PROBING FACILITATED COMMUNICATION BEYOND THE STATE OF THE ART: NEW SCIENTIFIC APPROACHES TO TEST LIMITS, POTENTIALS AND UNDERLYING MECHANISMS.

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Dedicated to anyone who has not found their voice yet.

Abstract

Little attention has been dedicated to the potential underlying mechanisms of Facilitated Communication (FC) beyond the ideomotor hypothesis. Moreover, few interventions in clinical psychology have resulted in such a polarized controversy. The main aims of this project are to address and disentangle the contradictory results, partially responsible for this controversy, and to study FC with a range of methods, with the hope of stimulating a change of perspective on the technique itself and on the ways it can and should be researched. The programme of research reported in this thesis comprises one study utilizing the traditional paradigm for researching FC (namely, the message passing test), one thematic analysis of texts written via FC, two experimental studies on the effect of touch on attention (in a lexicon decision task) and on writing style in the general population, and one complex data collection using an array of specialist techniques of measurements. All of the results collected through these very different methods suggest that all-or-nothing' explanations of FC will not likely do justice to the complexity of the matter at hand. On the contrary, a hypothesis of FC as a fluid phenomenon, functioning through co-acting processes, in a perspective of joint action, appears to be consistent with the research carried out. FC-user-Facilitator partnerships might then move on a continuum between independent typing, typing with a "simple touch" and typing with facilitation, which might include a number of added supports, influence, and priming.

FIGURES

TABLES

Introduction

Facilitated Communication (FC) and its underlying mechanisms are analysed from several vantage points in this project. FC was developed as a mean of communication for people with severe disabilities within the frame of Alternative and Augmentative Communication (AAC) approaches. Individuals using this technique tend to have complex disabilities with multiple impairments of a severe speech production impairment and a motor disorder (dyspraxia, muscle tone issues, or movement initialization issues), generally within a diagnostic frame of neurodevelopmental disorder or genetic syndrome. In simple words, these are individuals that do not speak and struggle to simply pick up a pen and write or type on their own. The main idea behind this technique is for individuals that would not otherwise have any functional communication means to express themselves by reducing the complexity of writing to pressing a single key at a time.

In this technique, a facilitator provides emotional support and maintains physical contact with the person while s/he uses a communication aid, usually the keyboard of a computer, but also signs with pictures and words (in this case, the communication is restricted to multiple choice). The person who uses this technique is called the communicator or FC-user in the international literature (in this thesis, the term FC-user will be used). The facilitator stabilizes and supports the movements of the FC-user, touching their hand, arm, or shoulder while s/he makes the pointing movement to indicate keys on a keyboard/letter board.

The different positions of the physical contact indicate the so-called level of facilitation. Hence, expert communicators use high point of facilitation (shoulder, back, leg, head, and so forth), often with years of experience and limited motor pathology. Conversely, a communicator who is not autonomous in isolating the index finger will need lower facilitation at the level of the hand. High and low adjectives, therefore, reference the body part where the physical contact occurs. This terminology is used in several countries, including Italy, the place of origin of all the FC-user participants in this research project.
In Anglo-Saxon countries, by way of contrast, the adjectives high and low are used not to refer to the part of the body but to the “quantity” of facilitation needed. Therefore, a low level of facilitation indicates a hand on a shoulder, and a high level of facilitation indicates a

hand on the wrist. Note that, since, in this thesis, an embodiment point of view will often be embraced, it seems only fit to use the body as the point of reference.

After each key typing, the facilitator will bring the FC-user's dominant hand back toward their chest and away from the keyboard; this movement is called the *return gesture*, and it is often done by the facilitator (other times, the FC-user might do it themselves) applying force against movement or withholding the FC-user's movement toward the keyboard. The reasoning behind is to provide a specific and defined typing rhythm, stop any perseveration and impulsiveness, and train the gesture in cases of problems with the initiation of the movement.

The description of FC provided above is based on the assumption that FC is, at least to some degree in some cases, a valid communication aid. This is not a shared perspective in the eyes of a large part of the scientific community researching FC. On the contrary, several authors (see Mostert, 2001, 2010 and 1012 for reviews) have defined FC as an invalide technique in which the facilitator, and not the user, is considered the author of the writing. It is supposed that there is a significant influence on behalf of the facilitator on the user's movement, though not necessarily within the awareness of the facilitator.

Communicative autonomy is always the ultimate goal of any FC training and, where successful, is achieved through a gradual reduction of physical support. Usually, the amount of required facilitation decreases over time, such as passing from a low (hand) to a high (shoulder) facilitation. However, there are objective obstacles in cases of significant motor pathology. Only a small percentage of FC-users (no specific data was found in the literature) achieve relative autonomy (high point of facilitation). The main variables that might be prognostic of independent typing are yet to be determined. Good candidates are the absence of important motor impairments, early and sensible use of the technique, once again, what characterizes a sensible use of the technique is yet to be determined, here it refers mainly to a cautious but extended (with several facilitators in different contexts) use which will be examined in detail later on.

Researcher's positionality. In terms of my own positioning with regards to FC, I started work in the area as a communication assistant (using various communication techniques, including facilitated communication) between 2011 and 2014. I have been supervising clinical cases (since 2020) in the capacity of clinical psychologist in which FC is

used. When I first encountered FC, I had doubts about the authorship of the text, but I saw very clearly the positive effect on self-image, self-esteem, social participation, and so forth.

I should mention that the person with whom I learned about FC could not isolate their index finger. This FC user has some of the most severe motor impairments that I have seen in a typist. A significant amount of what was written via FC was reasonable and non-verifiable information, such as “I prefer apples to oranges” or “I didn’t like that movie; it was scary." I continue using the technique (and other AAC techniques) at home with this one person because, to me, it was clearly verifiable the significant change in how the world treated this person on the basis if their usage of FC.

Their significant impairments made it so that any form of pointing needed to be supported. And indeed it became evident that this person could benefit from all-around facilitation of movements (from walking to sitting to eating). I subsequently experienced a ‘message passing’ event, in a natural setting. The person I was supporting typed specific information that I had no previous knowledge of and that I could not have known (details of an unexpected and unlikely event). It was a pivotal moment in my life when the need to understand this technique, together with its benefits and limitations, became compelling.

I knew then that I was experiencing something important, something that could help reduce the prejudice and attributions of communicative incompetence that many people with disabilities are subjected to. This person often spoke of FC as the only key to escape the cage of their body that did not obey their own wishes and commands.

I remember spending the following weeks using every free moment to study the scientific literature and becoming even more confused. I went to conferences, asked a lot of questions, trained as a facilitator, and did my post-master's year of internship in a facility that provided FC. I wrote a research project and applied to several Italian universities.I was told there might be interest in me enrolling for a PhD with them if I was willing to work on something other than FC. I wasn’t interested in doing a PhD for the sake of it; I wanted to research FC.

I saw a presentation by Anne Emerson in Mestre (Italy), where she presented the research she and Andy Grayson had carried out working with eye-tracking glasses. It was incredible work. I emailed Anne Emerson, and from there, enrolled at Nottingham Trent University for a PhD.

A large part of the research carried out and presented in this PhD thesis was

conducted with the collaboration, input, and participation of individuals with disabilities. Their role was not that of mere participants. They were included in the design of some studies and in the interpretation of results (Slattery et al., 2020). FC-users, facilitators, psychologists, speech and language therapists, and other professionals were all asked to participate, provide their expert feedback, and then provide their opinion on the design of certain studies.

Individuals with disabilities that use FC are referred to as FC-users throughout the thesis, but in the relationship between myself and them, I have always addressed them as co-researchers, making sure that any and all participation would be positive in their lives regardless of results. I also provided individuals feedback on results where they were requested by me and they could help in their everyday lives (for example, message passing results requested by a speech and language therapist and by a teacher).

Brief history. FC was developed as an Alternative Augmentative Communication technique independently in several countries (Sweden, Canada, Denmark, Australia, Ireland, Japan and the United States) spontaneously. The first article on communication with physical support was published in 1961, describing an experience of facilitated handwriting carried out with autistic individuals (Oppenheim, 1961). The article states that it was possible for some students with autism to write, physically supporting their hand and gradually reducing the support. To write, the children required a touch on their finger or some other body part, for example, the head. Several documented examples of individual families using the technique between the end of the seventies and the beginning of the eighties (Eastham & David, 1990; Schawlow & Schawlow, 1985).

FC was used with this name for the first time in Australia in the early 70s by educationalist Dr Rosemary Crossley, a teacher at St. Nicholas Hospital. This institution housed people with physical and intellectually disabilities. Crossley began experimenting with 12 young individuals of this hospital diagnosed as 'severely mentally impaired', for which there was no specific rehabilitation program (Crossley et al., 1980). Crossley observed that children could understand verbal language much more than expected, given their physical condition and performances. She began to develop a straightforward form of communication that would allow each child to give a positive or negative answer to questions asked. The answers showed that the children had an unexpected level of understanding, understood

quickly, and some even had unsuspected knowledge, given that they did not have ordinary learning opportunities. She also observed that they accurately identified objects or letters as long as their hand was supported.

In 1986 Crossley opened the DEAL Center for Communication (Dignity, Education, Advocacy and Language) in Melbourne, renamed the Anne McDonald Center in 2011. The Center was attended by individuals, mainly of developmental age, living with various disorders with severe communication deficits. Crossley committed herself to spread FC in Australia and abroad.

In 1989 Douglas Biklen, professor of Special Education at the University of Syracuse (NY), went to Australia to conduct an observation of FC at the DEAL Centre in which Crossley worked. Three years later, he founded the Facilitated Communication Institute at The University of Syracuse. Since then, the use of the technique has grown, and its use has expanded in the US. In 1992 Biklen established the Institute for Facilitated Communication at Syracuse University, where he promoted the training of facilitators. In the following year, the first controversies on Facilitated Communication arose, and several studies were carried out to verify whether the facilitators influenced the material produced.

In 1990 a collaborator of prof. Biklen, speech therapist Shubert, introduced the method in Germany, illustrating the method to a group of parents of children with autism in Berlin. There are experiences of Facilitated Communication of some interest also in France, where the speech therapist Anne-Marguerite Vexiau used FC at the centre (Vexiau, 1996) that she founded in Sureness, the EPICEA (Teaching and Practical Information on Communication Child with Autism).

In the early '90s, Facilitated Communication was introduced in Italy by Patrizia Cadei, who, after learning the technique from Biklen used it with her autistic son and founded, together with the speech therapist Francesca Benassi, the Study Center for Facilitated Communication, to ensure its dissemination, protection of correct use, to promote research and training of facilitators (Pozzar, 2001; Wehrenfennig et al., 2008a). Some years later, the Centro Studi changed its setting and became WOCE (Written Output Communication Enhancement). Meanwhile, centres and associations that use the technique in Italy and organise training courses for facilitators multiply, developing increasingly thorough and stringent protocols (Sesti et al., 2016).

Thesis outline. Although there is substantial literature on Facilitated Communication (FC), little attention has been paid to the potential underlying mechanisms of the communication technique apart from analysis from an ideomotor perspective. Furthermore, few interventions concerning disability have ever polarized opinions as much as Facilitated Communication (FC) technique. The enthusiasm of users, relatives, and practitioners clashes with a highly critical, often disparaging opinion of the scientific community. Reconciling these two positions is even more difficult in light of the fact that, to date, we have no valid, scientific explanation for why FC may (even in just a few cases) work.

The general aim of this project is to investigate FC with various methodologies and viewpoints and encourage a shift both on FC research and FC conceptualization. Chapter 1 introduces the topic by analysing the existing literature, its merits, and its limitations. Chapter 2 presents a study on message passing as a skill to be acquired, including both the training and the actual message passing test. Chapter 3 contains a set of FC-users' testimonies on the functioning and underlying mechanisms of the technique that are presented through a thematic analysis.

These testimonies supported the development of two studies on the effect of touch on attention and language production in the general population, which can be found in Chapter 4. Chapter 5 presents a complex data collection on FC using eye-tracking glasses, EMG and motor sensors and the analysis focuses on the FC-user and facilitator's pattern of muscular activation. Finally, a general discussion follows (Chapter 6), addressing and summing up all of the research conducted in this PhD and proposing a) a new explanation of how FC might work in certain cases, b) a shift in the current literature, c) a hypothesis on the development of thought and speech of individuals with disabilities and how this reflects on AAC communication techniques usage, d) future research.

All the studies conducted have been carried out with the ethical approval of the School Research Ethics Committee, adhering to the University's Research Ethics Policy and the ethical guidelines published by the British Psychological Society.

1. State of the Art

The analysis of the literature proposes an intriguing scenario. There is substantial evidence that denies the validity of FC, and an even more extensive number of studies provide results that support FC as well. The core of the discussion around facilitated communication concerns the "authorship" of the writings. FC detractors argue that texts written in FC are the product of the facilitators involved in the writing process; on the contrary, those who support the technique recognise the authorship of people with disabilities in their writings.

1.1. Introduction

Before presenting the state of the art, I hope the reader will agree that a brief motivational preamble is needed. The one piece of information the large majority of individuals that have been in contact with FC have is that it is a controversial technique, not accepted or accredited by numerous international institutions. Hence, before tackling the matter of the literature, it's important to explicitly state why FC is considered important by its supporters.

Communication is a basic human need; it's intrinsic to all our relationships and survival, and it is a legal human right. The Universal Declaration of Human Rights, Art. 19, states that "everyone has the right to freedom of opinion and expression." The Convention of the Rights of Persons with Disabilities (Márton et al., 2013) also establishes the right to communication, including AAC modes and techniques, underlying the importance of accessability to information and communication to enable “persons with disabilities to fully enjoy all human rights and fundamental freedoms."

Unfortunately, it seems that for some individuals with multiple impairments, speech

therapy seems to be an ineffective intervention (Jaswal et al., 2020), and evidence suggests that AAC techniques are effective for communicating everyday life needs but not developing more complex languages (Yu et al., 2020). When there seems to be a lack of effective intervention strategies to support fully alphabetic language expression, it becomes easier to understand why there is such a forceful defence of FC by its supporters.

There are currently approximately 250 published articles in the international literature, including various review articles. At first glance at the existing literature, a consistent finding is that FC emerges as a valid approach in most naturalistic studies whereas practically all experimental studies via message passing question the validity of FC (Hirshoren & Gregory, 1995; Myles et al., 1994; Simpson & Myles, 1995; Smith et al., 1994; Vázquez, 1995). These two different types of studies, while testing both the validity of the technique, use very different methodologies (although it should be noted that naturalistic studies have investigated broader topics not limited to the authorship matter).

Naturalistic, case study and observational studies have been using a wide range of methodologies including direct observation, clinical evaluations, linguistic analysis, the registration of naturally occurring message passing (FC-user communicating something while facilitated by a facilitator not aware of the content written), video analysis, and message passing test without a control condition (Bernardi & Tuzzi, 2011; Biklen et al., 1995; Biklen & Cardinal, 1997; Biklen & Duchan, 1994; Broderick & Kasa-Hendrickson, 2001; Crossley, 1997; Emerson et al., 2001; Goddard & Goddard, 2012; Grayson et al., 2012; Janzen-Wilde et al., 1995; Niemi & Kärnä-Lin, 2002; Robledo & Donnellan, 2008; Weiss et al., 1996).

In contrast, experimental studies have used one type of methodology, which is the message passing test: comparing the accuracy of responses when the facilitator knows the correct answer to a question (informed condition) with the accuracy when only the communicator but not the facilitator, knows the correct answer (so-called blind condition). In some studies, a third condition is added, the “misinformed condition” where the facilitator is given a piece of different information to the one given to the facilitator, testing the percentage of direct facilitator influence.

Over 100 of the qualitative articles have been published in professional peer-review journals, and about 40 articles about message passing with control condition (Cardinal &

Falvey, 2014). Most of the quantitative studies were carried out in the 1990s, while qualitative peer-review studies have increased significantly since then (Cardinal & Robledo, 2012).

1.2. Message passing

As reported in many reviews (Green & Shane, 1994; Hemsley et al., 2018; Hudson, 1992; Jacobson et al., 1995; Mostert, 2001, 2010, 2012a; Probst, 2005; Schlosser et al., 2014; Simpson & Myles, 1995; Wehrenfennig et al., 2008a), roughly all experimental studies provided solid evidence that the facilitator, unknown to them, is to be considered, in large part, the author of the produced text. However, what is very interesting and little noticed is the variability of these results.

For example, all seventeen studies included in Wehrenfennig and Surian's review showed a higher percentage of correct answers in the condition of informed facilitator compared to the blind condition (facilitator does not know the answer). Seven of these studies reported no, or hardly any, correct answers in the blind condition (Bligh & Kupperman, 1993; Hirshoren & Gregory, 1995; Myles et al., 1994, 1996; Simpson & Myles, 1995; Smith et al., 1994; Vázquez, 1995). Five studies report success rates of around 10 per cent. Another five studies find correct answers that vary from 13,2 per cent to 30,6 per cent (Bebko et al., 1996; B. Braman & Braman, 1995; Cabay, 1994; Kerrin et al., 1998; Vázquez, 1994).

If, on the one hand, these results clearly argue against FC, on the other side, there is some evidence that some of the communicators are at least partially autonomous in responding. It is interesting that in these studies (all published in peer-review journals and all with control conditions), there is a marked difference in the percentage of success rates (from 0 to 30 per cent) that has yet to be explained. One publication suggests that FC might be working only in some situations and only with some communicators (Weiss et al., 1996).

Supporters of FC have often criticized many experimental studies for not taking into consideration numerous variables that can interfere with the use of facilitated communication (Biklen & Cardinal, 1997; Cardinal et al., 1996), creating unusual communication settings. For example, Cardinal and colleagues (Cardinal et al., 1996) criticize the short time of many experiments, whereas Biklen and Cardinal (Biklen & Cardinal, 1997) argue that the artificiality of the tasks, the unfamiliar experimental conditions and the

presence of strangers may explain the results of many experiments. Biklen (1993, 2005) has argued that many FC-users might have difficulties in word finding, also known as retrieval difficulties, and dyspraxia, which can mean difficulty in starting and ending a movement.

In fact, several studies have used as participants individuals with little FC experience, individuals that did not know each other (facilitator and FC-user) and have provided no specific training assuming that the skill required for a message passing test are the same ones required for using FC in daily life (Biklen & Cardinal, 1997; Pavon, 2018). Subsequently, some researchers have removed potentially interfering variables. For instance, different studies have used experimental designs that develop over several weeks, thereby taking into account the variable of time needed to see improvement (Bebko et al., 1996; B. J. Braman et al., 1995; Eberlin et al., 1993; Vázquez, 1994). Others have conducted studies with no time pressure such that the communicator was allowed to finish the task in multiple sessions (Cabay, 1994; Konstantareas, 1998).

Some researchers have used naturalistic tasks that were familiar to the communicator (Cabay, 1994; Kerrin et al., 1998; Simon et al., 1994; Vázquez, 1994, 1995). In other studies where the facilitator and communicator did not know each other, a phase of familiarization was provided (Eberlin et al., 1993; Myles et al., 1994). For example, in Eberlin and colleagues study (1993) the facilitator and FC-user who didn't know each other were asked to spend time together for a span of two or more weeks. Whereas some researchers have allowed FC-users to familiarize themselves with the experimental procedure, context and tools before starting the actual experiment (Calculator & Hatch, 1995; Konstantareas, 1998). Furthermore, in parallel to the message passing task, an independent pointing task and a wide range of acceptable responses to address possible word findings difficulties were assessed (Saloviita et al., 2014).

Results of all of these studies are not significantly different thus, even under these more favourable and naturalistic conditions, FC has not been validated, although the variability in results continued, apparently unnoticed (Mostert, 2001). Moreover, it should be noted that none of these studies controlled simultaneously for the entire list of variables hypothesized to interfere with FC. If FC functionality were based on a process of mutual knowledge, support, trust and co-production, a familiarization phase with new and/or poorly trained facilitators (e.g. in Myles 1994, one of the participation critiria for teachers

recruitments was a “lack of prior experience with FC”) would still result in no significant difference, not to mention using participants that have not been using FC long.

There are a number of exceptions, three in particular, in which message passing studies have shown FC-users being able to pass specific messages being facilitated by a blind facilitator (Cardinal et al., 1996; Sheehan & Matuozzi, 1996; Weiss et al., 1996). Furthermore, there are other possible influencing variables that have been only marginally considered in the international literature or not considered at all. These possible explanations for the variability in authorship results will now be briefly reviewed.

1.2.1. *Motivation and implications of authorship testing:* Experiments on FC authorship test the communicator’s ability to comprehend and write. As such, they provide, in theory, an opportunity for the participants to demonstrate their ability to think. However, as reported by Crossley, testing is experienced as particularly threatening by many communicators because of the implication related to the test itself (Crossley 1980, 1997
Let us assume for a moment that these individuals have, in fact, cognitive abilities similar to those of their peers and that FC is the only way for them to communicate. If FC were found not to be a valid technique, FC-users would lose their one and only communication aid and would be relegated once again to a silent, passive, static, and incapable role.
The concept of intellectual disability and its link to communication skills are important notions for both clinicians and researchers, but also for communicators. This may have been underestimated in research. As a case in point, Annie McDonald, as recorded in the official records of the Supreme Court of Victoria, was always willing to demonstrate her competence, her learning abilities and her mathematics skills, yet she was extremely reluctant and offended by tests aimed only at authorship validation (Crossley et al., 1980).

Moreover, when there is a stereotype that is socially shared, such as people with disabilities being considered less capable, or less smart, and there is an activation of that stereotype, the worry of not confirming that stereotype is actually what can cause a reduction of working memory capacity, and therefore a reduction of performance. In other words, a message passing study could activate the stereotype and become a fertile terrain for stereotype threat (Aquino, 2011; Desombre et al., 2018a; Haft et al., 2022).

On the other hand, there are anectodical reports, and even the experience with a couple of FC-users in a study within this PhD, in which the FC-users seemed to not

understand the logic behind message passing and did not engage. And it is possible that this non engagement was because they did not see the point to it. The logic being a message passing test is obvious to researchers but might not be to FC-users.

1.2.2. *Level and experience of facilitation.* Research on FC has involved a wide range of FC-user populations, with surprisingly little attention to those FC-users who have reached a high level of autonomy. To test authorship under the most favourable conditions, considering FC as a process, researchers should focus on high point of facilitation cases. More importantly, FC-users should only be involved if they are using the technique for an extended period of time with several facilitators, in several contexts, etc. This is not always the case, as seen in several studies in which the FC-users and/or the facilitators had never used FC before the study (Bomba et al., 1996; Kezuka, 1997; Myles et al., 1996, 1996; Myles & Simpson, 1994; Simpson & Myles, 1995).

1.2.3. *Motor impairments:* In most of the studies reviewed, the diagnosis is specified, and sometimes a particular diagnosis corresponds to an inclusion criterion. However, the presence or absence of dyspraxia and apraxia is not always taken into account (Wehrenfennig et al., 2008a), which is peculiar because, according to the hypothesized mechanism underlying the FC, the touch of the facilitator is assumed to compensate for dyspraxia. In other words, it would be precisely the presence of dyspraxia (or other motor impairment) that makes it impossible or difficult for the communicator to write autonomously.

1.2.4. *Manipulation of blind facilitation*. Differential success rates may, in part, be attributed to methodological differences between studies regarding the facilitator blindness (Mostert, 2001; Wehrenfennig et al., 2008a). There are two primary ways to create a "blind facilitator" control condition, namely by withholding information (uninformed facilitator) or by providing misleading information (misinformed facilitator). Chances that the facilitator will overpower the communicator seem very high in the latter (but less in the former) manipulation. From an applied point of view, it appears more realistic to withhold information than to misinform the facilitator. Thus, it remains to be seen whether the two methodological approaches are, in part, responsible for the differential success rates.

For example, looking at a study where all three conditions were considered (facilitator informed, uninformed, and misinformed). The results are very interesting: although overall very low, the percentage of correct responses in the uninformed condition is 7.26 per cent

vs. 3.57 per cent in the misinformed condition, thus confirming a possible moderator effect (Simon et al., 1994). Moreover, an interesting finding is that in the informed condition, the percentage of correct responses is 50.86 per cent. It begs the question if the authorship could be attributed entirely to the facilitator, why then should there not be a success rate nearer to 100 per cent?

As this (partial) list of potential moderator variables suggests, there are many factors that may explain why there is such a large range in success rates across studies. Some others that, to my knowledge, were never considered in previous studies are muscle tone, pharmaceutical treatments and their collateral effects, and short-term attentional capacities. Overall, these variables might explain to some degree the results of experimental studies. As previously stated, the success rate (in terms of authorship) is, on average, very low. There is still, however, a considerable variability that needs to be explained. More generally, FC is a complex and sensitive communication support system that depends on many variables. It is, therefore, clear that approaches to studying FC that ignore its complexity (such as message passing tests) will not, on their own, be very useful as the basis for understanding and explaining the technique.

1.3. Other methodologies: video analysis, eye-tracking and correspondent speech

Some studies have recorded message passing happening in everyday usage of FC. For example, the writing of fourteen FC-users revealed that the majority of them wrote the same information with different facilitators who did not know about the previous communications (Emerson et al., 2001). Moreover, FC-users wrote specific information with different facilitators (some of whom knew very little about that person) that were not aware of that specific content, which was found to be correct. These communications were mostly about personal opinions on everyday life matters.

