialectics, and the life*
- Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Reviews Neuroscience*, 27, 169–192.
- Rizzolatti, G., Fogassi, L., & Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews Neuroscience*, 2(9), 661–670.
- Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology*, 35, 677–688.
- Rubin, R. (1980). *Children's Friendships*. Harvard University Press, Cambridge.
- Schaeffer, N., Cavallo, S. A., Wall, M., & Diakow, C. (2002). Speech breathing behavior in normal and moderately to severely dysphonic subjects during connected speech. *Journal of Medical Speech-Language Pathology*, 10, 1–18.
- Schütz-Bosbach, S., Mancini, B., Aglioti, S. M., & Haggard, P. (2006). Self and other in the human motor system. *Current Biology*, 16(18), 1830–1834.
- Searle, J. (1983) *Intentionality*. Cambridge University Press, United Kingdom  
Cambridge

- Sebanz, N., Knoblich, G., Stumpf, L., & Prinz, W. (2005). Far from action-blind: Representation of others' actions in individuals with autism. *Cognitive Neuropsychology*, 22, 433–454.
- Selman, R. L. (1980). *The growth of interpersonal understanding*. New York: Academic Press.
- Selman, R. L., Beardslee, W., Schultz, L. H., Krupa, M., & D. Podorefsky, D. (1986). Assessing adolescent interpersonal negotiation strategies: Toward an integration of structural and functional methods. *Developmental Psychology*, 22, 450–459.
- Sheffert, S.M., Pisoni, D.B., Fellowes, J.M., Remez, R.E. Learning to recognize talkers from natural, sinewave, and reversed speech samples. *J. Exp. Psychol. Hum. Percept. Perform.* 2002;28:1447–1469.
- Sirigu, A., Daprati, E., Pradat-Diehl, P. (1999) Perception of self-generated movement following left parietal lesion. *Brain* 122:1867-1874
- Srihari, S.N., Sung-Hyuk Cha, and Sangjik Lee, (2001). Establishing handwriting individuality using pattern recognition techniques. *Proceedings of the Sixth International Conference on Document Analysis and Recognition*, pp. 1195 –1204.
- Synofzik, M., Vosgerau, G., Newen, A. (2008) Beyond the comparator model: a multifactorial two-step account of agency. *Conscious Cognition*, 17:219-239
- Tarr, M.J, Bulthoff, H.H, (1995). Is human object recognition better described by geometric structural descriptions or by multiple views? *Journal of Experimental Psychology: Human Perception and Performance*, 21 1494- 1505
- Troje, N.F., (2002a). Decomposing biological motion: a framework for analysis and synthesis of human gait patterns. *Journal of Vision*, 2 371-387
- Troje, N.F., (2002b). The little difference: Fourier-based gender classification from biological motion. *Dynamic Perception Eds R P Wurtz, M Lappe* (Berlin: Aka Verlag) pp 115-120
- Tsakiris, M., Hesse, MD., Boy C. (2007) Neural signatures of body ownership: a sensory network for bodily self-consciousness. *Cerebral Cortex* ,17:2235-2244
- Tsakiris, M. and Haggard, P. (2003). Awareness of somatic events following a voluntary action. *Experimental Brain Research*, 149, 439–46.
- Tsakiris, M. and Haggard, P. (2005). The rubber hand illusion revisited: visuotactile integration and self-attribution. *Journal of Experimental Psychology. Human Perception and Performance*, 31, 80–91.

- Turk, D.J., Heatherton, T. F., Kelley, W. M., Funnell, M. G., Gazzaniga, M. S., & Macrae, C. N. (2002). Mike or me? Self recognition in a split-brain patient. *Nature Neuroscience*, 5, 841-842.
- Van Beers R. J., Wolpert, D. M., Haggard, P. (2002). When feeling is more important than seeing in sensorimotor adaptation. *Current Biology*, 12(10), 834-837.
- Van Sommers P. (1984) *Descriptive and Experimental Studies of Graphic Production Processes. Drawing and Cognition*. Cambridge University Press
- Vogeley K., Fink GR. (2003) Neural correlates of the first-person-perspective. *Trends Cognitive Science* 7:38-42
- Weinberger D.R., Berman K.F. (1996).Prefrontal function in schizophrenia: confounds and controversies. *Philos Trans R Soc B Biol Sci*, 351:1495-503.
- William K. Rawlins (1992). *Friendship Matters: Communication, Dialects, and the Life Course*
- Williams, H. L., Conway, M. A., & Cohen, G. (2008). *Autobiographical memory*. In G. Cohen & M. A. Conway (Eds.), *Memory in the Real World* (3rd ed., pp. 21-90). Hove, UK: Psychology Press.
- Wolpert D.M., Ghahramani Z (2000) Computational principles of movement neuroscience. *Nature Neuroscience*, 3:1212-1217.
- Wolpert, D.M., Ghahramani, Z. and Jordan, M. I. (1995). An internal model for sensorimotor integration. *Science*, 269, 1880-2.
- Wright D.B., Sladden B. (2003). An own gender bias and the importance of hair in face recognition. *Acta Psychologica*, 114, 101-114
- Wright DB, Sladden B. (2003).An own gender bias and the importance of hair in face recognition. *Acta Psychol*, 114(1):101-14.
- Wu C.Y., Ho M.H., Chen S.H. (2012). A meta-analysis of fMRI studies on Chinese orthographic, phonological, and semantic processing. *Neuroimage*, 15;63(1):381-91
- Zahn-Waxler C., Radke-Yarrow M., King, R. A. (1979). Child-rearing and children's prosocial initiations toward victims of distress. *Child Development*, 50, 319-330.
- Deterion Theory (2013) [www.en.wikipedia.org/wiki/Detection\\_theory](http://www.en.wikipedia.org/wiki/Detection_theory)
- Pat Keating (2004), [www.linguistics.ucla.edu/faciliti/facilities/statistics/dprime.htm](http://www.linguistics.ucla.edu/faciliti/facilities/statistics/dprime.htm)
- Corpus of written Italian, [www.dev.sslmit.unibo.it/corpora/corpora.php](http://www.dev.sslmit.unibo.it/corpora/corpora.php)