Intense video analysis has also been used to identify, for each FC-user participant, an individual and autonomous pattern in the gesture towards the keyboard: a movement pattern independent of the facilitator but specific to the FC-user (Grayson, 1997; Grayson et al., 2000). Similarly, eye tracking studies (Grayson et al., 2012) attempted to uncover the eye movements of FC-users within multiple writing sessions. The results show how the gaze of the FC-users dwells with a non-random frequency and constancy on the soon-to-be-typed

letters on the keyboard. These data seem to support the hypothesis that the FC-users are to be considered the authors of the writings or that at least s/he can predict the intention of their facilitator very often and direct their gaze accordingly.

The authors excluded the hypothesis that the orientation of the gaze towards the letter is a consequence of the finger's movement towards it and not vice versa, as the gaze towards the keyboard was done before the moment in which the direction of the pointing gesture became unambiguous, and in many cases before the forward movement towards the keyboard had even started (Grayson et al., 2012)

Finally, some studies have compared information from FC-writing and the verbal information resulting from the little oral language preserved by the same FC-users, finding a match (Broderick & Kasa-Hendrickson, 2001; Kasa-Hendrickson et al., 2009).

1.4. Linguistic Analysis

At first glance, the texts written in FC have unique or unusual styles; the syntax is correct but vastly different from the one used in the current language. Moreover, there seems to be an copious number of low-frequency words and the frequent use of neologisms. In particular, several studies (Biklen et al., 1991; Janzen-Wilde et al., 1995; Niemi & Kärnä-Lin, 2002; Zanobini & Scopesi, 2001) have found evidence of a specific communication profile as (a) Unexpected content, (b) Atypical spelling, (c) Unique phrases, (d) Information unknown to the facilitator, (e) Oral spelling, and (f) Self-corrections. Moreover, by performing complex statistical linguistic analyses of the writings of communicators, it was shown that FC-users use specific word patterns and sentence constructions that are different from those of their facilitators even when they share the same facilitator and vice-versa, when the same facilitator supports different FC-users (Bernardi & Tuzzi, 2011; Niemi & Kärnä-Lin, 2002; Tuzzi, 2008).

A sizeable interdisciplinary study (Bernardi, 2008) recorded cases of FC-users writing things the facilitator is not aware of (such as where they went that weekend and with whom), sometimes an FC-user will finish the word mid typing, and the FC-user's production remains stable even when the facilitator is changed or when the level of facilitation was changed.

Tuzzi (2009), in particular, has shown that individuals with autism have a richer and more complex construction in terms of the text's lexical structures, morphology, and syntax

than their facilitators. At the same time, Niemi and Karna-Lin identify lexis and spelling mistakes typical to a specific age level (Niemi & Kärnä-Lin, 2002).

1.5. The debate on Facilitated Communication

All of this pro-FC results (naturalistic studies, video analysis, eye-tracking analysis, movements studies, ethnography, interviews, narrative analysis, linguistic analysis) have not been considered as evidence supporting FC validity in the eyes of FC-detractors, mainly because the only evidence of FC effectiveness accepted seems to be from message passing tests with a control condition. All the other evidence is to be considered irrelevant and not significant (Hemsley et al., 2018). FC should be considered, as per the mainstream narrative, therefore, a result of the ideomotor process as demonstrated by (Wegner et al., 2003). The facilitator involved in the communication process would produce involuntary micro-movements that would direct the FC-users' arm to the keyboard. Due to the action projection mechanism, the result of such prompting movements would be attributed to causes outside of oneself, and consequently attributed to the FC-users.

An explanation of this type, although effective in accounting for the results of message passing testing, does not take into account some equally fundamental aspects: first of all, the denial of the FC-user's participation in the process, it begs the question how some of the least compliant clinical population would just become a micromovement antenna. Furthermore, the perception of the facilitator's micro-movements and the usage of these to guide movements aimed at the keyboard would require focused attention and relatively sophisticated cognitive skills, especially in cases where the facilitation is high, kinds of the absence of which are held to be one of the main reasons that the FC-users cannot be the authors of the disputed communication in the first place. In other words, the ideomotor interpretation of FC output is no more parsimonious than the notion that FC-users are, in part, authoring the typed communications that are attributed to them.

On the other side, supporters of FC have continued using the technique and doing research on it even though there are a large number of message-passing studies and reviews indicating how the technique is not to be considered a valid AAC technique and the facilitator is to be considered the author of the writing (Green & Shane, 1994; Hudson, 1992; Jacobson et al., 1995; Mostert, 2001, 2012a; Probst, 2005; Schlosser et al., 2014; Simpson & Myles, 1995; Wehrenfennig et al., 2008a).

As underlined by the international literature summary, the situation is more complex and intricate than is sometimes acknowledged, suggesting that maybe there is not one explanation that fits all cases of FC. If, on one hand, facilitated communication were to be fully considered an ideomotor phenomenon, then all informed facilitator cases should result in near 100 per cent correct answers, and there should be few cases at all of the message passing success (Cardinal et al., 1996; Sheehan & Matuozzi, 1996; Weiss et al., 1996). On the other hand, given the even small percentage of successful message passing, there has to be an explanation, other than the ideomotor effect, to clarify these cases.

The differences in results have contributed to the polarization of opinions and to an entrenchment of mutually exclusive positions. While supporters of FC have tried to engage with new types of research, new arguments and new formulations, the detractors of the technique have shifted the debate from a scientific discussion to a more argumentative and often attack-level (Chan & Nankervis, 2014), mocking the opposite position (Beals, 2022).

The social and media narrative on FC has helped convey the idea that those who do not think FC is a valid communication technique are defenders of a rigorous and rational scientific method, whereas the authors who do or who have found supporting evidence are exponents of anti-scientific and pseudoscientific positions. The two opposing factions, which attacked and defended the validity of the technique as a whole, seem to have lost sight of some of the more pressing questions: (a) why are there cases of successful message passing with blind facilitators, how does FC work in these cases and (b) why is there evidence of authorship when the eye-tracking methodology is used? Moreover, (c) instead of asking if FC as a whole works, why are researchers not asking if can FC be used and be useful for a specific person? (Ashby, 2018).

Clearly, studies on message passing have been tainted by a reasoning error; in cases where evidence of influence is presented, authors have directly inferred that, therefore all messages are influenced and have thus declared FC as an invalid communication technique. Similar reasoning was presented in cases with a higher percentage of successful message passing (as 47 per cent) where reviewers have viewed the evidence of some successful message passing, therefore pointed out that not all messages were successfully passed and therefore FC was to be considered an invalid communication technique (Ashby, 2018).

A careful look at the data (even excluding all other types of studies and just focusing on successful message passing studies) should certainly induce caution towards the

technique but at the same time should favour a greater in-depth study of those cases and situations in which FC has actually allowed a person to communicate who previously had not been able to do so (Wehrenfennig et al., 2008).

Understanding the FC controversy fully entails addressing the issue of competence (previously referred to in the literature as Intellectual Disability, and even before as Mental Retardation, Salvador-Carulla & Bertelli, 2007). One hypothesis suggests that the actual reason for such adversity against FC does not actually lie in the technique itself, but in the impossibility, for a large part of professionals and professional organisations, to accept that individuals with severe disabilities are capable of complex reasoning processes and the literary skills to word those thoughts (Kliewer et al., 2006; Mirenda, 2003).

In fact, when FC first became to circulate the issue professionals had with it was less about the technique itself but the fact that individuals diagnosed with intellectual disabilities were demonstrating literacy skills, writing complex texts (Mirenda, 2003). There is a long history of equating speech to thought, and therefore, lack of speech to lack of thought (Branson & Miller, 2002; Kikabhai, 2018; Kliewer et al., 2006).

Moreover, there is a history of negating and denying individuals' voices when these individuals are part of a minority (from racism to disablism). The lives and injustices perpetrated against Helen Keller and Phillia Wheatley are two well-known examples of individuals whose voices have been denied because their literacy competences have been believed to be impossible. Nowadays, there are many anecdotal cases of people with disabilities, unfortunately often reported as individual exceptions or exceptional individuals, where complex linguistic abilities are demonstrated (Kikabhai, 2018; Kliewer et al., 2006).

Individual cases, however, might not be sufficient to change the mainstraim prejudice as there seems to be an almost hegemonic root to these discriminarions and negations, supported by segregations (for example, special schools), isolation, and a medical model of viewing shortcoming and diversity instead of impairments and individualities (Deal, 2007; Friedman, 2019; Kikabhai, 2018; Kliewer et al., 2006).

1.6. Conclusion

Reading the international literature on FC and public discussion on web pages, blogs, Twitter, and so on might create, in some readers, a sense of cognitive dissonance: in a way, it reminds us of the rabbit-duck illusion () , in which it is impossible to see both animals at the same time (Jastrow, 1899).

Figure 1: Rabbit-duck illusion

Likely, the confrontational and aggressive nature of several discussions about FC, has shifted away the focus from normal scientific debate to a quasi-metaphysical debate on FC. However, there are important questions that remain to be investigated: (1) successful message passing with blind facilitators, however rare in experimental conditions, is evidence of the validity of FC for those FC-users, which poses the most interesting and important questions: How and through which mechanisms does FC work in those cases? And (2) in the cases in which FC does not appear to work, how is the spelling being produced? Since many authors objecting to the validity of the FC do not believe that there is an intentional deception going on by the facilitator, but more subtle forms of influencing about which the facilitator would likely not be conscious of (Burgess et al., 1998; Mostert, 2010; Wegner et al., 2003). If FC-users are illiterate and lacking attention and motor fine skills, how are they so skilled in perceiving micromovement from another person and acting accordingly?

To date, there are no studies that have dealt with the mechanisms potentially underlying FC. An attempt to search for references via OneSearch, PsycINFO, PubMed, and other databases, using “Facilitated Communication” or “Supported Typing” as keywords in association with "mechanism" or "explanation", yielded no valuable results.

Keeping the above metaphor, it could be argued that before deciding if the picture is, in fact, of a duck or a rabbit, one should first address the issue of why we can see two images but not at the same time and wonder how the picture has been drawn. In this project, FC will

be considered a complex and multifaceted technique with some degree of FC-user functioning and some degree of facilitator influence. The need for further research is precisely to understand the interactions and boundaries between these two factors. I suspect that, as for almost any other communication exchange in which two minds are involved (especially in educational-therapeutic settings), there is a certain degree of coproduction and mutual influencing.

Summary. The analysis of the literature paints an uncertain and heterogeneous scenario, with tones that are not conducive to increasing the knowledge on the subject. Little is known about the underlying mechanisms of FC and about the role that physical contact between facilitator and communicator plays in this picture. A large body of literature on touch and embodiment suggests that even the general population is considerably influenced by physical contact. Thus, the role of embodied processes (and their neuropsychological underpinnings) in FC, remains to be investigated.

2. Message Passing

As seen in the first chapter, the analysis of the literature has highlighted a somewhat more complicated scenario than it may appear at first sight. It seems challenging to disentangle such conflicting evidence. Moreover, message passing might have been wrongly framed as a simple experiment paradigm instead of a skill to be acquired that required a number of abilities (such as working memory), that might be insufficient in the target clinical population if not accurately trained.

2.1. Introduction

As detailed in the first chapter, Message Passing (MP) is considered in the experimental literature to be the primary research paradigm to test FC validity. In MP studies, the FC-users are asked to write specific content; usually one word, facilitated by a facilitator that was either not privy to that word (uninformed) or had been given a different word (misinformed). Sometimes the facilitator was provided with the correct word. The percentages in correct responses within the other conditions were then compared. The vast majority of these studies identify the facilitator as the author of the texts written and question the technique's validity (see for reviews Hemsley et al., 2018). There have been no further studies on message passing since 2014 (Hemsley et al., 2018). In Wehrenfennig's review (Wehrenfennig et al., 2008b), the authors report that even though in most studies the MP failed, there is nonetheless a significant difference in the percentage of success rates (varying from 0 to 30 per cent after correcting for prior probability) that has yet to be explained.

This study decided not to include a controlled condition (informed facilitator or without facilitation). Unlike previous studies, instead of considering MP as a simple research paradigm to test FC's validity, MP was considered a skill to be learned (both by the facilitator and the FC-user). From the supporter's perspective, one of the main limitations of FC is that the communicator is always placed in a position of dependence: s/he cannot fully or effectively communicate without a facilitator. It seemed, therefore, that message passing could constitute a possibility to address this issue. Moreover, testing can be challenging and draining for a person with severe and complex disabilities (and possibly a history of being assessed in a clinical setting). Therefore, it was decided to design a study in such a way as to bring benefits to the FC-users beyond the testing experience; namely, considering MP as a

skill to be acquired. It should be mentioned, every participant in the study has been asked in education and clinical settings to type on their own, and they all have failed to do so (apart from minor writing such as typing their own name or the dictated date).

The first aim of this study (aim 1a) is to examine whether FC-users can type a specific message unknown to the facilitator (uninformed) with the physical support of that facilitator if MP is conceptualized as a skill. That is to say to examine whether the percentage of correct messages passed significantly exceeds chance levels (Hypothesis 1a). The second aim is to examine MP as a skill that needs to be learned, both by the facilitator and FC-user. In practical terms, the success rates of MP are significantly higher than the percentages reported in the scientific literature (Hypothesis 2).

A legitimate doubt that can arise in passing single words is that the facilitator could guess the term after the first few letters and influence the rest of the word's typing. To address this doubt, two strategies were implemented: variability in "verb desinences" and "non-existent phrases". First, the verbs were declined (the Italian language has a very high number of desinences); thus, even if the facilitator might have guessed the root of the word, they still would not have been able to know how the term ended. Second, once the study was already in the testing phase, given the peculiarity of one FC-user's behaviour, it was decided to include very odd and unpredictable phrases as stimuli to be passed for the last four FC-users.

Accordingly, it was believed MP could occur even if the possibility of the facilitator guessing the *entire* stimuli to be passed was extremely low (Aim 1b-c). This was done by assessing if the FC-user could pass an entire verb, desinence included (Hypothesis 1b) and some meaningless sentences, sentences that do not make sense in the language and therefore with a very low baseline probability (Hypothesis 1c).

Two FC-users (Pa and Pb) were asked to pilot this study, practicing MP with family members in their homes and providing feedback on their experience. The family members facilitating them were also asked to provide a detailed account of their experiences, for example, if any difficulties were encountered. Through all this information collected, training for message passing was developed in a co-design framework. Eight FC-users (including the first two piloting the study) were asked to undergo that training and perform MP in a highly controlled setting.

2.2. Method

2.2.1. *Participants*

An invitation was issued within the "Vi Comunico che Penso" network for all FC-users who had used FC for several years (in different contexts, with different facilitators), who had the time to train with the primary facilitator close by and had a resilient personality (for example, somebody that would not get discouraged by an unsuccessful trial). They also had to have been supported by an involved family. The FC-users that participated in this study were eight FC-users, and at the time of testing, were between the age of 17 and 29 (mean age 22.2 years). Two FC-users were female, and six were male. All participation (both FC-users and facilitators) was voluntary. They had all been using FC for years (m = 12.8 years). Two FC-users who had undergone the pilot were facilitated in the testing phase by a relative, the rest by the professional facilitator(s).

The primary diagnoses received by the eight FC-users were: Down Syndrome (for three FC-users), Autism, Fragile X Syndrome, Severe Disorder of Expressive Language with Specific Developmental Disorder of Motor Function, Ataxic Encephalopathy and Dysarthria, and Pervasive Developmental Disorder and Specific Language Disorder for each of the remaining FC-users. They all had in common the inability to express themselves effectively through speech and also had some level of motor disability (dyspraxia).

2.2.2. *Procedure*

Information and consent sheets were provided to the FC-users, their family, and the facilitator in which the aim of the study and its methodology were detailed. Their participation was voluntary, and their right to withdraw was made explicit. No part of the study was kept from the FC-users. There was just one instance in which the facilitator was not informed of the type of stimuli that would be passed (e.g., single word vs double word vs image). This single case will be briefly described below, and a debriefing of that choice was provided immediately after that testing phase was over.

2.2.3. Pilot. As mentioned above, two FC-users and their facilitator (their mothers) decided to carry out the pilot of this study. They both trained for about four months on MP. The two couples were asked to train in different modalities of MP using different stimuli, different base probabilities, and so on. They provided specific feedback on their experiences regarding the stimuli used, the setting, the type of touch of the facilitator, the cognitive aspect of the task and such like. The facilitators were also asked to provide an opinion about

their experiences. Even though the two piloting FC-users reported very different psychological approaches to the training, they both underlined the issues they encountered at the cognitive level. Namely, issues remembering the stimulus long enough to type it. Both facilitators reported a certain level of stress, feeling anxious about the lack of control they felt and the unpredictability. All four people involved underlined the importance of practice, both for them and for their counterparts.

Among all the feedback provided, three critical concepts stood out. First, and the main difficulty encountered, was their working memory in retaining a single word that was not connected to a broader concept or reasoning. Second, MP requires particular management of emotions and relationships for both the facilitator and the FC-user. Third, MP training fits with, and benefits from, work aimed at increasing the general autonomy of the FC-user. When the couple felt confident, they were tested with cameras recording the message passing and mapping out the entire room. The stimuli passed were of different origins: words were chosen at random from a book or a dictionary, words chosen by the FC-users, words selected from their previous writing, images, and words chosen by the researcher (a complete list of the stimuli used in the pilot can be found in Appendix I).

2.2.3.1 MP training principles. Ten principles were outlined, following consultation with two experts in the field, that every MP training should follow. Below are the training principles and a brief explanation:

(1) The training is as much for the facilitator as it is for the FC-user. As seen in anecdotal reports, the experimental setting and the blind condition can be tiring and stressful for the facilitator too (if not more so than for the FC-user).
(2) The aim and reason of the MP can, at times, not be evident to the FC-user.
(3) Each training needs to be personalized.
(4) Damage can be done if the motivations and expectations of everyone involved (including the family) are not correctly assessed and supported.
(5) It is essential to permanently end a session with a success. If needed, the difficulty needs to be lowered to end the session with a successful outcome to support resilience and motivation.
(6) Failing an attempt is not proof of the absence of authorship but can be demotivating
(7) Especially at the beginning of the training, it is important to use salient stimuli to the FC-user.
(8) What may seem simpler for facilitators (as higher base probability) is not necessarily the case for the FC-user.

(9) It is essential to find the preferred perceptive modality (visual, auditory, etc.) for each person (written word, object, images etc.). It is suggested that several modalities be explored.

(10) The training must be repetitive and constant.

2.2.3.2. Individualized Training and Propaedeutic Activities. Subsequently, the FC-users began the actual MP training following these principles. The FC-user and facilitator couple were asked to practice MP in different ways, starting with stimuli that are salient for that FC-user (using words that were familiar or of particular interest to the person) and trying several perceptual modalities and then favouring the one(s) more congenial to the person. In the early stages, it was advised not to put the emphasis on the result (e.g., whether the word is passed or not) but more on the commitment to the test. It was recommended to start the training with stimuli that are visible, to become familiar with the modality, without creating too much anxiety in the facilitator and reducing considerably the potential memory issues.

In most cases, the FC-user started first to write words that were presented on a card, placed on the table with the computer s/he was using. They were able to see the word thus reducing the memory load. Moreover, this way the facilitator (even if she did not know the word the FC-user was about to write) knew the small pool of words (starting from four and adding more) that the word was chosen from. This allowed the facilitator to build her confidence and learned how to support the FC-user when s/he would write a specific word 'blind'.

Once the couple was feeling comfortable with these exercises, they could move on to stimuli not present on the table and for which the facilitator did not have a specific pool. In some cases, the FC-user found it easier to write a word with a different facilitator and then pass it with the MP facilitator. For other FC-users, it was considered easier to find a random word from a book, usually a noun chosen by them. Some FC-users found it easier when they were passing two connected words instead of one, as they explained it was easier to remember. Two FC-users found it easier when the word was given to them by their mother and not by another facilitator. Every FC-user and facilitator couple followed their own training program, making individual adjustments to address encountered problems and practicing with the modalities that worked for them (Table 1 provides a summary of this training for each couple.) The table provides a description of the training for each couple, explains which stimuli were used, if the FC-user and the facilitator needed the training (or

not), and if they did for which reasons. The table also reports if the couple had made use of salient stimuli at the start of the training, reported previous failed attempts, and in which cases there was an obstacle to understanding the aim of this activity.

Note that this is very different from the 'one size fits all' approach of published MP experiments. All the training programs had just the ten principles in common.

Table 1: Training summary

	Training required for FC-user	Training required for facilitator	1) Type of stimuli used	2) Type of stimuli used	3) Type of stimuli used	Salient stimuli at the start	Needs reasoning explaining	Previous failed trials
Pa	Yes (for STM and self-efficacy)	Yes (managing anxiety)	Salient words and images from previous user writing (FC-users)	Common nouns (3rd person)	Random stimuli (3rd person)	Yes	No	Yes
Pb	yes	No	Words from a visible set of 3-4 cards (FC-user)	Frequent disyllables from dictionary (FC-user & dad) to be written with 2nd facilitator before MP	Pool of 10 cards from the ones chosen from dictionary	Yes (refuse words that did not bear significance for him)	No	Yes
Pc	Yes (expectation and aim)	Yes (uncertainty)	Single words from a pool of limited high frequency nouns	Text comprehension + disyllabic and all of the words were high frequency salient			Yes, repeatedly	Yes
Pd	Yes (STM, praxis, procedure)	Yes (uncertainty)	Figures and single words from a small pool visible on the table	As memorized position of card instead of word, the common words were then passed orally by the mother	As words were repeated out loud → double words & sentences to be written with mother before MP	Yes	No	Yes
Pe	No	No	Pool of 6 visible figures	Pool of 6 visible words, then face down on the table	Random words from books	No	No	
Pf	Partially (only familiarization with tasks	Yes (manage high anxiety)	Single common and familiar words	Less common words, issues with spelling not memorizing the word		Yes		Yes
Pg	Yes (STM)		Images and words on visible cards; memorized position	Common words not visible, STM issues. Comprehension blind questions.	Non common words, issues with certain phonemes.	Yes		Yes
Ph	Yes (procedure)	No	Words from book			Yes		Yes

As can be seen, the need for training was evident for six FC users (one just needed a familiarisation phase and one didn't need any training at all) and four facilitators. The reasons reported are a combination of working memory issues, strong emotions (e.g., anxiety for the test), and becoming familiar with the praxis. The facilitator mostly reported an issue with feeling uncertain and anxious. The training was actually very personalised, and every couple proceeded with working towards more and more complex stimuli.

Six couples also used salient stimuli to begin the training. In one case, the aim of the activity was not clear after the first explanation, and it had to be addressed again. Finally, all but one person has had previous failed attempts at MP.

2) Type of stimuli used	3) Type of stimuli used	Salient stimuli at the start	Needs reasoning explaining	Previous failed trials
Common nouns (3rd person)	Random stimuli (3rd person)	Yes	No	Yes
Frequent disyllables from dictionary (FC-user & dad) to be written with 2nd facilitator before MP	Pool of 10 cards from the ones chosen from dictionary	Yes (refuse words that did not bear significance for him)	No	Yes
Text comprehension + disyllabic and all of the words were high frequency salient			Yes, repeatedly	Yes
As memorized position of card instead of word, the common words were then passed orally by the mother	As words were repeated out loud → double words & sentences to be written with mother before MP	Yes	No	Yes
Pool of 6 visible words, then face down on the table	Random words from books	No	No	
Less common words, issues with spelling not memorizing the word		Yes		Yes
Common words not visible, STM issues. Comprehension blind questions.	Non common words, issues with certain phonemes.	Yes		Yes
		Yes		Yes

	Training required for FC-user	Training required for facilitator	1) Type of stimuli used
Pa	Yes (for STM and self-efficacy)	Yes (managing anxiety)	Salient words and images from previous user writing (FC-users)
Pb	yes	No	Words from a visible set of 3-4 cards (FC-user)
Pc	Yes (expectation and aim)	Yes (uncertainty)	Single words from a pool of limited high frequency nouns known to facilitator and visible
Pd	Yes (STM, praxis, procedure)	Yes (uncertainty)	Figures and single words from a small pool visible on the table
Pe	No	No	Pool of 6 visible figures
Pf	Partially (only familiarization with tasks	Yes (manage high anxiety)	Single common and familiar words
Pg	Yes (STM)		Images and words on visible cards; memorized position
Ph	Yes (procedure)	No	Words from book

2.2.4. *Setting*. Five different settings were used to collect the data of the 8 FC-typers participating in the study: the FC-users that underwent the pilot performed the testing phase in their homes where they trained; Pa performed a second message passing test in the Human Movement Laboratory at Nottingham Trent University; four participants performed the message passing test in the Reggio Emilia Baobab centre and another three in the Gorizia facility. Apart from the message passing done in the HM Laboratory, all tests were performed in the setting in which the training was carried out. The room chosen had more than one entrance, which allowed the facilitator to enter the room at the appropriate time after the person giving the word to the FC-user had exited the room through another door.

2.2.5.*Protocol*. The person providing the FC-user with the stimulus to pass (called here "stimulus-provider") was a relative, a second facilitator or, in three instances, myself. After the stimulus was shown, said, or both to the FC-user, the "stimulus-provider" would knock hard on door A (behind where the facilitator was) and then exit through door B.
In the case of the data collected in Gorizia, to avoid the "stimulus-provider" and the facilitator seeing each other (since both doors exit on the same corridor) the "stimulus-provider" would knock on the A door then loudly call out "exit now" and exit the door (door A) whilst the facilitator would come in the other door (door B). In the cases of both the pilot's data collection and the data collected in Reggio Emilia, the two doors opened into two

different rooms. Hence the facilitator was told to simply enter the room 5 seconds after she heard the knocking on the door.

To ensure the facilitator could not hear the "stimulus-provider" say the word out loud, but could hear the knocking on the door, a number of pre-tests were done. The facilitator ended up wearing a pair of noise-cancelling headphones but staying close to the door. The entire procedure was videotaped, with a different number of cameras (between 4 and 6 dependent on room size) to make sure there would be no blind spots and that the entire room was mapped. This was done to avoid any doubt on the method in light of possible future publication. An example of the set up can be seen in the screenshot (Figure 2), the videos were edited in order to watch the entire action from all angles at ones.

Figure 2: Screenshot of MP recordings

There was one exception to this procedure, which was Pa's second data collection in the Human Laboratory lab at NTU, which does not have two doors. Nonetheless, a strict procedure was implemented so that the facilitator and "stimulus-provider" would never be able to even exchange a quick glance (Figure 3 Figure 4).

Figure 3: Pa is given a stimulus to pass

Figure 4: Pa is typing the stimulus with blind facilitator

Finally, FC-users were invited to write the word or sentence they were given. However, if they could not remember the stimuli and needed to access the stimulus again, they were asked to write something like “repeat” or “tell me the word again”. This happened once or twice per FC-user. Furthermore, they were urged to type “break” if and when they needed one. Some FC-users decided to pass all the stimuli in one day, others over several days. It was left completely up to the FC-user and facilitator to decide when to start and when to stop the testing.

2.2.6.*Materials*. The stimuli used in the message passing test were selected from the CorDIC corpus of written and spoken Italian words (Corpora Didattici Italiani di Confronto). From a pool of 500,000 words, the words of fewer than four characters were deleted. This also resulted in articles and pronouns being deleted (the few articles and pronouns longer than four characters were manually removed). Second, proper nouns, “proper” prepositions (a type of adposition which do not exist in the English language) and conjunctions were also excluded. The parts of speech left were nouns, adjectives, adverbs, prepositions, and verbs, for a total of 17,629 words. The words were categorized by frequency, from very common to very uncommon words. Verbs and adjectives respectively had 16 and 15 categories respectively, adverbs had 8, and nouns had 20. This was done so that a similar number of words was present in each frequency range.

A list of 69 stimuli was created made of 15 adjectives, 8 adverbs, 29 nouns, 1 preposition and 16 verbs of all ranges of frequencies. Italian has 21 verb tenses, 6 grammatical persons, the active and passive forms, and the desinence changes in regard to gender. Therefore, an average verb has one root and about 189 desinences. Of these, for average regular verbs, six are the same, so the actual variability is of 183 possibilities. The verbs selected were thus declined in order. This was done to increase the unpredictability of the stimuli. This ensured that had the verb been correctly guessed by the facilitator, the specific declination was still unsure.

Finally, the order of the 69 words was randomized. This was the process by which the final list of stimuli, that participants had to pass in the massage passing test, was selected. Some participants decided to pass more than 69 stimuli. Therefore, two lists were used. In addition, a number of short sentences or “double words” (as a noun and an objective or a verb and a noun) were prepared. This was done by selecting a word from the list and then

adding a second word that “made sense with it”. For example, to the noun “tunnel” the adjective “underground” was added, creating the double word stimulus “underground tunnel”.

During testing, one FC-user seemed to enjoy longer and less frequent words. His mother reported that he likes word games and is a very ironic person. Therefore, to support his motivation, a number of odd and unpredictable short sentences were provided to him as stimuli to pass, named here “meaningless phrases”. This was not communicated to his facilitator. As these seem to amuse him, and the level of predictability is very low for such sentences, usage of these was proposed also to the remainder of the FC-users. In addition, 260 simple images (made of one single object) were included as stimuli to be passed for the FC-users that opted to pass images, as well as words, to include a denomination task.

2.3. Results

2.3.1. *Main Results*. The average percentage of exact correct messages passed across the eight FC-users in the testing phase was 75.8 per cent (with the highest percentage being 91.5 per cent and lowest 65.3 per cent). However, a number of stimuli were passed with small errors which did not seem to preclude the recognition of the word. Seventeen ‘raters’ were asked to guess the intended word when looking at these misspelled words. When 15 or more (of out 17) identified the correct to-be-passed word, then the message passing was considered to have been successful. Percentages were recalculated to accept errors that did not affect the recognition of the transmitted message including typos, double consonant, simplifications, redundancies, omissions, and synthesis (below all the types of errors are presented with examples and discussed). The average percentage of correct stimuli passed across the eight FC-users was 91.3 per cent. These results confirm hypothesis 1a, as the percentage of correct messages passed significantly exceeds the chance probability (which would have been about 0.005 per cent given the pool of 17,629 words).

As reported by the more recent review that have examined MP studies (Hemsley et al., 2018), the facilitator was consistently considered the author of the written text. It was reported how in certain studies there were some messages being passed in the non-informed condition (although in a lower percentage than in the informed condition) that varied up to 30 per cent (Wehrenfennig et al., 2008). The success rate of this study (mean

across participants = 91.3 per cent) is significantly different from the percentages reported in the international literature. Several arguments can be presented for why the percentage here is so different, which are best explored in the discussion. Nevertheless, the main reasoning provided here, as stated in the second aim, is that considering MP as a skill to be learned, instead of a mere method of studying the validity of the technique, will allow both for FC-users to pass a specific message without the facilitator being aware of the message, and said facilitator to facilitate that writing.

Moreover, it was hypothesized that FC-users would be able to pass the correct desinence in most cases, even if the facilitator would have already guessed the verb (hypothesis 1b). Of the single words passed by the six FC-users, 69 were verbs. Of these, 56 (81.15 per cent) were passed correctly, whereas 18.84 per cent were not. Of these 13 verbs not correctly passed, the error analysis is telling: 3 were full errors, 2 were a phonetic anchor error but the verbal desinence was correct, in 3 cases the verbal desinence was correct but the verb was wrong (although there was a phonetic similarity with the original verb as *"mangerai – marcerai"*) and in 3 cases the verb was the right one but the desinence was wrong (1 was a contraction error and in one instance the desinence was wrong although just one letter was different than the correct desinence).

Phonetic anchor errors are those errors where there is more than one single letter that is wrong (different than a typo). Even so, the word or sentence's sounds are similar to the target stimuli as in "*scozzese - scoscese*" or "*sconfitta voluta – soffitta a volta*". It seems that the FC-users were mostly able to pass an entire word, including rare desinences, even when the facilitator might have understood which root it was and might have hypothesised a more common tense like infinity or the present. Only in 4.3 per cent of the cases the desinence, but not the verb, was wrong. Most of the errors had a phonetic anchor or similar, which suggests there might have been an issue in remembering the exact word to be passed, and that an auditory, instead of semantic, memory strategy was used.

As mentioned above, given the exploratory nature of this study (e.g., first time considering MP as a skill to be learned) and the intent to respect the individuality of each person involved, there was one aspect of this study that was not designed at the beginning but added during the data collection: namely the inclusion of extremely odd "meaningless phrases". The full list of these sentences is given in Appendix II. Here are reported a couple of examples to show how odd these sentences are, and therefore how close to zero is the level

of predictability for the facilitator: “smurf décor”, “I face the invasion of the locusts” or “The frog fields were ploughed”. A total of 57 meaningless phrases were given to four FC-users; of these 28 were passed correctly. Of the remaining 29, only 1 sentence was not passed. The remaining 28 were all passed with small errors (as typos or a missing accent).

Pa’s was asked to pass 27 words of different frequency, at the second data collection in the Human Laboratory lab at NTU. In addition, we added four capital letters within the words (e.g. beLLezza). She passed 100 per cent of these stimuli, including the within-words capital letters that could have not been foreseen by the facilitator (as not part of the written language). It seems, therefore, that the predictability of the stimulus to be passed, both when possibly trying to predict the end of a word or the next word to be written, on the facilitators’ part, was not a factor that influenced the message passing (thus confirming hypothesis 1c).

2.3.2. *Error analysis*. Similar errors are present across the entire study (with single or double words to be passed), both in the training stages and in the testing one. Most of the errors are typos, a missing of the double consonant, phonetic anchors, or slightly different forms of a word (as cold/cool or ensemble/assembly). A complete list of the errors and their specific type can be found in Appendix III.

2.3.3. *Particular results.* Some results are interesting when looked at individually. In the case of Pa, she struggled in the MP of simple images; not because she didn’t remember the image or could not type it or could not denominate the image but because it reminded her of schoolwork. She was asked to do a similar task that she found offensive given her age and ability at the time. Therefore, instead of writing the name of the image shown she tried to build a sentence describing or including the to-be-written word. For example, when she chooses the image of a star, this is what she typed: “~~The star~~. ~~The sky comes a star~~. The star shines.”

Another interesting case happened again with images with Pc. The image to be passed was an “axe” and Pc was expected to write “ascia” [axe]. He wrote “massaggiatore” [masseur]. When I asked him what that image was after the test, he said right away “Massan”. His mother explained that “massan” is the Friulan (regional language) for the word “axe”. Perhaps Pc started writing “massan” than realize it was not an Italian word and therefore wrote the first Italian word that came to mind that started in the same way, or it

could be a sign that the facilitator saw Pc starting to write “massan” and influenced him in finishing with a word that make sense to them in Italian: “massaggiatore” [masseur].

The two cases are good examples of how a FC-user can pass a specific message in a very original way and underline the importance of reading the results with curiosity and flexibility when working with a clinical population.

2.4. Discussion

As described in the results sections, the overall results of the message passing (average correct word or sentence passed = 91.3 per cent) support the main hypothesis that a specific message, unknown to the facilitator, can indeed be typed by the FC-user with the physical support of that facilitator as the probability is much higher than one would expect to see by chance (Hypothesis 1a). This was found even if the possibility of the facilitator to guess the *entire* stimulus to be passed was low (Hypothesis 1b-c).

The high percentage of correct messages passed, in addition to being substantially different from previous work (Hypothesis 2), suggests that the methods employed here might be the cause of this difference. The findings suggest that MP might usefully be reconceived as a skill to be learned, both by the facilitator and the FC-user by means of personalized training. Since working with a clinical population with complex needs and investigating a thorny technique, the methodology of this study was based on a specific philosophy aimed at including the FC-users in the work as much as possible whilst accommodating their individualities in a “noting about us without us” perspective.

In other words, treating the FC-users as co-researchers, and not just participants, should be considered a minimum requirement for researching FC via MP paradigms. Regarding the FC-users as co-researchers, instead of mere participants implies that the FC-user’s opinions and feedback were taken into account when developing the study’s design itself, when collecting data and when interpreting results. Moreover, the FC-users’ individualities, needs, motivation, and expectations were all taken into account and not just considered potentially confounding variables. In addition, part of the general philosophy of acceptance of individualities also included allowing flexibility and curiosity when reading the results (as seen in Pa’s sentences or Pc’s dialect interference).

When studying a topic as complex as FC, it is wise to consider that the existing controversy itself can have a detrimental effect on the research carried out on the topic.

Experiments on FC authorship in general test the user's ability to comprehend and to write. In particular, when it comes to message passing, the implication for FC-users can be severe. Thus, it is essential to consider and address motivation, expectations and emotions of anyone undergoing a MP test, making sure it is experienced as an exercise in empowerment and acquisition of new skills and not of stress or judgment.

The vast majority of MP studies have underlined the inability of the FC-user to pass a message with an uninformed facilitator, or have identified the facilitator as the author of the text written in misinformed conditions (Hemsley et al., 2018; Mostert, 2010, 2012b; Schlosser et al., 2014; Wehrenfennig et al., 2008). The results of this study differ enormously from all those present in the literature. It is imperative to understand why this occurred. There are most likely a number of reasons. Three reasons in particular are probably the most significant: (1) the MP training and its principles, (2) considering the FC-users as co-researchers instead of participants, and (3) flexibility in the testing procedure and conditions.

The principles of the MP training were explicitly detailed to any facilitator wishing to participate in the project in pairs with the FC-users they support. The MP training principles are to be considered as a deontological and practical code of conduct for researching MP in a safe, respectful, and meaningful manner. These principles have also been a way to address some previous research shortcomings. Regarding previous literature, so far, the burden of proof has always been on the FC-user alone. In this study I tried to remove the burden itself and shift more focus onto the facilitator's performance. Moreover, since FC supporters consider the technique to be a co-process, it seems fitting to put the focus on the two individuals as a couple and not solely on the FC-user (Principle 1). It might be useful to consider this principle in FC research in general, beyond the message passing study. To conduct research in an ethical and safe matter, the motivations and expectations of everyone involved need to be taken into careful consideration (Principle 4 and 6) and there ought to be a supportive approach when undergoing the training (Principle 5 and 6). It may also be that we can enhance the validity of such research by undertaking it in this way.

Furthermore, considering MP as not just a research paradigm, but an actual skill to be acquired by both the facilitator and the FC-user, created a shift in the approach to MP. Indeed, the MP training is considered to be a significant factor in the study's outcome. FC by its nature creates a close relationship and a dependency status on the part of the FC-user. The facilitator is used to having a certain level of predictability, especially in the first phases

of usage of the technique. Therefore, the ability to facilitate when being blind to specific content on the facilitator side and typing a specific content with an uninformed facilitator on the FC-user side, are arduous tasks that both facilitator and FC-users might not be accustomed to and that can create a sense of uncertainly and novelty. Thus, there is a need for more than a familiarisation phase as suggested in previous studies (Calculator & Hatch, 1995; Eberlin et al., 1993; Konstantareas, 1998; Myles & Simpson, 1994), and a proper training program is required.

For each training program, an individualized approach was needed to make the most of the exercises carried out. It is useful to address which difficulties are encountered and evaluate them as skills to be developed rather than a lack of ability. Most participants, but not all, had difficulties with working memory. Most facilitators, but not all, manifested anxiety and insecurity. It may seem a banality, but it is important to recognize that every human is different and in FC testing, individuals' emotions and thoughts must still be evaluated and supported. Importantly, the MP training might have had a positive effect beyond the capability of passing a MP test, namely it increased the FC-user independence in typing and the facilitator's sense of self-efficacy as a facilitator. These were effects reported by the facilitators, and by the ability of the FC-user to develop more independence in typing (such as starting to type basic things on their own, asking more questions, or requiring less facilitation).

As mentioned in the introduction, there were no structured controlled conditions in this study. Most FC-users at the start of the training were not able to pass a message, even with facilitation. Given everything that has been detailed regarding the implications of MP testing, it did not seem ethical to ask the FC-users to attempt to perform MP without facilitation. FC-users have been asked questions about their opinion on their ability (or lack of ability) to pass a message without facilitation. The majority said they simply do not think they would be able to perform MP without facilitation, as tried in the past.

One FC-user wrote that he might be able to pass very simple common words, but definitely not longer, less frequent words or sentences.

Excerpt 1

> "*Yes, many times I've asked myself why I could write certain things easily on my own and others instead require facilitation and my answer was that high motivation and frequency of certain words or ideas activate the automatic system. In the end it's always the same: I have to repeat actions hundreds of times to learn*

them well enough for them to become automatic, without the need to think about them. I don't know why I don't need to do this with facilitation. I really believe that the touch is a trainer of complex cerebral systems, regulating the flow of emotions".

These explanations are insightful and might excite curiosity toward the role of the touch in facilitation. Moreover, this (and other) texts have been written by FC-users that have "passed" a MP test. Nevertheless, they have been written via FC, hence still stand as potentially only anecdotal information.

There is no presumption to draw general conclusions from this study regarding FC as a technique in general. What can be said is that MP is a skill that can be learned and taught for some FC-users, maybe not for all, and that FC is most likely a valid communication technique for certain FC-users, at least in certain contexts or with certain facilitators. This opens up to one important question: "How does FC work?". Even if it did work for a small number of individuals, in a small number of circumstances, there is still a scientific responsibility to answer the question *how.* Furthermore, if facilitator influence turns out to be the main factor in play, we need also to understand how *that* might work. From a research point of view, it seems that the most interesting questions to understand are the 'how it works' ones and what the facilitator's touch does. Indeed, most of the remaining elements of the thesis will try to address this exact question from different viewpoints.

From a pragmatic, non-research, point of view, it seems important that MP training should be included in a facilitator's training and in an FC-user's communication independence and learning' projects. The beneficial effects might be considerable and may help to overcome a number of the shortcomings of the communication technique, such as the FC-user's dependency on the facilitator. It may also improve the facilitator's sense of security, allowing them to facilitate in more complex contexts in which s/he is much less aware of the vocabulary or topic to be written, as for example in university courses.

2.5. Summary

Message Passing can happen successfully when certain conditions are taken into account. If, on the one hand, these limited results do not put significant weight on the controversy as a whole, on the other hand they do present a very interesting question about the underlying mechanism. If FC were to be exclusively facilitator influence, how could

message passing happen? It seems more reasonable to hypothesize that FC might be a co-process that in some instances can allow certain individuals to communicate. Which opens up to one important question: “How does FC work?”. Even if it does only work for a very small number of users, in a small amount of circumstance, there is still a scientific responsibility to answer the question *how.* Thus, from a research point of view it seems that the more interesting question is to understand how it works (or even if, in limited circumstances) and what the facilitator’s touch does for the FC-user. In the following chapter a number of FC-users were interviewed to ask their opinion on the effects of physical contact by the facilitator on their pointing and writing.

3. What do FC-users say about FC functioning?

Between conflicting evidence in the international literature and the results of the message passing study, it appears clear that FC might be a valid communication technique for at least certain individuals and in certain settings. Therefore, the most pressing question has to be, "*how* does FC work, even for the small contextualized examples of writing *during* the message passing test?" The next logical step was to involve the individuals directly concerned: FC-users were interviewed about the effect of physical touch on them and their idea on FC-functioning to guide future research. If FC-users actually write the texts, the feedback provided would be invaluable and should be used as a primary source for future research.

3.1. Introduction

The studies that will follow in the next chapters, investigating the effects of touch and the FC underlying mechanisms, have been inspired by Picaro's previous work on touch (Picaro, 2012), the literature analysis on touch effects, and partly on the basis of what FC-users have typed about their interpretation of FC functioning and, in particular, the effects that the facilitator's physical contact has on them. To present these writings, FC will be provisionally assumed to be a valid communication technique for these individuals in the context of these writing, and this chapter must be read with the caveat in mind that some proportion of what is said may not originate from the FC users themselves.

There is no expectation that these texts and their analysis will bear any weight on the FC controversy itself. This work has been done to increase the knowledge on the FC topic. If FC is a valid communication technique, what are the empirical self-report experiences of FC-users, and how should these guide future research? The texts presented here came from FC-users of the Vi Comunico che Penso charity network and were recorded systematically. Many more similar anecdotal accounts that were not recorded but written on paper boards, at conferences or on iPads are not included.

3.2. Method

Participants. The FC-produced texts have been written by 22 FC-users and facilitated by eight facilitators belonging to three different facilities. Participants ages ranged from 16 years old to 50 years old, sixteen were male, and six were female. The participants have a

wide range of disabilities: Down and Fragile X Syndromes, Autism and other Neurodevelopmental Disorders, and multiple disabilities resulting from perinatal issues.
Settings. The texts were collected within three different FC facilities, all part of the national charity Vi Comunico che Penso: Il Giardino del Baobab (Reggio Emilia), Diritto di Parola (Gorizia) and Associazione Progetto (Livorno). The texts have been collected in the room the FC-user typically uses to type, supported by their professional facilitator at the respective facilities.
Procedure. The texts have been prompted initially by the question: "Could you provide us/me with your opinion on how FC works for you?" Sometimes this resulted in a clear and complete text. In other cases, a second question was asked to stimulate further reflection. "What does the facilitator's touch do for you?" In several instances, facilitators have asked follow-up questions to investigate further what the FC-user had typed.

As a result, some texts are short essays on the topic. Others are brief reflections stimulated by a question, and others are shaped as a question-and-answer dynamic. The texts were all written in Italian, the exacts presented are an English translation. A native English speaker, Italian bilingual, was asked to double-check the translation provided, and when in doubt, meaning and not form was given precedence. As these texts were collected in different facilities with different facilitators and FC-users, it should be noted that no one was aware of what others had written in other parts of the country until a conference in Florence in May 2016, where about one third of these texts were brought together and publicly presented.

3.3. Thematic Analysis

The aim of analyzing this collection of texts was to explore the experience of being facilitated within a "nothing about us without us" perspective (Charlton, 1998; Hogan et al., 2020; Stack & McDonald, 2014). Thematic analysis was chosen as it is a straightforward means to extract content and meaning, focusing on the FC-user's experience without inferencing or theorizing. The six analytic steps, as suggested by Braun & Clarke (2013) and Kiger & Varpio (2020) were followed (Table 2).

Table 2: Description of Analytical steps

As suggested by (Braun & Clarke, 2013; Kiger & Varpio, 2020)	
Familiarizing with the data	The texts were read several times and a number of notes were produced on initial thoughts and pre-codes.
Generating codes	Codes were generated in a data-driven matter. The majority of codes were recurrent, producing a certain number of similar answers. Other codes were generated to include more individual and unique responses.
Searching for themes	Codes were merged into sub-themes of collective meanings and then into larger themes. Special attention was given to pieces of texts that qualify for more than one code. Codes were graphically mapped in thematic maps to allow for a better understanding of codes' relationships.
Reviewing themes	The initial idea of producing themes in a deductive analysis was abandoned as reviewing the themes it became clear the codes, and first themes produced, did not fit the themes originally thought. An additional theme was produced to incorporate orphans' codes and unique content.
Defining and naming themes	A table was designed to organize headings of themes and define causal relationships between themes to best reflect the complex topics presented by the authors. Names were revised and defined.
Producing the report	The production of the report resulted in a very straightforward process after themes, subthemes and codes were already properly organized in thematic maps and a table for themes hierarchy. All that was left was describing the analysis carried out and the extrapolated content.

While familiarizing with the data, initially, the plan was to perform the thematic analysis in a deductive matter, assuming all FC-users' feedback to questions about touch effects would result in different explanations that could have fit into three macro-themes: motor, emotional, and cognitive effects. Interestingly, once the codes were generated and the themes were searched for, it became clear that this was not the case, and fitting all the codes into these three categories would have been an artificial and simplifying task. Consequently, the deductive path was abandoned, and an inductive process followed, leaving the coding to guide the research of the themes.

3.3.1. Findings

A total of four themes and ten sub-themes were identified, in brakets can be found the number of times that sub-themes and themes were found (Table 3). The main themes were “touch effects”, “meta-reflections on FC”, “complex FC explanations”, and finally, a theme artificially built to group orphans codes named “further arguments”.

Table 3: Themes and Sub-themes

Themes	Sub-themes
Touch effects (n.80)	Motor control and sense of physical self (n. 23) Thoughts flow (n.24) Concentration (n.5) Safety, confidence and support (n.13) Emotions (n.9) Metaphors (n.6)
Complex FC explanations (n.29)	(n.29)
Meta-reflections on FC (n.42)	Consequences of non-communicating (n.7) Authorship and influencing (n.18) Co-production (n.7) Facilitator characteristics (n.10)
Further arguments (n.11)	(n.11)

3.3.1.1. Touch effects

Participants described several effects that physical contact, the hand on the shoulder, arm or hand, have on them. In certain cases, participants described one main effect such as on their confidence or movements. At other times, they presented a number of consequences and used unusual metaphors in three cases to express their perception and changes in their body and minds due to being touched.

Excerpt 2

> *“The touch for me is like justifying a text (computer term) i.e. it tunes my emotional state on a level of centered balance. The touch forces me to put full stops in my flow of thought whereas the concentration comes from the supporting tone. The support tone is the part of the touch that allows me to be calm and sure; it is the stone of an empathetic presence. The facilitation touch allows me to collect and organize my thoughts, and their flow becomes ordered. My brain is like an infinite, frenetic Sufi dance, and it stops gently with the friendly, solid touch.”*

Fortheen FC-users described how touch affects their motor control, increasing the perception of their own body, the awareness of their body’s positioning in space, defining what kind of movement they need to be doing and being clearer on how to achieve that

action. The effects range from control over one's body, to an increased awareness of one's body, posture, and space.

Excerpt 3

> "*I can manage my posture, I find the total dimension of the space, allowing me to always know where I am positioned*", and to a sense of self- completeness "*When I write I feel all in one piece it's me with my arms, my legs, my head, it's me completely*".

Four FC-users also reported how their concentration increased and how they could better focus and dedicate more attention resources to the task at hand when being touched. In 24 instances, thirteen FC-users described how physical contact affects the flow of their thoughts as well, which, without touch, is often described as being disorganized, tangled, and chaotic. However, thanks to the touch, the thinking process is reported to become fluid, linear and orderly:

Excerpt 4

> "*Without form in the mind, thought devoid of order leaves an absolute tangle of words, and when our body receives firm and felt contact, the disrupted mass becomes a linear path formed by all the parts rightly returned to the ordered structure of the speech*."

Eight FC-users also expressed how the facilitator's touch would make them feel safe and supported, it increased their self-confidence and make them feel humanly connected. One FC-user expressed this quite eloquently:

Excerpt 5

> "*Touch works as an emotional support, as it passes empathy, trust, security and determination of the other through touch, but how? Well, there lies the mystery for me. I know clearly, I feel it inside that my facilitator is with me fully and solidly, and in addition I feel that he believes in me*".

Bordering on this sub-theme are the reports on the stabilizing effect that touch is reported to have on the flow of emotions. Touch would help organize and define the emotions the FC-user is feeling, as described in the ending verses of a poem written by an FC-user:

Excerpt 6

> *"A flow of emotions*
> *Accompany that tapping*

that only your touch
can make steady"

3.3.1.2. *Complex FC explanations*

All the explanations provided under the touch themes can be traced back to a limited and defined number of sub-themes: motor control and sense of physical self, thought flow, concentration, confidence and support, and emotions. FC-users also provided more complex answers that included analyses, hypotheses and arguments that could hardly be outlined within those defined sub-themes. To give due weight to the individuality and complexity of these responses, a separate theme was created encompassing these testimonies. A few of these explanations are an attempt to elaborate a neuropsychological relationship between motor functions and emotions.

According to an FC-user it is precisely the touch that would intervene in blocking the disorganizing and negative effect that one's emotions have on one's motor system and ability to move.

Excerpt 7

"For me, touch is like a depotentiation that discharges all the energy that emotions generate within my thoughts that I normally cannot control, and that causes me to have no motor control whatsoever, whether it be a pointing movement or complex gesture of any kind or trivial action that I have to do".

Another FC-user described his personal mechanisms of FC functioning in which touch would untangle his thoughts, which he would then be able to see in an organized and visual way, and his job would then become a simple copying job. Answering about the effect that touch has for him he wrote:

Excerpt 8

"*My confused thoughts, which thus returns to me in order, are as if I saw them in a mirror and I can then slowly copy them, it is important that while the letters strike me visually, there is no motor control in me which allows me to type the letters. Therefore, the other hand turns the motor control function on, allowing me to find the right key*."

Six FC-users proposed arguments about the level of motor autonomy and the difficulties in automating movements and composing sequences, reporting how touch has an

organizing effect on the sequence of actions and how it allows them to be more present, more connected to reality and their body:

Excerpt 9

> "*Arriving, apparently, independently to select words and wishes must heal an associative disability between functions in our mind. Arranging the decomposed sequence of actions proves impossible without the touch of a person who causes the order of associations to be recomposed."*

One person reported that touch retrains her thoughts, and this allows her to enjoy contact with reality that normally eludes her. Three FC-users also wrote about the way touch helps them organize and process information, allowing them to analyze and reason upon the subjects at hand in a way they find very hard to do without touch support. When asked what the facilitation did for them one person proposed an analysis on what effects the tactile perception of the facilitation has for them:

Excerpt 10

> "*More in touch with myself and my resources. It is a sort of emotional stabilizer, a regulator of information flows, it is a warm reminder to share attention but the miracle (that is, reaching the maximum transmission capacity) is the result of a much more complex process since it is not enough that one lend one or two hands, it needs to be someone who is emotionally involved, who believes in you, who reassures you, etc.. a sort of tactile-cerebral connection must be reached.*

It seems once again, touch was reported as having effects on a certain level of self-awareness, of one's resources, a stabilizing effect on emotions and support in processing information.

3.3.1.3. *Meta-reflections on FC*

FC-users wrote about FC beyond their individual experience of being touched, how it aids a number of attentional, cognitive and motor functions, and, thus, how it is conducive to expressing their own thoughts. Ten FC-users, in fact, when asked about their experience of being facilitated, underlined what happens when they need to function without physical contact, reporting a struggle in having little automatisms in actions, chaos in their thinking processes and generally increased fatigue:

Excerpt 11

"…I *have the normal interferences and disconnections that do not allow me to carry out even a simple task*".

In addition to the difficulties in having to organize and process information and focus on their own, is the lack of communication that comes from the lack of touch:

Excerpt 12

"Without the touch, the words remain not only confused but unexpressed, not finding the true meaning of my thoughts, leaving me motionless in silence, unable to verbalize my many feelings."

Six FC-users also took it upon themselves to use the questions about touch to express their opinions on the theme of authorship, claiming their voice and emphasizing how they are the authors of the writings. One FC-user said that the touch only serves to support, not to lead. Another FC-user claimed that, in his opinion, all of the individuals with a disability using the technique have their own thoughts and abilities, but they are unable to express everything they need in an orderly way. Moreover, the need to demonstrate that the problem of the individual with a disability is one of language production but not of understanding was also discussed.

An FC-user wrote about the possibility for the facilitator to guess what he was about to write, normalizing this phenomenon as a common prediction individual do when normally conversing:

Excerpt 13

"*It would certainly be easy to make transcendent induction of thoughts in the facilitator if we were telepathic, but it doesn't take much to make our interlocutor guess what we are writing once the writing has started. We are in the situation where two people are in the act of conversing normally, but expressing themselves by writing is slower than speaking and enables the facilitator to imagine the whole word. There are many times that we surprise the facilitator with an unexpected deadline."*

Four authors, trying to report not only the effect of touch on their person but also the relationships within which those effects happen, seemed to have framed the concept of facilitation as a co-process as "*our common action*". FC-users reported touch not only as a mere physical contact between two individuals but as a bond that is established between two individuals, a "sort of circuit". Touch is, therefore, a way for two individual people to be together. Not surprisingly, touch is not only a tool to enter into a co-acting relationship, but it also provides information on the emotional and cognitive state of the other person.

Following the sub-theme of co-production several FC-users went on to describe what characteristics make a good facilitator. First, five FC-users underlined that having a willing facilitator is not enough and that they need to be present and focused

Excerpt 14

> "*Being physically together doesn't always mean listening to each other; when the facilitator follows his thoughts, mine can't be heard.*"

Many texts report how the facilitator needs to be present but not focused on their own things, positive but not invasive. The facilitator needs to be serene, calm in themselves, and form a sort of "*void*" or blank mental space where the FC-user can then find space to organize their own thoughts. Moreover, the facilitator needs to enter into a common relationship and common action process with empathy and harmony. The facilitator needs to be solid, warmly present, but also liberating.

One FC-user used a surprising metaphor comparing the role of the facilitator to that of a midwife:

Excerpt 15

> "*A facilitator must first of all be humble (see the meaning of modest), he must be an enthusiast who also knows how to reflect. He is one who listens to the other and to himself, he is present but knows how to leave space to the other, he is someone who knows how to bring out, a bit like a midwife (art of maieutic). Here the touch brings out because it gives the rhythm to the push. The facilitator knows how to stay firm inside himself and it is precisely this absence of trembling that allows the typer to overcome both performance and exposure anxiety. De-uterize.*"

3.3.1.4. *Further arguments*

FC-users proposed certain analyses and reflections that do not fit in any of the above reasoning and that were therefore enclosed in a separate theme. One topic further discussed was the type of thinking processes that certain FC-users have, who reported mostly a non-verbal visual, image-based type of thinking. Images, and a few words, would create the basis for an associative thinking style. One FC-user reported a mixture of words and images:

Excerpt 16

> "*I believe that our mind is organized differently from yours we perceive reality in a way of associations of words and images that complement each other and form our thoughts".*

Although an alternation of sentences and images might be a common experience for most people, three FC-users did write repeatedly about having a different functioning of the mind to the rest of the population and reported how that task would have to be for its nature quite delicate. Finally, one FC-user wondered, if a simple touch can produce such a big result, what would be the effect of a more extensive and deep containment?

3.4. Discussion

The aim of this study was to collect the opinion of FC-users about the technique they use and, in particular, the effect physical contact has on their person. The study findings point to touch effects on motor control and sense of physical self, on thoughts flow and concentration, on a sense of safety and support, and on one's emotions.

Moreover, FC-users provided complex explanations of FC functioning, writing about how emotions and actions are related, how touch has a calming effect on their emotions and an organizing effect on their actions, adding how touch also increases their sense of connection to reality, to the real world. Finally, FC-users also provided a number of arguments and personal reflections on the consequences of non-communicating, claiming their authorship in writing, explaining how typing feels like a joint action, and outlining what characteristics a facilitator should have.

Some of these results are in line with what certain authors pro-FC have written in the scientific literature. For example, it is not surprising that movements and actions were reported as functions affected by touch as touch is often presented as a "starter for action" in FC-training (Crossley & Brandt, 1994; Pavon, 2019; Wilson et al., 2014). This explanation, however, has always remained at a fairly superficial level, with no specification of how this effect should occur. It is, therefore, interesting to see how several FC-users wrote about how their body posture and proprioception are increased by touch, which indeed are necessary for voluntary movements (Montell, 2019).

The relational closeness, the mutual trust and the feeling that the facilitator believes in the FC-users are repeatedly reported as significant factors that transpire through touch (Biklen & Burke, 2006; Biklen & Kliewer, 2006). Moreover, it seems like FC-users count on their counterpart for emotional support and trust. Once again, these arguments are not surprising as they are in line with what specific authors have written in describing FC

functioning, underlying the importance of emotional support and especially assuming competences (Bigozzi et al., 2012; Biklen et al., 1992, 1995; Biklen & Kliewer, 2006).

The effects of the facilitator's touch on the FC-users thinking flow and organization are, to my knowledge, not previously discussed in the scientific literature. A search on PsycINFO, PubMed and other databases combining the terms *facilitated communication* or *supported typing,* and the words *thinking*, *flow*, or *organization of thought* did not return any relevant sources.

Since there is currently no system for measuring the fluency of thought, nor a certainty that humans have sufficient insight to self-report this phenomenon, it is important to take these data with a pinch of salt, and it is difficult to link them to the previous scientific literature. For example, in psychiatry, the fluidity or organization of thought, as when assessing thoughts in psychosis, the diagnostic criterion of speech is used as an index for thought. Nonetheless, it is a common human experience to differ in the organization of thoughts, which likely varies depending on the topic, current mental resources, movements and emotions.

Given all the shrewdness, the interesting fact remains that so many FC-users have reported the organizing, untangling and ordering effect of touch on their thinking, almost as if with the touch, it would become easier to reflect and think. The word "flow" was used ten times within 4376 of the total words. Although it is a common word in Italian and English (respective ranking of 3747 and 1225 for the CORDIC and Leeds corpora), to find it ten times, it is undoubtedly highly above ranking. It bears particular meaning in relation to the topic of automatic versus voluntary processes. In chapter four, the effects of touch on attention will be recorded in automatic versus voluntary tasks. It will be argued that physical contact affects non-automatic tasks.

It is possible that in some people with disabilities, and especially with difficulties of a praxis nature, there are difficulties in automating goal-directed movements, thus resulting in difficulties in performing actions autonomously and fluidly, as occurs for most of the general population. Touch, then, could play a facilitating role precisely in making these actions that are struggling to become automatic more sliding and fluid.

In one case, an FC-user reported his difficulties in having to repeat actions many times before being able to perform them without having to think about them, see Excerpt 1.

Finally, the significance that FC-users give to being supported and believed clearly emerges. The expectations of competence on the part of the facilitator are significant. As known from the famous experiment of Rosenthal and Jacobson (1966), the expectations of a teacher towards their students are more predictive of the performances of the actual intellectual potential of these students. There are decades of research on the powerful effect that teachers' expectations have on students' performance and future outcomes (De Boer et al., 2018; Gentrup et al., 2020; Papageorge et al., 2020; S. Wang et al., 2018) as well as in other contexts as seen in the literature on the self-fulfilling prophecy (Jussim, 2012; Madon et al., 2011).

In addition, in the case of people belonging to social minorities, such as individuals with disabilities, social expectations placed on them by teachers or health care professionals might have a heavier weight because of the phenomenon of stereotype threat (Desombre et al., 2018b; Zhao et al., 2019). When there is a socially shared stereotype, such as that people with disabilities are considered less capable and intelligent (Biklen & Burke, 2006), and there is the activation of that stereotype, concern about not confirming that stereotype, on behalf of the individual part of that group, can cause a reduction in the ability of working memory, and therefore a reduction in performance (Aquino, 2011; Desombre et al., 2018b; Haft et al., 2022). Therefore, the importance of assuming skills, competences, and maintaining a positive attitude (Biklen & Burke, 2006; Biklen & Kliewer, 2006) , as described by many FC-users, appears evident.

Summary**.** In the following chapter, the touch literature will be examined, and the empirical explanations presented here might become more surprising to readers of this manuscript. Indeed, the theoretical hypothesis provided at the end of the thesis on FC functioning is not too far off from those produced here. However, it's based on previous theories and research and not on individuals' testimony. It seems automatizing processes are problematic in many FC-users, plus a lack of fluency in thoughts and movements, and that the physical contact with the facilitator aids these functions. From these texts also appears that these effects on attention, body perception and motion lay atop a foundation of trust, positive expectation of ability, emotional regulation and support.

4. Touch

In chapter 3 “Message Passing”, it was shown that MP can be performed successfully when it is considered as a skill to be learned. This does open up key questions about the facilitation itself: what does the facilitator’s touch do? If it is not all mere influence, why is there a need for physical contact? Indeed, an important unresolved question is what function touch plays in FC, and why even the most autonomous communicators usually need a hand on their back or knee to write. In this chapter, a brief review of the literature on touch precedes two experiments carried out to provide a better understanding of what exactly touch does when a person holds a hand on the shoulder of somebody else.

4.1. General introduction. In the field of perception, the sensation of touch is considered the sum of five different cutaneous sub-modalities (temperature, pain, itch and of course tactile and pleasure) and the sense of touch is formed through different sensations including pressure, temperature, skin tension and vibrations (Whitehead & Grider, 2020). Touch has a dual role in providing the basis for interaction with the outside world and one’s body (Salvato et al., 2020). The sense of touch provides information about external objects or persons that we touch or that we are touched by which corresponds to the exteroceptive function of touch. In contrast, physical contact (depending on the body part, the person/object acting, the context and the intensity of it) can stimulate an internal feeling and provide information about one’s body (interoceptive function). The exteroceptive system, created by the combination of cutaneous sensations and proprioception, pilots the movements of the body and provide a sense of bodily self-awareness (Salvato et al., 2020; Serino & Haggard, 2010).

The perception of touch arises through the sensory receptors of the skin that is richly innervated by primary afferent axons. These axons flow through the network of nerves towards the central nervous system and the Sensory Cortex (S1) through two different routes: painful and thermal sensations are transmitted to the thalamus by the *anterolateral column*, whereas the route that carries out tactile sensation and limb proprioception are transmitted to the thalamus by the *dorsal-medial lemniscus columns* (DCML) (Hertenstein & Weiss, 2011). The dorsal axon bundles carry tactile information as well as information concerning the position of the limbs or proprioception and vibrations. In other words, there is a close connection between tactile perception of external stimuli and the perception of one’s own body; not only when looking at function, but also at the level of structure. Moreover, tactile capacity increases when the person is using that part of the body. This suggests a sophisticated and

complex role of the somatosensory system in the motor exploration mechanism (Hertenstein & Weiss, 2011; Serino & Haggard, 2010).

Proprioception is the sensation of one's body position and movement, and it is not usually experienced at a conscious level as other senses. Vision, proprioception, and the vestibular system provide most of the sensory information needed for movements. In fact, the skin is the organ that determines the boundaries of the human body and the peripersonal perceptual attentional space (Pellegrino & Làdavas, 2015). Proprioception has an essential role in coordinating movement: stabilizing the posture of, and protecting, the body (Tuthill & Azim, 2018). Touch has been studied in different psychological fields, from the deprivation of touch, the beneficial effects (or not) in clinical settings, transmission of emotions through touch, relationship between touch and compliance and so forth. The main findings emphasize, among others, the importance of touch in early development, in overcoming the effects of stress, in improving attention, and in reducing aggression (Field, 2003; Field et al., 2005; Field, 2010, 2019).

In this chapter, first, the literature on interpersonal touch will be briefly presented, following which a brief review of the light touch paradigm argument will be presented. Second, two experiments on the effect of touch on a lexical decision task and on writing will be presented, where the role of touch in supporting, prompting, or maintaining reactions and behaviours that are conducive to attention and communication is explored. The basic idea behind the two experiments is to compare the performances in different tasks when there is physical contact, namely a hand on the shoulder, in contrast to when there is no touch. The results of these two studies will then be discussed in the general discussion at the end of the chapter.

In these two studies, the participants are individuals who are part of the general population and not FC users. A significant amount of time and effort was put into finding an experimental paradigm to test the effects of touch on attention and writing at a behavioural level with FC users. Logically, it would have been ideal to carry out these studies with participants who actually use FC. However, any tasks and tests that were considered, especially those with a time component, would have been too stressful and pressing for FC users.

In addition, many tasks would have required support, such as tactile support, to perform the task. In other words, individuals with disabilities would have been forced to fail in performing certain tasks (especially with time pressure but not excusively) without the support of touch in the control condition. And the question of support's influence would have clouded the main effect of touch. In conclusion, an ethically valid behavioural modality for testing the effects of touch with FC users was not

identified. On the other hand, studies on the light touch paradigm and the effects of touch show how the effects of touch are more accentuated in individuals with motor, coordination, balance, vestibular difficulties, and so forth, but they are present, even if to a lesser extent, in the general population. So, it is also a matter of general human significance to establish the effects of touch.

4.2. Interpersonal touch. Touch has been studied in several contexts regarding interpersonal relationships: from its beneficial effects, to a large literature on compliance, to social and intimate relationships. From new-borns, to romantic couples, to clinical/therapeutic relationships even to strangers, touch has been shown to be beneficial and having positive physiological and psychological effects (Field, 2010, 2019). Specifically, touch has been shown to decrease stress (cortisol decreases, and serotonin and dopamine increase), blood pressure, heart rate (Ditzen et al., 2007; Field et al., 2005; Sumioka et al., 2013), touch aversion, off-task behaviour, attention to irrelevant sounds, and stereotypical behaviour in children with autism. Touch also has been found to improve attention span, to lower hyperactivity in adolescents with ADHD, and to increase body awareness (Field, 2010; Sumioka et al., 2013). Moreover, touch and massage therapy have proven to be a valuable aid to restore an overall balance in compromised psychophysical functions (Field, 2010).

4.2.1.*Touch and compliance.* Many studies have been carried out in very different scenarios all asking the question, how does a person's attitude change when they are touched in different contexts? It was found that when slightly touched, people tend to have a more positive attitude: from an increased probability of doing a generous or prosocial act (Guéguen, 2004; Guéguen & Fischer-lokou, 2003; Kleinke, 1977a; Stephen & Zweigenhaft, 1986; Vaidis & Halimi-Falkowicz, 2008) to a more positive opinion toward a specific object/person (Fisher et al., 1976; Hornik, 1992; Kleinke, 1977b).

Generally, in interpersonal relationships, both the quality and the quantity of touch seem to be crucial for generating compliance and cooperation. For example, some studies show increased compliance in the presence of two touches with respect to a single touch, or one touch versus no touch (Vaidis & Halimi-Falkowicz, 2008). In healthcare settings, a simple touch from a nurse on the day before surgery can reduce stress levels (measured via self-report and heart rate and blood pressure) and increase the compliance toward medical recommendations in female patients (Whitcher & Fisher, 1979). Furthermore, in addition to verbal encouragement, when healthcare professionals were touching the elderly they were caring for, they actually ate more. This effect lasted for five days after the physical contact (Eaton et al., 1986).

4.2.2. *Social communication.* Touch works as a communication system in several species. In animals, touch is used to impose one's dominance, to create attachments and bonds, and to provide

comfort and support. Intuitively, touch seems to be more central in species that are socially based and living in groups (Hertenstein, Keltner, et al., 2006; Hertenstein, Verkamp, et al., 2006). Not surprisingly touch serves as a communicative system also in human beings. In fact distinct emotions can be identified through the touch of a stranger on our arm without any additional kind of information (Hertenstein et al., 2009; Hertenstein, Verkamp, et al., 2006). In Hertenstein's studies, participants had to communicate one of 13 specific emotions through touch. Results show that they were able to identify the correct emotion between 48 and 83 per cent of the times.

4.2.3. *Interpersonal relationship.* The physiological effect of touch in a couple suggests at least one of the reasons why human beings are social animals usually looking for companionship. Indeed, affectional physical contact results in lower cardiovascular reactivity in subsequent stressful situations (Grewen et al., 2003). Analogously, participants' levels of cortisol and heart rate, when in a stressful trial (Trier Social Stress Test) were both lower when previously receiving physical contact by their partner (Ditzen et al., 2007). Similarly, premenopausal women that reported having been in a relationship in which they received a lot of hugs from their partner had higher levels of oxytocin and lower blood pressure and heart rate compare to those that did not have a history of partners that gave them a lot of hugs (Light et al., 2005). Furthermore, prosocial affiliative behaviour such as grooming, cuddling and caretaking stimulates an interoceptive function providing homeostatic information about the body and the sense of self (Craig, 2009).

This brief review shows how touch can have a number of different positive effects on social and interpersonal level both in humans and in animals. The more interesting question that naturally arises is, "why would all of this happen?". One hypothesis would be that people receiving touch probably believe that the other person touching them is in sincere need and/or likes and trusts them. These positive perceptions would then in turn increase compliance or otherwise positive behaviours and attitudes. The potential issue with this interpretation is that it assumes that the person is conscious of the physical touch happening which, through self-report measures, seems to not always be the case.

In fact, a different hypothesis that is not based on an explicit elaboration of the tactile stimuli would suggest that a positive response to touch stands from an innate correlation between human touch and stress reduction from new-borns to adults (Reite, 1990). From a physiological point of view, indeed, there are skin receptors that are specifically dedicated to coding pleasant touch (McGlone et al., 2007). Therefore, perhaps the positive effects are, at least partially, due to a simple positive physiological elaboration of touch.

Understandably, the experience of being touched is not a simple result of bottom-up histological and physiological sensation. In fact, cognition does influence the way physical contact is perceived. Top-down reasoning such as, “Who is touching me?” or, “Where and why are they touching me?” are key factors to the whole perceptual experience (Gallace & Spence, 2010). Top-down reasoning on touch not only influences the perception of that physical contact but also the neural representation of it. This phenomenon has been studied in the context of pain, as attention and motivation both play an important role in the quantity of pain felt (Spence et al., 2002).

Physical contact can also be perceived as unpleasant even when consensual, or it can be non-consensual. This is of particular importance when considering a clinical population, such as individuals with a disability, since such individuals experience more non-consensual physical contact than the general population (Brown et al., 2017; Harrell, 2011; M. Mitra et al., 2016). Individuals with a disability seem, in fact, to experience violent victimization at almost double the rate than persons without disabilities (Harrell, 2011). Individuals that live, or have lived, in institutions have an even higher probability of experiencing physical or sexual abuse (Mirfin-Veitch & Conder, 2017). In addition, even in the case of consensual and caring physical contact, people who experience challenges with processing sensory information, including many individuals with autism, might experience distress when touched (Marco et al., 2011; Robertson & Baron-Cohen, 2017).

4.2.4. *Light Touch Paradigm*. The light touch paradigm (contact between the index fingertip and an inanimate fixed object) has been shown to support motor control in an upright stance (Jeka, 1997). This is believed to occur through the reduction of body sway. Body sway has been constructed as a perceptual signal in stretch receptors that provide vital clues about the action that is needed at any given time to maintain balance. Thus body sway would be a reflection of postural instability (Błaszczyk, 2016). Another hypothesis identifies body sway as physiological noise that would need counteracting and reducing (Riccio et al., 1993). In this thesis, the function of body sway as an automatic method to increase body posture and stability in the upright position is presumed.

Interestingly, light touch is not enough to provide meaningful mechanical support to increase the stability of the body in a standing position. It does, however, provide additional somatosensory feedback and therefore it has been shown to reduce body sway (Baldan et al., 2014; Johannsen et al., 2007; Wing et al., 2011). A light tough will, in fact, provide additional information on the body’s and limb’s orientation, enabling the adjustment of muscles for a better trunk position, and in turn reduce postural sway (Rabin et al., 2013). This effect was found also when participants were pushed on the shoulder, showing how light touch results in increased stability following perturbation (Kwon et al., 2020)

When the support effect of touch on upright positioning was studied in relation to vision, it was shown that vision and light touch (touch on inanimate object with closed eyes) alike reduce body sway (Riley et al., 1997). In other words, vision and light touch provide equal information about the body's orientation to the environment when the motor task at hand is standing still. In one study with elderly individuals, touch was found to be more effective in supporting balance compared to vision (Kwon et al., 2020). Indeed, one secondary effect of light touch is that it seems to improve visual search accuracy (Chen & Tsai, 2015), likely a direct consequence of increased postural stability.

The effects of light touch seem to be larger in individuals with postural problems due to motor and/or sensory disability or aging (Baldan et al., 2014; Johannsen et al., 2009). Light touch seems to increase balance control and posture in individuals with neural lesions (Lee et al., 2018). Similarly, light touch improves locomotion in people with Parkinson Disease (Watanabe & Tani, 2020). Individuals with balance difficulties might benefit from additional sensory information in particular when other senses are not (fully) available (as in cases of vestibular or vision issues, Magalhães & Kohn, 2011). Postural and coordination issues in people with Neurodevelopment Disorders have been widely reported in the literature, in particular in the cases of autism and others neurodevelopmental disabilities (Barozzi et al., 2013; Klotzbier et al., 2020).

Body sway has also been studied under conditions of interpersonal light touch (both at the level of the fingertips and at the shoulder) in neurotypical individuals with eyes closed. In the two individuals touching, the body sway was reduced in both touch conditions, although the reduction was increased at the shoulder level than the finger (FU-Chen et al., 2015). Moreover, cognitive activity can influence postural stability differently depending on the type of cognitive process (Maylor et al., 2001). When participants were asked to perform a cognitive task, body sway increased. However, when light touch was introduced the body sway diminished (Lee et al., 2018, 2020).

In the two studies presented in this chapter, the effect of touch on attention (via a word recognition task) and on writing will be explored. There are two parallel rationals to support these studies. At a psychological level the positive effects of interpersonal touch are likely to create a positive supportive emotional state in the touch receiver (provided that the physical contact happens within a supporting or helping context). The touch receiver might benefit from a reduction of stress levels (Field, 2019) and from the awareness of a positive emotion communicated through physical contact (Hertenstein et al., 2009), which in turn is likely to increase the willingness to commit to the task at hand (Guéguen, 2004). At a physiological level, individuals, while performing a cognitive task, might benefit from the physical contact (Lee et al., 2018, 2020). Touch might provide them with added information on

their trunk position and limbs' orientation (Rabin et al., 2013), and therefore reducing the attention dedicated to action.

4.2. Experiment 1: The role of touch on attention in a lexical decision task

4.2.1. Experiment Introduction. In this study the role of touch on attention in a lexical decision task is explored. The topic of the effects of touch on attention was partially studied in regard to attentional issues in children with ADHD and autism, which did improve with massage therapy. And touch has been shown to improve children's ability to focus on tasks (Escalona et al., 2001; Field et al., 1997). It is likely that touch, in this context, would have enhanced focus and reduced, somewhat, the cognitive load associated with undertaking the tasks.

In fact, light touch was also shown to reduce postural instability arising due to a concurrent cognitive task (Lee 2018, 2020), suggesting that light touch may reduce the overall load of a cognitive-motor task as a in the case of FC. As explained in Chapter three, the testimonies of the FC-users to this effect do not weigh directly on the evidence base relating to the FC controversy. They have, however, guided a part of this research project, and were an influence in the framing of the two experiments presented in this chapter. As FC users have repeatedly pointed out how touch has an effect on their writing abilities via their concentration and thoughts flow (amongs other things), it was decided to investigate these two aspects in these touch studies.

Given that attention needs to be measured via a task's performance that specifically requires attention, and that in this (and the following experiment) a resemblance towards FC was aimed for, attention was measured through a lexical decision task. The lexical decision task was performed with another participant acting as a "facilitator" and touching their shoulder. Given that touch might act as a "facilitation factor" in activating the motor component of language processing (Bergen, 2015), the list of stimuli included both action verbs, namely verbs that indicate human actions, and non-action verbs.

It was hypothesized that participants would perform better in the touch conditions in contrast to the no touch condition (hypothesis 1). It was also argued that this effect is not, or at least not entirely, due to the facilitator "prompting" or influencing. Conversely, it was hypothesized that touch would have an effect on different cognitive and motor processes regardless of the (sub)conscious influences of the "facilitator" (hypothesis 2). This hypothesis was tested with the "facilitator" providing a hand on the shoulder while being blindfolded, rendering them unable to see the task at hand. The difference between the two-touch condition (if found) would provide important information about the mechanism

underlying the touch effect (for example, conscious motor prompting versus a non-conscious mechanism).

In addition, there is a good argument in the literature to support an embodied perspective in both language production and comprehension. Sensory and motor information seem to be necessary for the representation and cognitive processing of linguistic stimuli (Meteyard et al., 2012). Foroni and Semin have shown that action verbs elicit a muscular activation of the corresponding actions when studying emotion expressions via EMG, suggesting a multimodal, bodily-grounded functioning of language referring to facial actions (Foroni & Semin, 2009). In fact, when individuals read action words referring to the face, arm or leg (for example, to kick) the motor cortex's areas (or adjacent ones) that fire when performing real movements with those body parts are activated (Hauk et al., 2004). Interestingly, the motor cortex activity does not seem specific for conceptual content, as it also fires for non-words "looking" like verbs. Thus, it seems to be an ortho-phonological implicit recognition more than a simulation of the action (de Zubicaray et al., 2013).

Given that touch provides sensorimotor information, does touch act as a facilitator in the processing of action language? The effects of facilitation and disturbance are found when language processing precedes or is simultaneous to an action (Bergen, 2015). It seems sensible to hypothesize that touch might have a facilitative effect on language recognition and processing of action verbs (compared to non-action verbs; Bergen, 2015). It was, thus, expected that participants would be faster and more accurate in recognizing an action verb compared to non-action verbs in the touch condition (hypothesis 3).

4.2.2. Method

4.2.2.1. Participant. Participants were recruited from a variety of sources, including the psychology research credit scheme, and through existing networks of academic and social contacts. Participants were asked to come in for the experiment with a partner with whom they felt comfortable (girlfriend, boyfriend, husband, wife, sibling, friend, roommate, colleague, and so on). Each pair of participants was asked to take turns to act as 'participant' and 'facilitator' in each of the tasks. For practical reasons, the first participant recruited is called participant 1 whereas the person s/he is coming in with is named participant 2.

Participants were 25 couples (n=50), average age 23.3 years old. There were 10 males and 40 females. Forty-six participants were included in the final analysis, Four were excluded due to incomplete data caused by technical malfunctions. Cultural background was mixed. There were 31 British participants.

The rest were Italian, Korean, Libyan, Persian, Bulgarian, Portuguese, Spanish, Indian, German, Kurdish, and Singaporean. Thirty-seven had English as their native language and the rest of the participants had a high proficiency in English.

4.2.2.2. Design. This study was a within-participants 3x3 design with two independent variables having three levels each. The first independent variable *touch condition* comprised two experimental conditions: (1) touch and looking at the screen, and (2) touch and blindfold, and one control condition: (3) no touch. The second independent variable *word type* had again three conditions: (1) action words, (2) non action words, and (3) non-words (meaningless letter strings). Given that the lexical decision task was conceptualized to measure attention, the two dependent variables were (a) accuracy of response and (b) reaction time.

4.2.2.3. Materials. The list of stimuli comprised 162 non-words and 162 words: 81 action verbs and 81 non-action verbs. A complete list can be found in Appendix IV. The non-words stimuli were selected from the MCWord-Orthographic Wordform Database (Medler & Binder, 2005). Non-action verbs were selected from different categories of verbs: non-human actions verbs (such as trotting or bucking), natural phenomena verbs (such as blooming or raining), sensations and perceptions verbs (such as hearing or smelling), emotions verbs (such as grieving or worrying), cognition verbs (such as knowing or guessing) and others (such as costing or owing). Action verbs were of roughly three types: hand actions (such as uncapping or signing), leg or feet actions (kicking or trampling) and whole-body actions (running or swimming and so forth). All three types of stimuli, namely action verbs, non-action verbs, and non-words were matched for length. The first two were also matched for frequency. Finally given that all verbs were presented in the gerund form (-ing) all non-words also ended in *-ing*.

4.2.2.4. Procedure. Each participant was asked to perform a lexical decision task at the computer. Participants were asked to distinguish between words and non-words in three experimental conditions: touch with facilitator observing the screen, touch with facilitator blindfolded, and no touch (the "facilitator" being sat near the participant with no blindfold). The participant acting as "facilitator" wore a pair of dedicated glasses to create the blindfold. After participants read the information sheet and signed their consent for the study, the instructions were provided to participants on the screen of the computer. As soon as they were ready, they pressed a key and the experiment started. Participants responded with a joystick, pressing right for yes (real word) and left for no (non-word). Participant had to perform the lexical decision task for two minutes in one of the three touch experimental conditions. After two minutes, regardless of how many stimuli the participant had responded to, the experiment paused, and the participants moved on to the next experimental condition. Once again, as soon as the

participant was ready s/he pressed a key and the experiment resumed. Each participant performed the lexical decision task in each of the three touch conditions.

Therefore, every participant performed the recognition test for the same amount of time but responded to different numbers of stimuli. The experiment was designed with an ample stimuli to cover all 6 minutes even for the faster participant; hence no participant responded to every stimulus. This choice was made because the aim of the study was to assess the ability in recognising stimuli as an index of the effects of touch on the focusing of attention and the attention span. The order of the three experimental conditions was counterbalanced. Moreover, the experiment was built so that even if the order of the stimuli was different and randomized for every participant, words and non-words were present, or absent, within the 6 minutes, in the same frequencies.

4.2.3. Results

The accuracy for each individual was above chance level across conditions, thus, no participant was removed from the analysis. However, looking at accuracy for each word item, 10 stimuli had accuracy responses below chance (< 50 percent). These stimuli were, therefore, removed from further analysis. First the accuracy was analysed, then the reaction times only for correct responses.

A preliminary analysis revealed that the two touch conditions (touch and looking, touch and blindfold) did not differ reliably from each other with respect to accuracy, $chi^2(1) = .18$, $p = .67$, hence they were collapsed into a single "touch condition". As expected, accuracy was higher for words (action verbs = 92.5 per cent, non-action verbs = 92.3 per cent) compared to non-words (90.2 per cent), $chi^2(1) = 12.14$, $p = .002$. However, since action verbs did not differ reliably from non-action verbs, $chi^2(1) = .04$, $p = .84$, they were also collapsed into a single "word" category.

Therefore, a log-linear 2x2x2 analysis (with touch and no touch, word and non-word, and accurate and inaccurate responses) was carried out. The analysis showed a significant interaction effect $G^2 = 15.01$, $p < .005$. As can be seen, the accuracy for words was not affected by touch condition, whereas the recognition of random letter strings as non-words was facilitated by touch (Table 4).

Table 4: Accuracy percentages per word type and touch condition

Accurate responses	word	Non word
Touch	92.4%	**90.5%**
No touch	92.4%	**89.4%**

Reaction times (RTs) were only analysed for accurate responses. The curve distribution of the RTs had a right skewness (skewness 3.14, kurtosis 16.24). Hence the data were log-transformed before analyses. A Linear mixed effect model was conducted with word type and touch conditions as repeated measures (3x3), and participants and word length as random effects. The analysis revealed two main effects but no interactions. The main effect for word type, $F(2,7068)=333.08$, p <.001, shows that RTs are lower for non-action words (M= 6.58, SD= .057) and action words (M=6.57, SD= .057), compared to nonwords (M= 6.76, SD= .057), pairwise comparison both p <.001, as can be expected. No difference was found between action and non-action words (p=.90).

The main effect of touch condition showed a significant difference between the touch conditions $F(2,7067)=4.888$, p=.008, with RTs being higher for non-touch (m= 6.66, SD= .057) compared to touch and looking (m= 6.63,SD=.057) and touch and blindfold (m= 6.63, SD= .057). No difference whatsoever was found between the two touch conditions (touch and looking versus touch and blindfold), p = 1.

4.2.4. Discussion

As expected, accuracy was higher for words compared to non-words and RTs were higher for, non-words compared to words as participants took longer to identify these. More interestingly, touch provided a facilitating effect on the speed of the recognition of words and non-words, and on the accuracy of non-words (touch did not have a facilitating effect on the accuracy in recognizing words). This probably happened because recognizing a word is such an automatic task that individuals, without any postural issues or disabilities, carry it out in an fast and automated way (Carreiras et al., 2014; Rastle, 2016). A number of models have been presented to explain how word recognition occurs, the most recent ones calling for more flexibility in the recognition process (Snell et al., 2018) compared to the former Interactive-activation model (McClelland & Rumelhart, 1981) which suggested the recognition happened via absolute letter positioning coding by activating of positioning nodes. Regardless of the exact way in which words are recognised in a lexicon decision task, participants were likely to use a lexical-visual reading path (recognizing positioning of letters, shape of the word or bisyllables or positioning nodes) which are all very fast and automatic processes, compared to the non-familiar task of recognizing a random string of letters, as seen in the classic word-superiority effect (Cattell, 1886).

Computational and quantitative models suggest there is a temporal deadline. Individuals would first try to recognize the word and only then, if they were not able to recognize it automatically, decide it is a non-word (Coltheart et al., 2001; Grainger & Jacobs, 1996). When presented with a non-word

stimulus, the lexical reading path would most definitively return a result of “stimuli non existing in my vocabulary” turning to the a-grapho-phonological route, forcing the individual to transform the graphemes to phonemes (Jobard et al., 2003). Another hypothesis would be that participants still used a more visual-lexical approach, empirically exploring all options. In other words, checking every similar option (as words that start with that letter or which are of that length, or with that letter in the middle, and so forth) to the non-word before being able to say “no this is not a word” without actually needing to read it phonetically, as hypothesised in the diffusion model or LCA model (Dufau et al., 2012; Norris, 2009; Yap et al., 2015).

Hypothesis one can therefore be considered supported as touch appeared to enhance performance in a lexical decision task in the general population. It is interesting to note that the touch effect does not rely, neither in the case of accuracy nor in the response times, in this study on whether the participant acting as facilitator was looking at the keyboard or not. This suggests that it would be fruitful to explore other hypotheses about the mechanism underlying the support of touch other than a mere influence of a second mind engaging in the task of lexical decision.

Light touch has also been shown to reduce postural instability arising due to a concurrent cognitive task (Lee 2018, 2020), suggesting that light touch may reduce the overall workload of cognitive-motor task. This might not be relevant, or not significantly relevant, when the task at hand is as automated and practiced as recognizing a word as such. However, it is not surprising that a facilitation effect occurs when the task presented is unfamiliar and might require increased attention intentionally directed to the purpose, as when transforming graphemes to phonemes (Jobard et al., 2003). Different from the binary evaluation of the correctness of the answer, it is probable that the effect of touch is also evident in recognition of words through RTs simply because RTs are a more sensitive investigation measure.

Second, touch seems to act as a facilitator in the elaboration of action language. As seen above, there is abundant evidence that the comprehension of language is at least partially grounded in action (de Zubicaray et al., 2013; Hauk et al., 2004; Meteyard et al., 2012). This effect was not reported in this study as no significant difference was found between the two action and no action conditions.

The study is inevitably explorative as little is known about the effect of touch on a lexicon decision task. More research is, indeed, needed into the effects of interpersonal physical contact on cognition capability, especially on information processing, thought, and attention. Moreover, because of the high number of within variables (3x3), it might be useful to carry out the study again in a simplified way

collating the two touch conditions (as no difference was found between those) and keep the number of trials constant instead of the time.

It is quite possible that these effects, when recorded in the general population, might acquire a whole different dimension than when investigated in the clinical population that uses FC. It is taken for granted that none of these results are *directly* relatable to FC. Although they do provide some clues as to the central role that interpersonal touch may have on the FC-user, especially considering that in Neurodevelopmental Disorders and Learning Disabilities there are likely to be sensorimotor and Executive Function issues that might be supported by touch more effectively than in the general population (Daunhauer & Fidler, 2013; Demetriou et al., 2018; Lanfranchi et al., 2010). Moreover, it is interesting that several anecdotal reports of FC-users talk about the lack of automatisms in cognitive and motor tasks and how touch sometimes compensates these. It might be that touch in FC-users has a specific compensatory effect when it comes to processes that are automatic in the general population, which instead require active and conscious attention from some people with disabilities.

It would be important to investigate the effects of interpersonal touch on automatic and non-automatic cognitive tasks further in individuals with sensorimotor issues. As mentioned, further research is needed into the effects of interpersonal physical contact on cognitive capability, especially in relation to thought and attention. Since both thought and attention cannot really be measured directly, the more studies that use a wide range of indexes for attention and fluency of thoughts, the better.

4.3. Experiment 2: The role of touch in writing production

4.3.1. Introduction

As for the previous study there are gaps in the literature as the effects of touch take us into relatively uncharted territory, in the context of Augmentative and Alternative Communication (AAC) techniques and linguistic communication in general.

An unpublished Master's Thesis (Picaro, 2012) suggests that participants without any particular pathology react to FC-like touch by disclosing more personal information. The author explains the findings on the basis that touch acts as mediation in communication and interpersonal relationships, increasing the usage of personal pronouns and emotional terms. The study conducted by Picaro on a sample of participants without disabilities may be central to clarifying the role of touch in text production. Therefore, a conceptual replication to Picaro's study was run. Specifically, in this experiment, the role of touch in written production is explored. Participants were prompted by a brief vignette and asked to write some text in response.

In fact, in writing and speaking, the words used, and how they are used, can reflect a lot about what individuals pay attention to, how they reason, how they are feeling; essentially how they think and feel. Linguistic Inquiry and Word Count (LIWC) is a software that counts words that are significant for psychological categories (Pennebacker et al., 2015; Tausczik & Pennebaker, 2009). It counts both content and function (style) words, therefore not focusing solely on content but also on *how* people write. The content words communicate what people want to say, the function words how they want to say it (Pennebaker, 2011).

Certain psychological processes can be inferred from text analysis, especially when it comes to individuals' priorities, intentions, and thinking processes. For example, individuals tend to use more personal pronouns referring to themselves when completing a questionnaire in front of a mirror (Davis & Brock, 1975). Logically, higher usage of pronouns tends to indicate an extended focus on the writer's life and persona (Tausczik & Pennebaker, 2009). The specific language used can also provide information on an individual's emotionality and social relationships. LIWC provides three categories to evaluate emotional content: (1) emotional tone (Cohn et al., 2004), (2) usage of positive and (3) negative emotional words. Emotional words tend to be more present in a narrative style of writing and therefore are inversely proportional to articles and preposition. By way of contrast, emotional words have a positive correlation with usage of pronouns, auxiliary verbs and negations (such as 'not' or 'never').

Thinking styles and complexity can also be inferred by the language one uses. Two components of reasoning seem particularly significant when assessing the thought complexity of an individual: (1) The differentiation between competing solutions and (2) the integration among those solutions (Tetlock, 1981). The LIWC's *differentiation* words (hasn't, but, else, without) help in making distinctions, and *conjunctions* (and, but, whereas) knit together pieces of thoughts, representing these two thinking components (Graesser et al., 2004). A higher number of *prepositions* can also be an indication of more complex language (Hartley et al., 2003). Moreover, a higher number of *tentative* words (such as 'maybe' or 'perhaps') tend to indicate that the writer has not fully finish processing an event or may still be organizing a narration to an event (Pasupathi, 2007).

A large text analysis of over 50000 university admissions essays (Pennebaker et al., 2015) revealed a prediction of the type of language used on later grades. Students who used more articles and prepositions (indexes of more categorical and analytical thinking and writing style) would go on to get higher grades than students who used more auxiliary verbs, personal, and impersonal pronouns, adverbs, conjunction, and negations (indicating a more dynamic thinking and writing style).

The main aim of this study is to investigate whether touch has an effect on the thinking, and therefore writing, style of a brief essay. One possibility could have touch stimulating a more *narrative-dynamic thinking style*, with the disclosing of more personal and emotional information in participants (as seen in Picaro, 2012), as part of a more general phenomenon of self-focus (hypothesis 1a). In this case we would expect to find a higher number of emotional terms and pronouns, especially pronouns including the writer (such as 'I', 'me', 'our' and so on). Interpersonal touch might induce a mental state of self-focus that could result in increased usage of auxiliary verbs, personal and impersonal pronouns, adverbs, conjunction, and negations, indicating a more dynamic thinking style (hypothesis 1a, as see in Pennebaker et al., 2015).

A second possibility could be that touch supports a more *categorical-analytical thinking style* (hypothesis 1b). Touch might indeed help to focus thoughts and arguments in the participants' minds. There are indeed a number of anecdotal reports of FC-users on the organizing and "flowing" effect that touch has on their thinking process (please see some examples in Chapter 3. In this case the essays written in the touch condition would have larger usage of articles and prepositions, typical of an analytical thinking dimension and lower number of auxiliary verbs, pronouns, adverbs, conjunctions and negations (hypothesis 1b).

A number of potential moderating variables were also investigated, relating both to an emotional and self-focusing view and both to cognitive effect of touch: (1) self-rated intimacy of produced text, (2) self-evaluation of emotional and cognitive experience in writing with a hand on their shoulder, and (3) self-rated perceived closeness to the situation proposed in the vignette. It is reasonable to assume that if the vignettes were perceived as closer to the experiences of the participant, they would produce more intimate written content. This potential moderating variable was assessed as well.

4.3.2. Method

4.3.2.1. Participants. Participants of this study are the same as the ones that participated in experiment 1. The usable data for this study were those of 48 participants who provided a total of 96 texts (48 per touch condition).

*4.3.2.2. Design***.** The design consisted of a 2 (touch vs. no touch) x 2 (positive vs. negative vignette) within design in which pairs of participants wrote two essays and responded to one questionnaire concerning their subjective experiences of writing with and without FC-like touch. Participants in each pair acted both as a "facilitator" and "communicator". The main dependent variables were (a) number of singular and plural first-person pronouns (relative to total number of words), (b) number of emotion terms (relative to

total number of words), (c) number of secondary emotions (compared to total number of emotion words), (d) number of articles and preposition (indexes of a categorical and analytical thinking style) and (e) auxiliary verbs, personal and impersonal pronouns, adverbs, conjunction and negations (indicating a more dynamic thinking style). Potential moderator variables were also considered in this study: (1) Self-rated intimacy of produced text, (2) self-evaluation of emotional and cognitive component in writing with a hand on the shoulder, and (3) self-rated closeness to the situation proposed.

4.3.2.3. Materials. The vignettes used to prompt participants' writing were four in total (see Appendix V), two with positive and two with negative emotional tone; a small panel of 10 individuals tested the vignettes confirming the perceived emotional polarity. These vignettes briefly described positive or negative situations students can often experience (as struggling with exams or being asked out on a date). An example of negative vignette is, "Ariel is having a very tough time getting used to her new life in Athens. She feels lonely, has difficulties making new friends and getting used to the Greek culture. She is struggling with the language, the different alphabet and missing her friends". Participants were also asked to fill in a short questionnaire (Appendix VI) composed of a couple of demographic questions, two control questions, and questions of self-rating emotionality of the produced text. Demographic questions are to assess a possible age, sex, cultural or language moderating effect. For example, it is known that languages of more individualistic cultures require a stronger presence of personal pronouns than communitarian cultures (Na & Choi, 2009).

The two control questions assessed the degree of comfortableness of the participant having a hand held on their shoulder. If a participant felt uncomfortable or was not used to physical contact with their partner, the data of the participant was not considered in the analysis. In fact, if the physical contact was perceived as uncomfortable, chances are it would have interfered with the "positive" effect that touch might have. Moreover, participants were asked to assess the information they disclosed in the text on Likert scales linked to the items of 'intimate', 'superficial', 'confidential', 'personal' and 'detached'. Participants expressed their opinion on how it was for them emotionally writing with a hand on their shoulder (rated by the terms 'strange, comfortable, unfamiliar, cosy, confusing, protected, reassuring, awkward, easy, secure, odd') and cognitively (see Appendix VI for details). Before writing what they would have thought if they found themselves in the protagonist's position, participants expressed their opinion on the closeness of the situation to the participants' own life in a Likert scale.

4.3.2.4. Procedure. Participants were prompted by a vignette (Appendix V) about an emotional situation and were asked to write "what would they have thought and felt if they were in the shoes of …". Both participants responded in two conditions, with "facilitator" sitting close to them with no contact versus

"facilitator" sitting close and keeping a hand on their shoulder, producing a total of 96 texts across the experiment as a whole. Participants were asked not to speak with each other during the experiment. At the end of the task participant 1 answered the brief questionnaire (see Appendix VI). At that time, participant 2 was asked to stay on the other side of the room letting participant 1 complete the questionnaire in privacy. After that, the participants switched roles. To make sure there were no priming effects the order of vignettes was counterbalanced, creating eight different orders of vignette presentation, alternating the two experimental conditions, namely with and without touch and the polarity of the vignette.

4.3.3. Results

All the following analyses were carried out both with and without the participants (n=11) that had responded with a very low value (1 or 2 on a 5 point likert scale) to the control questions (that assess the comfortableness of the physical contact of the hand on the shoulder). No difference was found in any of the tests carried out therefore all participants were included.

4.3.3.1. Pronouns analysis. To test hypothesis 1a, and to see if similar results were found as in Picaro's study, the number of pronouns was counted. All types of pronouns were identified, but only the words that were actually used as pronouns were considered. Pronouns were considered an index of a self-focusing attentional state. There is a difference when participants wrote with a hand on their shoulder and were prompted by a negative vignette, which resulted in a reduction in the usage of pronouns (Table 5).

Table 5: Number of all pronouns divided per condition

	Negative Vignette	Positive Vignette	tot
No Touch	194	184	378
With Touch	**151**	194	345
tot	345	378	

Subsequently, the pronouns that include the person who writes (I, me, my, myself, our, we) have been isolated (Table 6). The same pattern of 8 Table was found: a reduced number of pronouns is used in the touch condition when responding to the negative vignette.

Table 6: Number of pronouns including the writer

	Negative Vignette	Positive Vignette	tot
No Touch	138	131	269
With Touch	**111**	143	254
tot	249	274	

A Chi-squared test confirmed the interaction between the with-touch condition and the negative polarity of the vignette, revealing a lower number of pronouns, χ^2= 4.12, *p*=.042.

4.3.3.2. Sentiment analysis. To further inquire into hypothesis a1 a sentiment analysis was performed. The entire corpus was split into four different groups according to the experimental condition, namely: negative-no touch, negative-with touch, positive-no touch and positive-with touch. Each group comprised 25 texts. Within each group the 25 texts were merged together to form a longer text. The texts were then run through R tokenize. The sentiment analysis is determined on the word count of positive and negative emotional words, not taking into account syntax and grammar (Naldi, 2019). Every word is compared with a vocabulary (bing vocabulary in this case) in which words are given a positive or negative value. For each text, it delivers a sentiment value given by the difference between the number of positive words minus the number of negative words.

It appears that touch does, in fact, affect the choices of words made. In the touch conditions participants were less likely to use negative words while describing a negative situation and are more likely to use positive words while describing a positive event (Table 7).

Table 7: Sentiment Analysis results

Experimental condition	Words' number	Negative words	Positive words	Sentiment
Negative-no touch	1461 words	57	41	-16
Negative- with touch	1300 words	32	54	22
Positive- no touch	1253 words	47	43	-4
Positive- with touch	1312 words	**28**	**72**	**44**

4.3.3.3. LIWC analysis

Investigating whether a simple hand on the shoulder can have an effect on the type of thinking style was done using the LIWC software (hypothesis 2). First the effect of touch on the two summary variables, *Analytical thinking* and *Narrative-Dynamic thinking,* were assessed. A pair t-test revealed a

touch effect on *Analytical Thinking*. In the touch condition, the level of analytical thinking (M=36.40, SD=27,35) was significantly higher than in the non-touch condition (M=25,12, SD= 24,43), t(df=47) = 2.28, *p*= .027. A 2x2 analysis (touch vs. no touch x positive vs. negative vignette) was carried out to assess if there was an interaction effect with the type of vignette for analytical thinking as well for other LIWC words categories. None was found. No significant difference was found for the variable *Narrative-Dynamic thinking*.

Secondly the single variables defining the above summary variables (*Analytical thinking* and *Narrative-Dynamic thinking)* were investigated. A paired t-test revealed an effect on *adverbs*, with lower numbers (M=6.2, SD= 4.2) in the touch condition compared to the non-touch one (M=8.5, SD=4.6) t(df=47) = -2.25, *p*=.029 as would be expected given the effect of touch on *Analytical thinking.* Given the large evidence indicating the importance of function words for psychological processes the categories were also investigated (Pennebaker et al., 2015). Indeed, paired t-tests showed effects of touch in increasing both *comparison* (M=3.94, SD=3.34) and *quantifiers* (M= 2.23, SD=2.47) compared to the non-touch condition, respectively (M=2.23, SD=2.87) and (M=1.22, SD=1.63), t(47)=3.03, *p*=.004 and t(47)=2.15, *p*=.037. Interestingly, *tentative* words, as 'maybe' or 'perhaps', were found in higher numbers in the non-touch condition (M= 4.43, SD=3.31) compared to the touch condition (M=3.31, SD=3.06), t(47)=-2.03, *p*=.047. The LIWC variable *Present Focus* also resulted in significant differences in a paired t-test with lower number words in the touch (M=11.30, SD=4.81) vs. no touch condition (M=13.59, SD=4.93), t(47)=-2.57, *p*=.013.

The questionnaire items regarding the emotional experience of writing with a hand of the shoulder were collated to one item given the high internal consistency of the scale (α=.86). Analogously, the questions regarding the cognitive aspect of the experience of writing with a hand of the shoulder were aggregated as they also had a high Cronbach's Alpha, α=.86. No moderation effect was found at all for these variables and for the questions on self-evaluation of the texts.

4.3.4. Discussion

In this study it was investigated whether touch, in the form of a hand held on another person's shoulder, can in fact have an effect on writing style. Originally the first hypothesis, developed in the previous similar study by Picaro (Picaro, 2012), supposed that touch would stimulate a higher number of personal pronouns and number of emotional terms as part of a more general phenomenon on self-focusing. Although this finding was not replicated, in this study it was confirmed that a simple hand on a shoulder (of a neurotypical person nonetheless) does, indeed, have an effect on the writing style.

This by itself is a noteworthy result as the research existing on language analysis has focused on how beliefs, social relationships, personality characteristic, psychological traits and so on influence different style of writing (Chung & Pennebaker, 2007; Tausczik & Pennebaker, 2009). Very little has been done on the influences of tactile stimulation on writing. Attentional focus has been seen to effect usage of language (Davis & Brock, 1975; Rude et al., 2004); interestingly, it seems that the touch effect is not mediated by an evaluation of the touch itself (as it appears from the lack of moderating effect collected through the questionnaires), so it appears that whatever mechanism underlines this phenomenon it does not involved a top-down evaluation of the tactile stimuli.

A second perspective investigated whether touch would support a more categorical and analytical writing style as indicated by a more extensive usage of articles and prepositions (placing a higher value on the analytical thinking dimensions) and lower number of auxiliary verbs, pronouns, adverbs, conjunctions and negations. The main results found via LIWC are that a significantly higher value for analytical writing style, and larger usage of comparison and quantifiers words, are found in the touch condition. Moreover, words regarding the present focus, adverbs and function categories were found to be less present in the touch condition.

At least part of the results appears to be related to each other, indicating an effect of touch on the type of reasoning stimulated in the participants. Touch seems to stimulate a more analytical, categorical way of thinking, which is known to be related to lower usage of adverbs (Chung & Pennebaker, 2007; Pennebacker et al., 2015). The result on the use of words indicating a focus on the present also seems to be indirectly connected. It seems logical to assume that a focus on the present would be higher when a more narrative, self-focused, "here and now" thinking style is used. It is therefore not surprising to observe that touch was associated with an increase in more analytical thinking style while also correspondingly stimulating a reduction of present-focusing.

Comparative words are used to compare two or more things, ideas, individuals, situations and so on. No specific literature was found on underlying psychological meanings or thinking styles linking the use of comparative words. Nonetheless, it seems reasonable to assume that an increased usage of comparison words in the touch condition might be another result connected to the stimulation of analytical thinking style: a thinking style that is more categorical and, thus, more inclined to compare objects and people. A very similar argument can be presented regarding the increased number of quantifiers in the touch condition. Both comparative and quantifier words were, for example, found more in TED talks compared to discourses of the European Parliament; most likely this indicates a more rhetorical, ornate and effective speech (Meier et al., 2019).

Tentative words are usually use by individuals who are insecure or unsure about a subject and tend to be less used when a person has a clearer idea in mind (Tausczik & Pennebaker, 2009). The reduction of tentative words in the touch condition is also very telling as it suggests that participants have more fully processed, and formed a clearer idea of, the event read and of how they would have felt. In other words, participants might have more deeply processed their personal story on that event (even though just imagined as "if I were in their shoes…"). Perhaps touch helps to process an event and create a coherent narrative. Even though there is no specific literature linking touch to usage of certain types of language (or linking the above categories to each other) the current study suggests that these variables might be connected.

The main result, concerning an increase of analytical writing style in the touch conditions, concurs with the perception reported by some FC-users that touch facilitates their thinking ability. Touch appears to support a more complex, formal, logical, categorical and hierarchical way of thinking. This could happen for a number of reasons, including the increased attention in non-automatic tasks, as seen in the experiment. In the current experiment, it may have helped participants to focus their attention on the task and stimulate a more complex analysis. Alternatively, one may hypothesize that in the absence of physical contact between participants, they felt freer to write a more personal response - using a more narrative style. This might be an explanation, to some degree, although in the non-touch condition the indexes of a dynamic-narrative writing style were not fully present.

4.4. General discussion

In the two experiments presented above, it was shown how a simple hand on a shoulder can increase the performance in a lexicon decision task and can haves an effect on writing style, which may be indicative of it having an effect on thinking. In particular, touch seems to favour a more analytical-categorical style of writing. While these results are not surprising considering the countless positive effects that touch has on human beings, these results do pose an exciting challenge from a theoretical level. Exactly how does touch have an effect even on higher cognitive functions such as attention and reasoning? To explore this central question, it is necessary to take a step backwards.

As mentioned in the chapter's introduction, all motor tasks require some degree of resources and even sitting or standing necessitate good postural control. Even while sitting, humans are subject to the force of gravity and the trunk and limb muscles' feedback. Humans need, therefore, to integrate sensorimotor information and interrelate all the body parts to maintain balance and postural control. All

of these tasks require attention (Bayot et al., 2018a). Hence, it seems there is the potential of interference between cognitive tasks and postural control as both share the same attentional resources. There is in fact a wide literature on the potential interfering effects of cognitive tasks on motor abilities and reverse.

Cognitive tasks and motor coordination and postural control grasp the same central attentional resources and therefore can compete for it (Bayot et al., 2018a). This effect is referred to as Cognitive Motor Interference (CMI). When individuals are asked to perform two tasks simultaneously, one motor and one cognitive, performance on one or both tasks generally diminishes (Al-Yahya et al., 2011a; Leone et al., 2017). It usually result in cognitive costs, in coordination costs, and rarely in cognitive facilitation effects (Alloway et al., 2016a; Hsiu-Chen et al., 2020a; Huang et al., 2019a) or motor facilitation effects (Jehu et al., 2020; Rusnakova et al., 2020). In the majority of cases when participants have performed a dual task, the interference of attentional and ongoing coordination and balancing resulted in a reduction in performance in one or both tasks (Al-Yahya et al., 2011b; Fraizer & Mitra, 2008; Li & Lindenberger, 2002; Woollacott & Shumway-Cook, 2002).

The capability of the neural system to decode, process, and respond to information is limited, and therefore it will balance requests and allocate attention and resources to the most pressing task at any given moment (Marois & Ivanoff, 2005). One theory is that this happens because cognitive and motor operation share the same processor and therefore these tasks require turn-taking. Other authors have argued that the interference happens because there is a limited mental capacity or resource pool, which has therefore be shared by the two tasks (Bayot et al., 2018b; S. Mitra, 2004; Tombu & Jolicoeur, 2003). The underlying causes of the effect are, however, irrelevant for the thesis's research.

CMI is more likely to happen in aging people (Hollands et al., 2017; Lajoie et al., 1996; Peper et al., 2012; Yeh et al., 2014) but has also been found to be the case in healthy young individuals (Al-Yahya et al., 2011b; Fraizer & Mitra, 2008; Li & Lindenberger, 2002; Woollacott & Shumway-Cook, 2002). Even a simple activity such as texting or talking on the phone effects postural stability (Onofrei et al., 2020) in healthy young individuals. In general, if the competing cognitive task requires lots of resources, there will be a negative interference. However, if the cognitive task is an easy one, than postural control might improve in certain cases (Abou Khalil et al., 2020).

As seen in the chapter's introduction, the effects of light touch on the body's postural control are widely known. Even a light touch that does not provide mechanical support will assist posture, coordination and stabilize the body both in healthy young adults by providing additional somatosensory information (Jeka, 1997a; Baldan et al., 2014a; Johannsen et al., 2007; Wing et al., 2011) and in the

elderly and individuals with motor issues (as in the case of Parkinson disease, Watanabe & Tani, 2020a). The added somatosensory information on the body and limb's positioning and orientation allows the body to adjust for better trunk position, reducing body sway (Rabin et al., 2013). Moreover, the way the dorsal axon bundles carry tactile information as well as information concerning the position of the limbs or proprioception and vibrations underline a structural close connection between tactile perception of external stimuli and the perception of one's own body.

Given that cognitive tasks and postural control do, in fact, draw on the same attention pool, and that even a very light touch has a positive effect on motor coordination and postural control, it becomes easier to see how touch might have an effect on higher cognitive tasks as thinking or non-automatic sorting tasks. Sure enough, touch provides support to the posture and coordination, stabilizing the body, by reducing the amount of attention that the person requires to remain seated. In this way it frees attentional resources for the cognitive task; therefore, participants would have found themselves with increased access to the attentional resources used to perform the lexicon decision and the writing tasks.

Clearly, touch can have multiple and diversified effects on individuals. These include reduced stress levels, increased compliance, increased interpersonal closeness and interpersonal communication, and the facilitation of balance and action. Touch seems significant in the context of touch-assisted communication, as for Facilitated Communication, because it might very well be one of the reasons why some individuals might be able to communicate with physical contact.

Summary. In this chapter, two experiments regarding the effects of touch on cognitive tasks have been explored. It appears that having another person holding a hand on the shoulder can increase attention's capability for non-automatic task and favour a more analytical-categorical style of thinking. This probably happens because the physical contact provides an aid to the body's postural control freeing up attentional resources for the task at hand. In chapter 5, this hypothesis will be further explored for the specific case of people with a range of disabilities, taking also into account the preliminary results of laboratory study.

5. Looking within Facilitated Communication

As seen in the previous chapter on the effects of touch on cognitive tasks in the general population, having another person holding a hand on the shoulder can increase one's attention for a non-automatic task and favour a more analytical-categorical style of writing. It has been hypothesised that this might happen because the physical contact might provide support to the body's postural control effort; thus, freeing up more resources. Considering that this effect seems to be more significant in people who experience wider difficulties with their bodies, a logical next step is to investigate whether this might be a mechanism by which FC works (albeit in specific situations). In this chapter a complex and multi-method data collection is presented, investigating the underlying mechanisms of FC. The first part of the analysis, namely on the EMG data, is then presented and discussed.

5.1. Introduction

A significant time and energy has been put into evaluating the validity of a single message (Mostert, 2001; Probst, 2005; Wehrenfennig et al., 2008) and then in expanding those results to the technique as a whole. Surprisingly, very little attention has been dedicated to the small percentages (up to thirty percent, Wehrenfennig et al., 2008) of successful message passing. If FC were fully decoded as an ideomotor phenomenon (Wegner et al., 2003), how do we explain those percentages? Moreover, it seems a stretch, or at least a shortcut, to invest and focus almost all the research on the subject of validation before having carefully observed and described such a complex phenomenon.

Observation and descriptive research have been awarded a significant role in the epistemology of science since Aristotle, Bacon, Galileo and many philosophers of science. Observations should be the way through which experience leads to first scientific hypothesis and theories (Bogen, 2009). In the last decade, there has been a significant increase of qualitative descriptive approaches in health science research due to the often complex topics, with hardly measurable concepts, that are investigated (Colorafi & Evans, 2016).

Clearly FC falls into this category of a complex, on top of controversial, phenomenon, with variables that are arduous to measure and used by a heterogeneous clinical population with complex needs. In this chapter, an observational approach will be favoured in the description of the facilitator pattern of activation, designed to contribute to future explanation and theory postulation.

A complex, unprecedented and exploratory multi-method data collection has been designed to observe, in detail, possible functioning mechanisms, of FC. Briefly, FC users and their facilitators used the technique in a Human Movement laboratory while wearing a pair of eye tracking glasses (SMI glasses), position sensors (Odin Codamotion System) and an electromyography (EMG) sensor on their deltoid muscle.

This multifaced data collection constitutes a comprehensive ongoing research project whose borders exceed the ones of this doctorate. Given how limited the opportunities are to conduct studies (especially laboratory studies) with this particular clinical population (having complex disabilities and having used for an extended period of time a controversial communication technique), it was decided to capitalize on this opportunity and dedicate extensive time to the data collection. All data collection was, indeed, organized and carried out within this doctorate, however, part of the analysis will be carried out after this PhD's ending. Given the touch's support on action and language processing hypothesis developed through the touch studies, it was planned to analyse, in this PhD, the EMG's data.

Furthermore, leaning on the publications of Emerson and Grayson (Emerson et al., 2001; Grayson et al., 2012) eye-tracking data was collected for both participants and their facilitators. Thus, further analysis will focus on the visual research behaviour at the keyboard of the FC user (aim 1) and of the facilitator (aim 2). This part of the analysis will not be included in the thesis here.

The main aim of the study is, thus, to describe the way facilitation appears to happen for the participants, looking for similarities and differences among them. Where the facilitator is more active the aim will be to study their pattern of activity in relation to the FC-user activity and movements. Where the facilitator might be less active, it will be to study the FC-user pattern of movements and activation. The study is unashamedly exploratory because no previous work of this sort has been undertaken done in this field. As a consequence, the study is framed less in terms of theory, and more in terms of data collection procedures documented in the method section.

5.2. Method

5.2.1. Participants. FC-users that had used the technique for a long time with several facilitators and who, at the time of testing, were in a positive and healthy time of their life and were not focused on any significant life events (for example, changing school, parent's divorce, new therapy, and so forth) comprised a fairly small pool. Therefore, there was an overlapping of

only five participants in the message passing study and in the EMG data collection. Everyone who trained for the MP test did so after coming to Nottingham to participate in the EMG data collection, except for Pa and P11 (the same person), who was piloting the MP study and had already done some trials.

Thirteen Italian FC users were involved in the study (five of which also participated in the MP study). There were four women and nine men, between the ages of 17 and 30 (mean = 24.14). One participant (P10) struggled with being in the laboratory and, therefore, the data collected was significantly less than for the rest of the participants. Every participant had a severe communication disorder that prevented them to communicate effectively with speech. Participants were recruited through the network of Vi Comunico che Penso. An invite was extended to anyone who had been using FC for a significant amount of time (average is 13.5 years, maximum usage 24 years and minimum 6), did not have specific vision issues, did not have tactile hypersensitivity (given the research gear) and were motivated (both them and their family) to participate in the study.

As it would involve travelling, long data collection hours and the necessity of wearing sensors and eye-tracking glasses, careful consideration was dedicated to the involvement and motivation of the FC-users. Only individuals who would see their participation as an opportunity for empowerment and engagement with scientific research, were involved. Five facilitators also participated in the study, supporting the communication of the thirteen participants. In all cases, apart from P13, the facilitator supporting the FC-user was in fact their primary facilitator. As with any FC-user, the levels and modality of facilitation changed according to fatigue, muscle tone, motivation, and so forth.

5.2.2. Setting. The data were collected in four separate periods (between July 2016 and February 2018) in the Human Movement Laboratory of Nottingham Trent University. Two researchers, myself and a speech therapist Giovanni Nicoli, were in the Movement Laboratory to collect the data. In certain instances, a family member stayed in the laboratory with the FC-user and their facilitator. In other cases the family members waited outside.

5.2.3. Procedure. Both the FC-user and the facilitator wore eyetracking glasses, an EMG electrode attached to the deltoid of their dominant arm, and an active marker for movement tracking on their dominant wrist. Two video cameras where positioned to (a) record the pointing movement toward the keyboard and (b) record the type and level of facilitation used at every moment. Participants were then asked to write on a keyboard while facilitated. Most of the writing consisted of free conversation. No specific instructions were given. Instead, the choice was made

to follow the natural development of communication with one of the researchers in the room and only rarely with their facilitator or a parent. The rationale was to remove the facilitator from the conversation with the FC-user as much as possible and have them act only in a support-to-type role.

5.2.4. Apparatus. The Electromyographer (EMG) used was a Delsys Trigno Wireless System which transmits muscle activity and movement data from the synchronized wireless sensors to a base Trigno station. Each Trigno EMG sensor has a four-bar contact for detecting the signal on the skin, a triaxial accelerometer, a wireless transmission range of 20 meters and a rechargeable battery of at least seven hours. The EMG sensors were placed along the muscle fibres on the anterior deltoids of the FC-users and their facilitator, as the deltoid flexes for each pointing movement. A Delsys Adhesive Sensor Interface was used to attach the deltoids without causing any irritation or discomfort to the skin.

The EMG has seven minutes of consecutive recording autonomy. Therefore, the data were collected in large numbers of chucks of EMG data, named here “sessions” of a few minutes each. The EMG setup allowed for the collection of information about the muscle activations of the FC user and of the facilitator. Needless to say, it was of interest to examine the sequence of activations that happen in these communication partnerships.

To record the position of the FC-user and facilitator’s arm at all times, the Odin Codamotion System was utilized. The Odin Codamotion System allows the recording and analysis of 3D movements, and integrates with third party sensors (in this case, the EMG). The Odin Codamotion system tracks 3D marker positions in real time within a Cartesian plane. The Odin Codamotion software was combined with Active Hubs allowing for synchronization for movements data with the EMG, Be Gaze videos (from the SMI eyetracking glasses) and the videorecording to be then analysed as a single report on a single screen.

Position sensors allow tracking the position of the FC-user and the facilitator at any given time in space. Hence it made it possible to look at the correlation between muscle activation, eye gaze and real-time hand positioning FC-user and facilitator, especially in regard to the keyboard and the FC-user’s body.

The eyetracking glasses used in this study are the SMI 2 wireless Eye Tracking Glasses, that record the natural gaze behaviour in real time with a high-definition scene camera. As they are a pair of actual glasses to be wear (compared to other types of eye tracking technology as Tobii) they allow for maximal peripheral perception and 60Hz binocular tracking. Moreover, they allow

freedom of movement to the participants who do not need to keep their head in a certain position or angle for the recording to continue. The eyetracking data was then analysed through the SMI BeGaze software which allows to analyse relevant sequences of recording both via qualitative visualization as well as quantitative analysis.

Finally, Panasonic HD HC-V160 camera were used to record the participants, one positioned from the side that recorded the whole setting and a front or read camera that recorded the type and level of facilitation.

5.3. Preliminary observations and FC description of FC-users

The first thing that any observer might notice looking at the recordings is that the FC-user appear to have all very different styles of typing. The similarities can be summarized with all sitting on the chair, maintaining some level of physical contact with their facilitators and typing with their dominant index finger on the keyboard in front of them. Some FC-typers like P1, P6, P12 and P13 appeared to have only minor issues with impulsivity and hypo or hyper muscular tension and seemed to require less assistance. Other FC-users (P2, P3, P5 and, to a lesser degree, P7 and P8) required counter-movement resistance due to perseveration and impulsivity as P3, P5, and P8 all present issues with dyspraxia and required support in the initiation of the movement and counterbalancing lateral involuntary movements. Only P3 and P5 presented severe hyper-muscular tension, and the facilitator appeared to need to provide a larger amount of force to balance it out and allow for genuine voluntary movements.

The level of facilitation does appear to be related to the level of assistance needed. In general, the higher the point of contact of facilitation (as in neck or shoulder), the lower the proactiveness of assistance the facilitator seems to provide. In contrast, the lower the point of contact on the FC-user's body (as in, for example, wrist) the more the facilitator appears to coact. This relationship is, however, not always straightforward. For example, P13, who has the most organized and tidy movements of all, requires, in addition to a hand on her shoulder, a second hand under her elbow, which P11 and P12 do not need, even though the facilitator appears to provide more facilitation to P11 and P12, being more verbal and giving more squeezes to their shoulders.

The brief descriptions that follow do not claim to explain the mechanism by which the writing takes place. They are merely descriptions based on observations of what happens for the majority

of the time in the video recordings. The data from P3 and P10 were excluded for technical reasons, including difficulties experienced at the time of data collection.

P1's facilitator held her hand on his shoulder or, more often, just below his shoulder on his deltoid. P1 tends to be a quick typer. His movements are vigorous, almost "spring-like", he seems to easily find a quick rhythm in the typing. The facilitator rarely used her other hand to touch below the elbow lightly. The facilitator seems to provide a little support in the return gesture and increased assistance in significant change of direction, as for example when typing the letter "P" (far right on the keyboard) after typing the letter "A" (far left of the keyboard).

P2's usual level of facilitation consists of his facilitator holding one hand under the elbow as if P2's elbow was resting on the facilitator's hand. The facilitator seems to stabilize at times some small lateral oscillations of P2. At times of particular need, in which P2 deals from impulsiveness, perseveration and/or fatigue, the facilitator removes his hand from under the elbow and places it on the forearm stimulating the return gesture with two fingers (helps P2 to bring his arm towards his body after each letter) and providing resistance contrary to movement.

P3's facilitation consists in a fixed facilitator's hand on the shoulder that at times gives a squeeze and a second hand under the elbow or wrist. This second hand imposes moderate force by helping P3 bring his arm towards his body after each keystroke (return gesture). In some cases where there is muscle stiffness and/or perseveration, this force constituted a resistance contrary to the P3's movement which instead would tend to push towards the keyboard. In other instances, in which P3 seems to require less assistance, the facilitator simply keeps one hand on his shoulder.

Facilitation for P4 consist of the facilitator's hand placed at the level of the neck. At times it is clearly visible in the video that the facilitator provides P4 with a slight squeeze, apparently when there is a need to interrupt perseveration and/or impulsiveness.

P5 has significant muscular hypertension. Therefore, the facilitation required is abundant, having one of the facilitator's hands on her wrist and the second one on her arm. The facilitator provides a significant amount of counter-movement resistance both away from the keyboard to prevent impulsive non-voluntary movements and to reduce lateral jerks.

P6's facilitation consisted of a hand on the shoulder and one under the elbow. He appeared very focused and calm in the laboratory and did not seem to be struggling either at a motor level or emotionally with the high-demand situation as others did. P6's pointing is very organizing and precise. The facilitation's touch appears to be light and in general not providing much assistance.

P7's facilitator holds a hand on his arm and, in general, appears to provide rather light and weak facilitation. The facilitator appears to help mostly in finishing the movement. In fact, the ballistic part of the movement appears fluid, fast, and intentional, while uncertainty is perceived in the close loop phase of the movement, which loses fluidity and where the facilitator seems to help the most. At times P7 seems to show uncertainty and/or tiredness, and in these cases, the facilitator holds him more, providing more counter-movement resistance.

P8, similarly to P7, required just a hand on his shoulder and, at times, a second hand to provide counter-movement resistance when there was a need to interrupt a perseverating movement (they both were assisted by the same facilitator). P8 started each day needing a little more support in the first couple of minutes which then faded quickly. His movement velocity also clearly increased through time. The facilitator appears to support the return gesture and broad lateral movements. Out of all the FC-user, P8 and P9 are the ones who struggle most significantly with dyspraxia, motor coordination and especially sequences to the point of resulting in "linguistic dyspraxia" with syllable reversal (especially in dictation and copying).

P9 wrote with two different facilitators holding a hand on his arm, between his elbow and shoulder closer to his shoulder, sometimes with a second hand on his shoulder (therefore having the two facilitators' hands close together). With the first facilitator (P9's primary facilitator), there is not a wide extension of the facilitator's movements, as with others. The facilitation support faded over time, bringing the hand closer and closer to the shoulder. P9's movements are very ordered, and each movement is as the previous one. P9 starts quickly, moves fast toward the keyboard, then there is a long tail where P9 searches for the right key, making several changes of direction at about 2 cm from the keyboard. P9 clearly has difficulties in finishing the movement. Hence once a good stable rhythm for the return gesture is established, the facilitator reduces the support in the return gesture raising the level of facilitation and focusing mostly on the close loop ending of the pointing.

With the second facilitator (who is not P9's primary facilitator), P9's movement pattern seems to remain nearly the same, although the facilitator's mV peaks seem to appear sooner. The facilitator in fact seems to provide much more support in the return gesture pulling P9's arm toward his body and withholding the gesture more when he goes for the keyboard. The second facilitator also seems to provide less support in the closing part of the movement.

P11 is facilitated by her primary facilitator (mother) with only a hand on her shoulder. When she was facilitated by a professional facilitator that was not her mother, she required a second

hand either on her arm or opened palms up upon which her elbow rested. P12's facilitator held a hand on his shoulder, P12 did not seem to require much facilitation and did not present as having any specific motor or neuropsychological need.

P13's writing and facilitation style is characterized by tidy, methodical, never rushed, almost "elegant", rhythmic, movements with low variability in her movement patterns. The facilitators held one hand on her shoulder and the second kept contact below her elbow. Regardless of how FC works, it is clear that there cannot be one explanation to fit all these typing styles, all of the facilitations, and all of the facilitators' possible actions and influences. Simply looking at the FC-users' EMG activations (which are not part of the analysis conducted in this PhD), shows that they are not uniform and homogeneous.

5.4. Preparation of the data for analysis

To analyse the EMG data in relation to the Codamotion's movement data, a number of actions were taken to facilitate data analysis through Python Programming Language. First, since Codamotion Odin sensors were oversampled, as they produce five points for each EMG recording, only one position recording from every five was considered (Kotsiantis et al., 2006). Second, a masked array was created for all the data in which the Odin sensor was not visible (for example when the person turned the wrist causing to lose the signal for a few moments).

The activation of FC-user and facilitator were then looked at. In the large majority of cases the FC-user had a significantly bigger activation than their facilitators (see Figure 5 for an example). This is to be expected because the movement that the FC-user does is in most cases simply a larger movement (Tokuda et al., 2016).

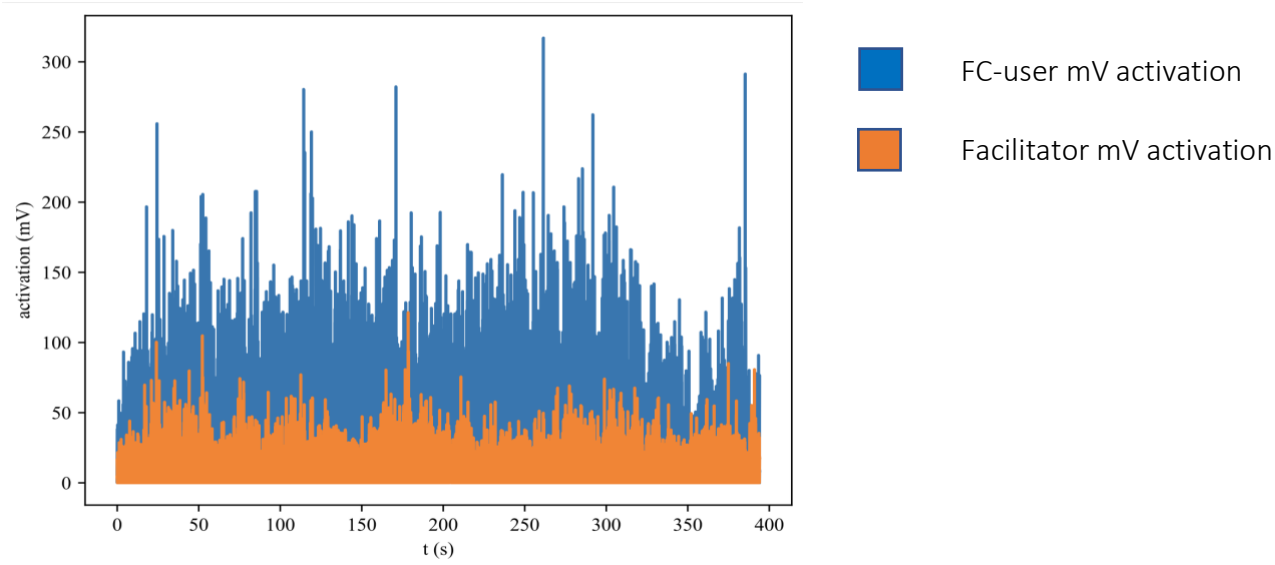


Figure 5: EMG segment of FC-user and facilitator mV

Therefore, since it was clear by the position sensor and the EMG data that the FC-users were actively moving their arm, it was assumed, for the benefit of the analysis, that the FC-user would be considered always active (example given, always actively *doing* something).

The sessions of the EMG recordings (most of three to four minutes, maximum time of seven minutes) that were included in this analysis are 185 (≋ 11 hours). To analyse the pattern of muscular activation and movement of the facilitator in relation to the pattern of muscular activation and movement of the FC-users, these sessions were divided into each pointing movement. Each pointing movement was identified by the lowest value of FC-user's wrist in the vertical axis Y (which corresponded to the pressing of the key) and its highest value (the farthest away from the keyboard for each pointing, also called "return gesture") and back to the key Figure 6). In other words, a pointing movement went from pressing of a key to the next pressing of a key.

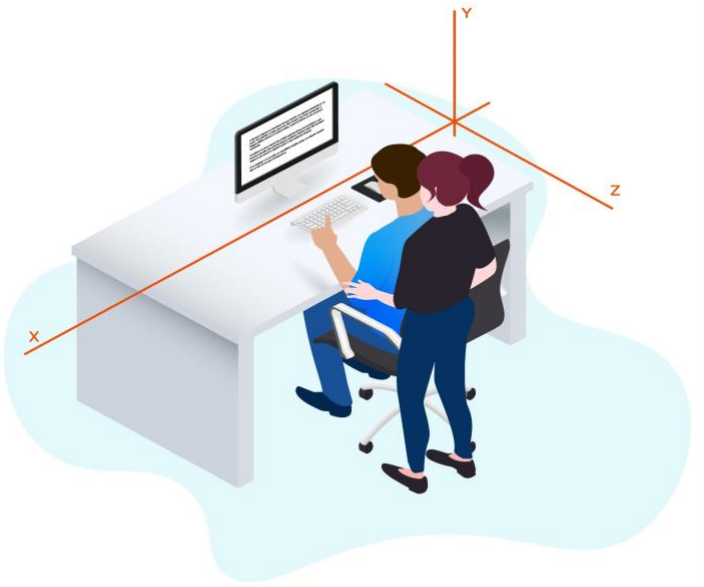


Figure 6: Computer-generated image of data collection setup

Looking at a total of 185 sessions across 11 participants, the times in which the facilitator had their hand accompanying the FC-user's movement but did not have a noteworthy muscular activation, were named "null_event". These "null events" were defined within a specific timeframe of the facilitator's action, during which the facilitator's deltoid activation was not significantly active.

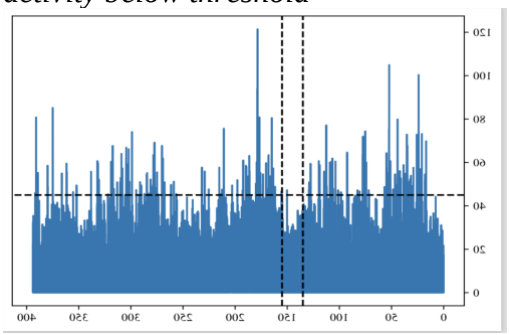
First, looking at the videos and at the facilitator's EMG signal an activation threshold was identified above which the facilitator's movements were clearly made with conviction, as pushing the FC-users' arm towards their body or assisting a significant lateral movement. This was done looking mostly at the facilitator's peaks in which there was no reasonable doubt on their "vigorous activeness". This threshold was not only different for each FC-user and facilitator couple, but in two cases, it had to be set for specific sessions (namely, at times the first session resulted in an activation very different from all the following ones and for which a different threshold was forced to be defined, see Table 8).

Table 8: Facilitator's threshold for null events per each participant

	mV Mean	mV Sigma
P1	2.22	0.86
P2	3	1.18
P4	1.83	0.68
P5	3.14	1.25
P6	3.7	0.35
P7	5.54	2.2
P8	5.0	2.56
P9	3	1.27
P11	12.3	6.15
P12Day3	8.2	1.62
P12Day4	10.75	6.87
P13Day2	4	1.7
P13Day3	4.7	1
P13Day4	5.2	2.22

Second, a search was made for chunks of EMG activity below the activation threshold where the facilitator's signal was reduced and did not seem to correspond to a particular action, but merely accompanying or touching the FC-user (Figure 7).

Figure 7: Example of segment of mV activity below threshold



Equation 1: sigma of null event

$$\sigma^2 = \frac{\sum_{i=1}^{N} (x_i - \bar{x})^2}{N}.$$

Third, the mean of this null event was calculated for each FC-user and facilitator couple, and then the sigma was calculated (Equation 1).

Once the null events were defined, several strategies were attempted to identify the sections in which the facilitator's deltoid was instead active in relation to the null-events, in other words where the facilitator was actively doing something. The need for usage of different strategies to identify active sections of the facilitator's behaviour was dictated by the high number of factors affecting the variability of the signal, including, but not limited to, individual differences of the facilitator involved, motor capabilities of the FC-users (Bojanek et al., 2020; Parma & de Marchena, 2016; Z. Wang et al., 2019), level of facilitation (for example touching the shoulder compared to touching the wrist), the level of counter-movement resistance needed, and level of impulsivity of the FC-users (Ahsan et al., 2009; Nazmi et al., 2016).

The strategy that seemed to better identify the sections in which the facilitator was actively doing something was found applying a Butterworth filter, which made the signal averaged and less fluctuating. Therefore, a Butterworth filter, a type of signal processing filter built to have a frequency response that is as flat as possible in the passband, was applied to the facilitator's mV signal to extract more easily their general movements from "noise".

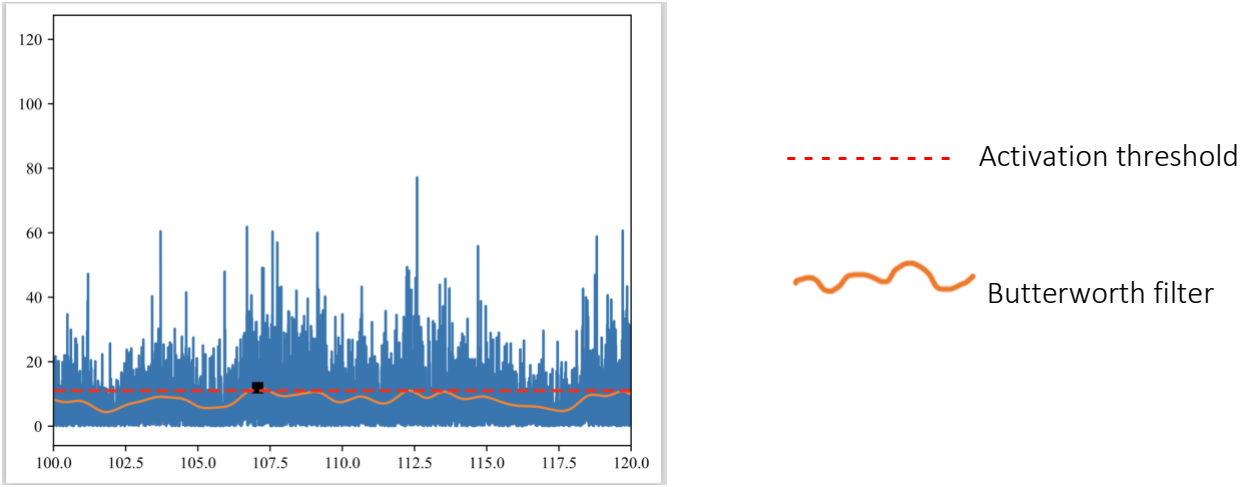


Figure 8: Butterworth filter and activation threshold

The new activation threshold was defined as being one sigma above the mean of 'null_events' once the data was run through the Butterworth. This system transpired to be quite reliable in identifying the facilitator's active sections and also assessed how many peaks it displayed. Once all the events of the facilitator's activation were identified, they were studied in relation to the FC-user's section of the movement; for instance: is the facilitator active at the beginning versus the end of the FC-user's movement? However, it seemed that the large majority of the facilitator's

activation events span over more than one FC-user's movement. Therefore, this line of enquire was abandoned and the mV facilitator's signal was studies in relationship to the FC-user movements in general and not within single pointing movements.

The videos were then synchronized with the facilitators' EMG data via Odin Codamotion software, which combined with Active Hubs. A sample of the videos across participants was reviewed and it was noted down what happened while the facilitator was active. In the large majority of cases, it appears that the facilitator's activation was happening during one of three events: (1) "major" lateral movement (for example, going to the cancel key on the top right side of the keyboard), (2) return gesture and, (3) final search at the keyboard immediately before the pressing of the key.

These three events were therefore demarcated in order to analyse how many times they co-occurred with the facilitator activation events. (1) To define a "major" lateral movement, the letters A and L were used to represent the length of the keyboard. A major lateral movement was then defined as a movement, in the direction of the keyboard's horizontal axis (abscissa), that was half of the length of the keyboard or above. (2) The return gesture was defined using the axis perpendicular to the computer's screen.

(3) To define the "search of the key" behaviour, first the space-key was set up as the boundary of the area of interest. That is, every time the FC-user's hand crossed over the space-key on the Z axis (perpendicular to the screen) it would be considered as part of the area of interest. Second, all situation presented with a lateralization value (in the abscissa axis) that changed direction between entering the area of interest and the pressing of a key, and between the pressing of one key to the pressing of the next within the AoI, were selected. At this point it was tallied how many of these occurrences took place during an episode of activation of the facilitator.

The script returned therefore a histogram for each session with number of times in which the FC-users, and the facilitator, were active while moving laterally and toward and away from the keyboard.

5.5. Results

A first straightforward explanation of FC is that of a facilitator guiding/moving the arm of the person they are supporting. If the facilitator were, in fact, to move the FC-user's arm to a location one might expect that kind of guiding to generate a repetitive profile of EMG bursts of activity that precede movement onset (Figure 9). Additionally, there would likely be a somewhat reduced

activation of the FC-user pattern. Looking at the EMG signal it seems clear that the facilitator in all provides often active assistance but none of it seems to reflect this repetitive pattern. Moreover, the FC-users tend to have a higher EMG activation than their facilitator, seemingly contesting the hypothesis of one person moving the other's arm. It seems clear, as seen from the videos, that one simple explanation does not fit all situations.

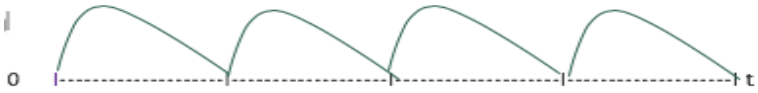


Figure 9: Gross simplification of a repetitive pattern of activation during typing

As seen in the videos and the EMG pattern, what catches the eye is the heterogeneous profiles which seem to suggest that the facilitators *do* something that is probably more complex and diversified than simply guiding the arm toward the keyboard.

In total, the data from eleven participants, comprising a total of 185 sessions, was analysed. The number of total pointing movements per session per each participant and the percentage of time the facilitator was active are reported in Table 9.

Table 9: Number of pointing movements and percentage of time the facilitator was active per participant

	Number of Pointing Movements	Number of times the facilitator was active[1] (%)
P1	20 sessions: 6987 *pm* (M = 349.35)	394 tot (5.6%)
P2	12 sessions: 3131 *pm* (M = 260.9)	910 tot (29%)
P4	7 sessions: 1995 *pm* (M= 285)	172 tot (8.6 %)
P5	24 sessions: 7842 *pm* (M 329.75)	5618 tot (71.63%)
P6	17 sessions: 5731 *pm* (M = 337.11)	1431 tot (24.96%)
P7	15 sessions: 4871 *pm* (M = 324.73)	909 tot (18.66 %)
P8	14 sessions: 3216 *pm* (M = 229.71)	1148 tot (35.69 %)
P9	23 sessions: 10646 *pm* (M = 462.86)	6800 tot (63.87 %)
P11	28 sessions: 8740 *pm* (M = 312.12)	407tot (4.65 %)
P12	3 sessions: 750 *pm* (M= 250)	106 tot (14.13%)
P13	22 sessions: 6750 *pm* (M = 306.81)	950 tot (14.07%)

[1] *Above the threshold identified with the Butterworth filter (see method section)*

To avoid any misunderstandings, I will be explicit in stating that these percentages do not imply that the facilitator was not influencing or priming the FC-user when not active (when below the identified threshold) nor that they were certainly influencing or priming their FC-user when they

were active (above the threshold). Instead, it is useful to look especially at the difference in percentages and with curiosity to observe if these are linked to the particular motor needs or movement patterns of the particular FC-user.

At first glance, it is apparent that the FC-users who seem to be accompanied by less active facilitators are P1, P4 and P11. P12 and P13 also seem to require less intervention on their facilitator's part. Conversely, P5 to P9 seem to require more involvement from their facilitators, followed by P2 and P8.

The histograms (two per each session, see Figure 10 for example) represent the number of times (on the ordinate axis) the FC-user and facilitator were active within a session while the FC-user was performing a lateral movement (left histogram) and back-and-forth movement (right histogram), distance expressed in millimeters on the abscissa axis (X axis). It should be noted that these peaks do not refer to EMG signal peaks (which would be understandable when moving the arm away from the body), but to the number of times the FC-user was actively making a movement of that magnitude. The orange histograms represent the times in which the facilitator was active while the FC-user was doing that size of movement (axis X). The blue histograms represent the number of times that the FC-user performed those movements, but the facilitator was not active. Orange and blue coloring of respectively facilitator and FC-user are consistent in all histograms and will therefore not be described again.

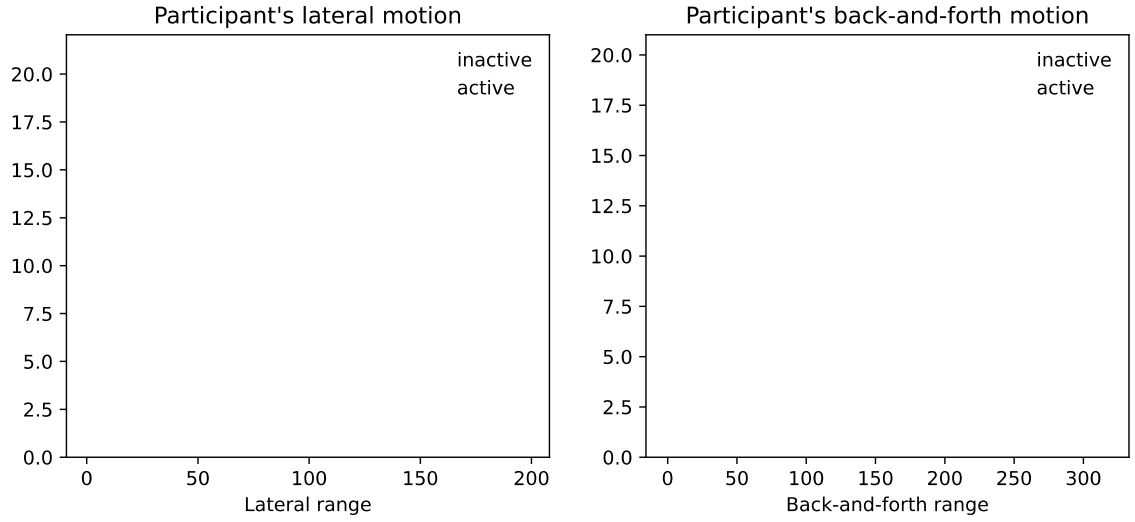


Figure 10: Example of histograms of FC-user and facilitator's activation for FC-user's movements

The histograms were searched for patterns in the FC-user's and facilitator's activation to see if the facilitator actually tends to be more active during the three events identified: (1) "major" lateral movement, (2) return gesture and, (3) final search at the keyboard immediately before the pressing of the key. At first sight, it seems recurrent that in the majority of histograms, there is an initial peak, both with respect to lateral movements and forward and backward movements, which then goes down as the magnitude of the movement increases.

The first thing that catches the eye is that in the vast majority of cases we find a large number of times in which both the FC-user alone and in the company of the facilitator are active during small movements, both lateral and back-and-forth measuring less than 1 centimetre. Of the total of 362 histograms only 9.39 per cent did not have many times in which the FC-users (and sometimes the facilitator) were engaged in micromovements of below 1 cm (Figure 11).

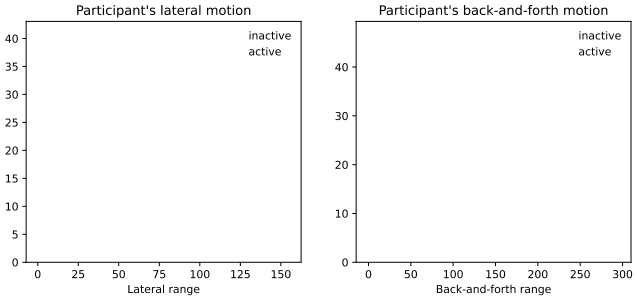


Figure 11: Example of high number of movements <1cm both lateral and back-and-forth

The second thing that becomes evident by observing the histograms is that except in rare cases of an undefined pattern (35 total, 9.6 per cent), all the movement patterns of the FC-user and facilitator can be traced back to four fairly defined patterns (Table 10): a decreasing pattern with an initial peak of movements below 1cm (Figure 11's lateral movements only); a Bimodal distribution with an initial peak of movements below 1cm and a second one around 5-7 cm for lateral movements and 15-25 cm for back-and-forth movements (Figure 11 back-and-forth movements only); a pattern that resembles a log-normal distribution (Figure 12); a pattern consisting of one significant initial peak of small movements (below the 1cm) and comparatively few other movements (Figure 13).

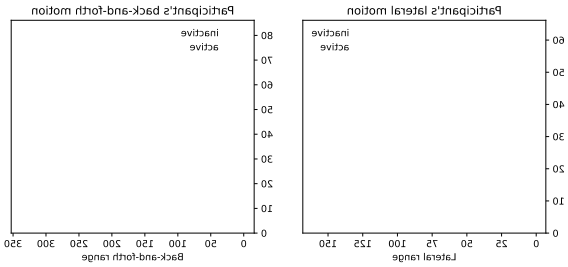


Figure 12: Example of a log-normal distribution

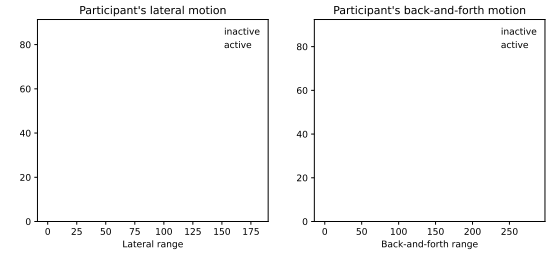


Figure 13: Example of an initial peak and few larger movements

The fourth type of pattern, with an initial peak and fewer larger movements, could be in theory included in the first pattern identified, of a decreasing distribution. However, it was decided to create a separate category since the distribution with almost only one peak (below 1cm) was considered quite extreme, and therefore seems sensible to give due prominence to this peculiarity. It should be noted that even in the cases of undefined pattern in almost all cases there is an initial peak representing frequent small movements below 1 cm both lateral and back-and-forth.

Regarding the Bimodal distribution the first peak is in the large majority of cases of movements below 1cm (both in the lateral and back-and-forth movements, which is why they are not reported individually Table 10). Whereas the second peak tends to be of smaller distance of around 5-10 cm for the lateral movements (likely representing lateral search movements on the keyboard perhaps from a key on the far right to a key on the far left) and larger distance for the back-and-forth movements (around 15-25 cm) likely representing the back-and-forth movements.

Table 10: Summary of mV activation pattern per participant

Participant and number of histograms	Decreasing pattern with Peak 0-1cm	Bimodal distribution	Log-normal distribution	Undefined pattern	Peak <1
P1 (40)	22	18 (10 L, 7-15 BaF)			
P2 (22)	18	1 (7-8 L)		3	
P4 (12)	8	2 (5 L, 5 BaF)		2	
P5 (46)	30	4 (5 L,7 BaF)	3	7	2
P6 (34)		16 (6-7 L, 15	10	2	6
P7 (30)	30				
P8 (26)	14		8	4	
P9 (46)	2	33 (11L, 22BaF)		11	
P11 (56)	23	21 (6-7 L, 15		2	10
P12 (6)	1	4 (5 L, 20 BaF)		1	
P13 (44)	12	19 (5 L, 30BaF)	9	3	1
TOTAL	160	118	30	35	19
NB: in parentheses are the distances in cm for lateral movements (L) and back-and-forth movements (BaF)					

Finally, a recurrence that is certainly worth underlining is the fact that in the majority of cases, the facilitator and the FC-user seem to be mirrored in the activation patterns. In the case of P9, inherently in the back-and-forth movement, there seems to be a consistency between the facilitator and the FC-user movement, whereas in the lateral movement mirroring is present in less than half of them. All histograms were studied, participant by participant, and the groupings presented below were created inductively.

5.5.1. Participants who showed a significant return gesture: P1, P6, P9, P12, P13.

In the cases of P1, P6, P9, P12 and P13 all FC-user presented a significant rhythmic return gesture which is likely visible in the bimodal distribution. Given these distributions, it seems probable that both the facilitators and the FC-users put significant effort into the close-loop part of the movements (such as movements below <1 cm) and in the bigger movements of return gesture and/or movement toward the keyboard.

The amplitude of most of the back-and-forth movements varies from a minimum of 7 cm for P1 to a maximum of 30 cm for P13. Looking at the videos, it is interesting to note how this difference makes sense by observing the type of movement that the FC-users and facilitators make.

P1 effectively appears to perform a return gesture quite independently, even forcefully, hence maybe there is little resistance force on the facilitator's part in that. P1 and their facilitator seem more focused instead in the closure of small movements (as witnessed also by a significant number of decreasing movements). In the cases of P9, and even more with P12 and P13, the return movement is very striking and defined and from the videos it seems the facilitator and the FC-user put significant force into the movement away from the keyboard.

In the case of P6 it seems as there was less focus on small movements (< 1cm), and more effort in the return gesture. In fact, even the log-normal peaks probably represent the return gesture, at least so it appears from the observation of the videos. P9 was facilitated by two different individuals. These clearly defined bimodal distributions are very characteristic of P9 ways of writing as they persist across the two facilitators. Needless to say, the consistency of FC user behaviour at this micro-level of analysis across facilitators is of potential interest. The P9 gesture appears tidy but not fluid, repetitive but jerky. That may be the reason why there is a consistency in pattern accompanied by a notable presence of the facilitator.

P13's writing method looks very tidy, organized, clean. P13 in general does not move very quickly, keeps a steady rhythm and only slows down as the movement closes. For the rest of the time, P13 moves fluidly with a well-defined return gesture that is probably represented in the second peak of the bimodal distributions for back-and-forth movements.

5.5.2. Participants with many small movements: P2, P4, P7, P8.

P1 seems to bridge these two groups somewhat having half decreasing pattern and half bimodal ones. In the cases of P2, P4, P7 and P8 there is a majority of decreasing patterns with fewer and fewer larger movements. The main focus of these facilitations seems to be small movements. As described in the video observation section, it is evident that P2 and P7 find significant difficulty in closing the movement, so both with little to no presence from the facilitator and with direct support or influence from the facilitator, much time is dedicated to the last part of the typing movement when P2 and P7 are about 1cm from the key, which will be pressed shortly thereafter.

The case of P4 is slightly different as it is the only case of facilitation where the facilitator holds a hand on the FC-user neck and not the arm. The facilitator's patterns, although reduced, show a more significant presence in correspondence with P4's movements below the centimetre. It is possible that, in the limited cases where the facilitator is active when P4 is less than 1cm from the

key to be pressed, the facilitator gives a light squeeze with the hand to influence or confirm the choice of key.

In general, P7 appeared to be quite tidy and organized in their writing, and this was mirrored in a low variability of distributions (every histogram presents the same type of descending distribution). In all 15 sessions, the pattern is one of an initial peaks for small movements (both back-and-forth and lateral), generally <1cm, with a curve that drops quickly with the increase of distance (Figure 14). This is not surprising if considering P7 tidiness of movement and lack of a significant return gesture.

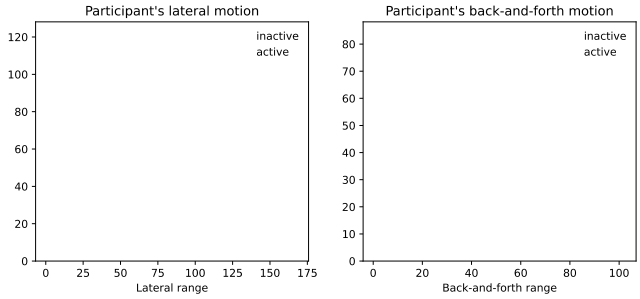


Figure 14: P7's decreasing pattern

Different from the previous participants, in P8's case, the first peak seems to be for movements a bit bigger than 1cm at about 2cm. Even though the facilitation appears in the videos to be very similar to the one provided to P7 (and it is the same facilitator), it seems logical to assume that P8's dyspraxia would result in both a larger presence of the facilitator, which is in fact the case, and in a wider motor instability that might be visible in those larger close-loop movements. Once again, a general decreasing trend is found with the increasing distances in movements, the curve then seems, in general, to descend more slowly, perhaps representing a return gesture which in P8 is partially present even if not clearly defined in a codified action as for others.

5.5.3. Facilitators' activation.

P1, P2, P5 and P6 were all facilitated by the same facilitator (minus a couple of sessions P5). In all but one session of P1, the facilitator was rarely active, therefore making it hard to search for a specific relation between the facilitator's mV and the FC-user's movements. Session 001 of Day 3 had a bit more activity of the facilitator and it was the first session of a new day. Perhaps that could explain the difference.

In the case of P2 in general, the facilitator was more active than in P1 and, especially in the first descending pattern, following a similar pattern as the one of the FC-user. There was one exception of P2, in which the facilitator was significantly more active than the FC-user. Looking at the videos and the writing is hard to identify any significant difference that would justify such a divergence from all other sessions, the only thing that catches the eye, compared to all the other sessions, is the significant quantity of missing data.

The facilitator is clearly much more active when facilitating P5 than any other participant they facilitate. Of the 24 sessions, the facilitator is significantly more active than the FC-user in 14 in one equally active, and in four cases the facilitator was overall more often active apart from <1cm micro-movements as in Figure 15). It might be the case that P5 is very rarely active and moving without some assistance on behalf of the facilitator.

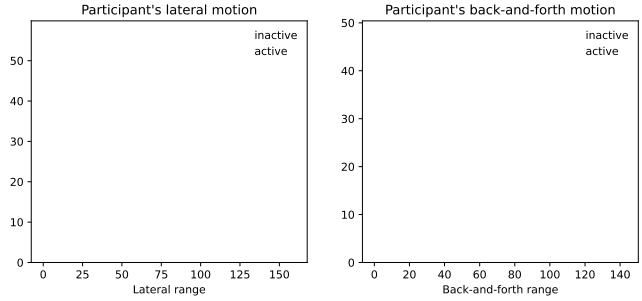


Figure 15: P5 and facilitator mV activation

Generally, P6 was significantly more active than the facilitator. In two instances the facilitator was more often active than the FC-user, but even in the other cases, they are active especially in the second peak, perhaps supporting the return gesture on larger movements such as going toward the keyboard or the pressing of the 'cancel' key after a pressing of a key on the left side of the board. Once again, both P6 and the facilitator seem to focus on movements below 1cm in abundancy.

The facilitator of P4 was either practically not active or significantly less active than the FC-user. The presence of the facilitator is minimal; this is not surprising considering that they only held one hand resting on P4's neck without making any actual movements of the arm.

One facilitator facilitated both P7 and P8. In all but three sessions of P7, the FC-user was significantly more active than his facilitator. Of the 3 exceptions, two were at the end of a long day of testing and one wonders if perhaps P7 was simply very tired. In the latter case, it is difficult to identify a reason why the facilitator was so much more active than in the other sessions. Whereas,

in nine sessions P8 was more times active than the facilitator, in three sessions it was the facilitator who was active more often and in two sessions both were similarly active. In general, it seems logical that P8 dyspraxia would result in the facilitator being more present than P7.

When P9 wrote, the facilitator was always fairly active, either active as much as the FC-user in twelve sessions (Figure 16) or significantly more active than the FC-user (9 sessions). Interestingly, the five sessions in which the facilitator was the most active and especially in relation to the FC-user, it was not the main facilitator but a second one to facilitate P9. In the remaining two sessions (23 total sessions) the FC-user was more active than the facilitator who nonetheless remained significantly active.

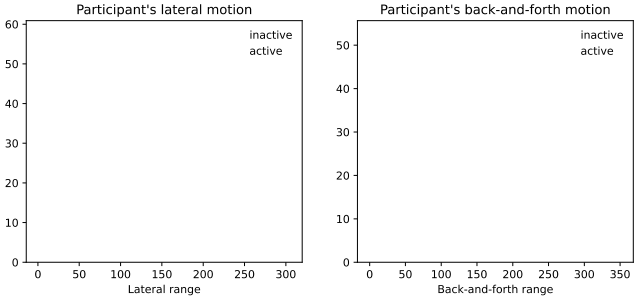
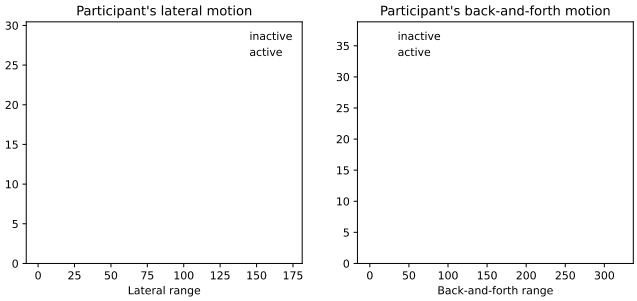


Figure 16: P9 and facilitator's mV activation

The same facilitator that wrote with P9, wrote also with P13. In the first four sessions, the facilitator was more active (similarly to the FC-user), in the fifth, the facilitator's interventions seem to start to fades, while in the rest of the sessions it appears as if the facilitator's presence is quite reduced. In the remaining sessions, it seems like the facilitator might be providing assistance or influencing mainly in micromovements below 1cm of distance (Figure 17).

Figure 17: P13 and facilitator's mV activation



P12 had only few sessions and they were always more active than their facilitator, who facilitated also P11. The peculiarities encountered by P5 and P11 are the reason why it was decided to present the data of these two participants individually.

5.5.4. The peculiar case of P5

P5 had 23 (46 histograms) valuable sessions. Both by watching the videos, by looking at the mV signal, in the facilitator's self-report and both in the clinical evaluation of P5, it appears evident that P5 has a severe issue of muscular hypertension and this obviously results in a facilitator providing forceful assistance. The facilitator is clearly much more active when facilitating P5 than any other participant they facilitate.

The three cases in which the FC-user was more active than the facilitator are interesting. For many other FC-users a pattern can be seen where they might need more assistance, or the facilitator influence more (or in a less subtle way), at the beginning, or at the end of a data collection day when tired. In this case, instead, we observe a different pattern, the FC-user starts more relaxed (first two sessions in which the facilitator is much less active), then from the videos, they seem to get excited and tense and from there the level of muscle tension does not really decrease. The third case is when the professional facilitator is substituted by P5's mother who facilitates P5 not toward the computer keyboard but toward a paper-printed keyboard and reduces the return gesture (Figure 18).

Figure 18: P5 and their mother typing on a paper keyboard

P5 mean activation is about double that of the mothers. It is possible that in this case that P5 was simply more relaxed with typing with the mother, the muscular hypertension was reduced and therefore less facilitator support was needed. Or it could be that the mother was more used to influencing P5 and therefore needed less force to do so. Although watching the video it does

appears as the facilitator is significantly influencing or even guiding P5 movements hence the actual mV values are unexpected to say the least.

Again, it seems the final stage of closing the movement is more difficult to accomplish and requires more help or influence from the facilitator. In this instance it might be that those small (<1cm) lateral movements are provided by the facilitator to reduce lateral jerks and impulsive non-voluntary movements.

5.5.5. The peculiar case P11

P11 has recorded 28 total sessions of writing, including four in which they are doing a message passing test (MP). In all but three sessions, there were virtually no active sections of the facilitator. Of those three sessions, two are particular instances in which the "facilitator's sensor" is positioned in the non-dominant arm on P11 as s/he attempts to facilitate themselves (Figure 19).

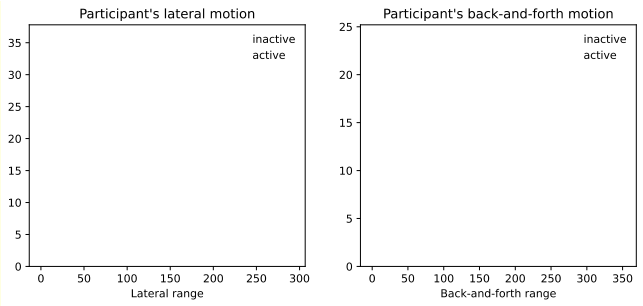


Figure 19: P11 attempting to facilitate themselves

In the MP sessions, there was a clear pattern, consisting of frequent movements below 1cm of distance and very few activations for any other distance. It can be hypothesized that P11 spent a lot of time in the final phase of the movement, trying to finish the movement, while other types of keyboard search or return gesture movements were almost completely absent (Figure 20).

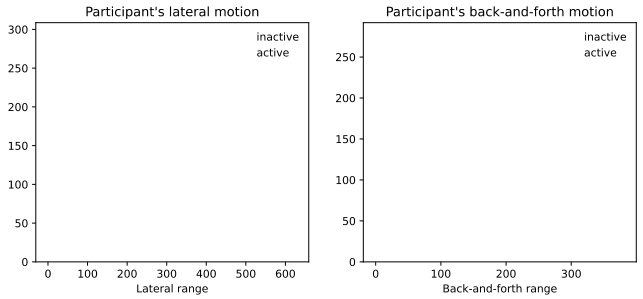


Figure 20: P11 during Message Passing test

Every other session had a peak for <1cm movements and then either a descending curve or a bimodal one with a second, much smaller peak, around 10-20cm, especially in the back-and-forth movements. It is not surprising that P11 has a facilitator that, looking at the videos does not appear to be very present if we consider that P11 is an FC-user who generally requires reduced facilitation, and has been using the technique in several environments including university exams.

The majority of histograms seems to have a decreasing pattern in the lateral movement and a bimodal one for the back-and-forth movements. It is extremely interesting to notice how in the two sessions where P11 attempts to facilitate themselves the pattern of activation actually remains exactly the same.

5.6. Discussion

In the large majority of sessions and across participants, there is a very high number of cases in which the FC-user does small movements, of below 1cm, both laterally and back-and-forth. Results tend to be somewhat different from person to person, often indicating an internal consistency for each participant, however with some similarities among participants. For the participants whose return gesture was more conspicuous (P5, P6, P9, P11, P12, P13), there seems to be a higher number of bimodal distributions in the back-and-forth movements and of log-normal distributions. It is possible that the forcefulness of the return gesture is represented in the back-and-forth peaks of these distributions. There seems to be, where the facilitator is more present, a mirroring in the distribution patterns. No case was found in which the participant was moving and only the facilitator was active.

Looking at the videos, it appears that all FC-users slow down their movement at the end just before pressing of the key. In cases of FC-users with increased dyspraxia (such as P5, P8 and P9) there is a discernible pause just before pressing the key. The small movements (<1cm) are abundantly present even in the FC-users with more fluid and tidy typing movements; it seems most likely that those small movements represent the close loop part of the movement. Aside from the fact that some FC-users do not seem to require much help from their facilitators other than mere touch (for example, P4 and P11), it appears that the facilitator is most helpful or influencing in sub-centimetre movements and in very large movements, especially back-and-forth from the keyboard.

Why would FC-users and their facilitator create so many small movements (both lateral and back-and-forth) in a pointing task that by logic should not have at all movements of that size? One

explanation could be that they are “fighting” over which movement to perform, which direction to take, which key to press. I would assume that at least a small degree of those movements will be counter-resistance that the facilitator provides. The fact that, however, so many of these <1cm movements happen without the facilitator being significantly active means that another explanation has to be searched.

Temporarily generalizing this result, why would *anyone* require more effort in a particular part of a movement? Woodworth’s Two-Component Model analyzing the speed and accuracy of arms movements, identifies two different phases: a first central ballistic open-loop mechanism and a second closed-loop feedback one (Woodworth, 1899). Open-loop movements tend to be high in speed and low in accuracy, as the speed itself does not allow for any sensory feedback integration or other mechanism for error regulation or compensatory capability. Open-loop movements rely on feed-forward control, are fast and ballistic (Lemasters & Flach, 2015) and do not require feedback on positioning of the body.

More refined limb movements (such as typing a letter on a keyboard) do need proprioceptive feedback. These movements, often the second part of an action, are also called closed-loop and rely on proprioceptive information to adjust for the size and timing of the movement, for potential perturbation or for a movement of the targeted object (Montell, 2019; Tuthill & Azim, 2018). Closed loop motor control is necessary for actions that are continuous and need regular control. However, since sensory processing and then accounting for that feedback requires time, this mechanism of motor control is not fast enough for ballistic movements, but it is more precise. The faster the movement the less accurate it will be as it will not be able to incorporate and process feedback information.

There is growing evidence that motor control difficulties in children and individuals with Autism and other Development Disabilities are likely due to poor proprioceptive capabilities (Blanche et al., 2012; Schauder et al., 2015). This may explain why this population group (of which FC-users are a part) appear to struggle, especially with more refined movements such as pressing a key. A group of authors (Haswell et al., 2009; Izawa et al., 2012) suggest that children with Autism tend to use proprioceptive feedback more than visual feedback from their surroundings, suggesting another possible explanation as to how the physical contact might play a supporting role in motor learning, again, especially in that part of the action that requires increased feedback information.

It is therefore logical to deduce that the movements of less than a centimeter are in fact mostly movements performed when the FC-user's index finger is a few millimeters from the key to

be pressed, a phenomenon known to the facilitators and called “girella” (swivel) in various FC centers in Italy (Pavon, 2019). Could it be that having arrived close to the keyboard, the facilitator may want to influence and direct the typing of the key? This is doubtful for two reasons.

First, let's assume that the facilitator is indeed to be considered the primary author of the writings: Why would s/he stop so long near the keyboard as seen in the videos (or away from it for that matter), when the movement towards the keyboard has already been directed? Second, how can we explain all the cases of micromovements in which only the FC-user is significantly active but not the facilitator? Perhaps they could be cases of very subtle prompting, however we also find them (even though in a reduced number) in FC-users with a certain muscle contraction and jerky movements such as P5, P8 and P9, making this hypothesis unlikely.

The explanation that appears more reasonable is that FC-users find it difficult to close the movements and for this reason they change the trajectory by readjusting it when they are a few millimeters from the key, as seems to happen for all the study participants. Is it possible then that the facilitator influences the choice of the key among the two or three available nearby? Absolutely yes. The risk of influence is always present, especially once the word and sentence have begun. However, considering the strict rules of alternation between consonants and vowels, and the limiting rules regarding the alternation between vowels and vowels, and between consonants and consonants, it seems difficult to think that once the index finger of the FC-user is so few millimeters from the key, there are multiple linguistically plausible options.

Another noteworthy result found is the high number of log-normal and bimodal distributions found in participants with the presence of a significant return gesture, with bigger back-and-forth movements toward the keyboard, which perhaps represent return movements (as seen in participants P6, P9, P11, P12, P13). Unfortunately, it was not possible in the analysis to establish the directionality of movements. Given the resistance against movements toward the keyboard provided by the facilitator, and the position of the facilitator’s right hand right below the FC-user’s elbows, observation of the video would suggest that those peaks (the second in the bimodal distribution and the peak of the log-normal one) are in fact representing the return gesture. Obviously, the fact that the data and videos are compatible with this hypothesis does not confirm the hypothesis itself.

Why would FC-users and facilitators go through the trouble of taking the FC-user’s hand away from the keyboard after every key pressing? It might be that if the influencing is done in a priming way, and not in a guiding-the-hand way, getting away from the keyboard for every pointing

movement will result in an easier task for the facilitator. However, there might be a reason why a person with motor difficulties would benefit from a reduction in variability of movement. When looking at any action, the muscular activity that has to be generated to produce a particular movement's outcome is dependent on the position of the starting point.

If facilitators assist somebody whose motor planning is deficient, one of the key things they could do to help them is to support them in initialising the movement in a consistent way, so that the complexity of managing different starting points (and velocities) is reduced. The less variability there is in an arm movement, the better the accuracy of the movement, and practice reduces variability (Darling & Cooke, 1987).

Even in error analysis, when there is a disturbance to a well-practised movement, then a correction will be put in place to return the arm to the pre-learned trajectory (Cooke, 1980b, 1980a). When the end goal is clear (such as a key of the keyboard) by reducing the variation of the starting point, it is likely to have a better outcome. This can also be seen in highly ritualized initiation movements in skilled sports, as for example for a tennis serve; there is a lot of effort that goes into standardising the starting position, as it was shown that an increase in the variability of movements results in a decrease of performance (Antúnez et al., 2012). In addition, a return gesture will likely interrupt most perseverations often find in individual with disabilities who uses FC (Martin et al., 2012; Rehfeldt & Chambers, 2003).

The influencing or helping we see in many facilitator graphs in large back-and-forth gestures is likely to be, at least in part, due to this work of standardizing the starting point. As well as self-support put in place by FC-user themselves (as we can clearly see in the peculiar case of self-facilitation of P11).

Looking at the movements of the facilitators we can identify three levels of activation: very little activation (P1, P4, P11, P13), medium activation (P2, P6, P8, P12) and very high activation (P5 and P9). The activity levels of the facilitators are in line with the observation data. In the case of P4, given a very high point of facilitation, the facilitator (who only facilitated P4) is not moving much at all, barely holding a hand on P4's shoulder. The facilitators are very active in the cases of P5, P9 and to a certain degree P8. These are the FC-users who present most hypertension and motor jerks. P1, P4, P11 and P13 are some of the most expert FC-users who not only have used FC in several contexts, including public speaking, but also have used it as a means to study in higher education courses. P2, P6 and P12, at the time of the testing had not had such extensive experience with FC

(even though they had been using it for years), hence it might be that they needed more 'presence' on behalf of the facilitator.

It is interesting to see a lack of consistency within each facilitator's sessions with multiple FC-user. The first facilitator supported or influenced P1 in a very superficial way. For P2 the facilitator did not seem to provide significant support in either return gesture or searching of the key, nonetheless, as seen observing the video, the pattern of mV activation suggest s/he did provide a small amount of support or influence for few moments of all length, likely stabilizing any type of movements that might have been subjected to impulsivity and perseveration. With P5 the same facilitator was significantly active likely trying to contain and react to the jerky and abnormal movement of the FC-user. Finally, for P6 they appear to be present in what have been identified as likely return gestures and small search movements at the keyboard. This facilitator provided assistance to four FC-users and it seems that their job was different each time. Needless to say, observations of within FC-user consistencies of movement and within-facilitator *inconsistencies* of movement are pertinent to the general questions of who is doing what in these complex interactions.

The cases of P7 and P8 are interesting. Both are facilitated by the same person in a fairly light and apparently similar way, both make a return gesture, and both slow down significantly before pressing the key. However, the facilitator is more present with P8 than with P7. The facilitator's activation levels are also much more heterogeneous with P8, perhaps in response to the movement heterogeneity of P8, while they are much more stable and constant with P7.

P9 and P13 were also facilitated by the same person. Again, differences in facilitator movement are evident. The facilitator was much more active and 'present' with P9 than P13. Moreover, from the little facilitation with P13 there seems to be a mirroring of activation, whereas P9 is the only case where with regards to lateral movements, there is no mirroring between the FC-user's and the facilitator's activation.

Finally, the last facilitator facilitated 4 sessions of P9, and all the sessions of P11 and P12. Again, different levels of activity across the FC users are observable. In the case of P9 the facilitator was extremely active in what they were doing. In the case of both P11 and P12 the facilitator only holds a hand on their dominant shoulder, and is more active when facilitating P12 than P11.

It is not appropriate at this stage to draw conclusions about authorship from this kind of analysis and observations. These are the first stages of a complex description of FC at a movement

level, and should be regarded as a necessary basis for future work. However, it is possible to do some preliminary reasoning in this regard.

If the writing was to be attributed entirely to a facilitator who would take the arm of the FC-user and guide it to the keyboard, one would expect to find more sequences in which the facilitator is more active than the FC-user and perhaps even sequences in which the FC-user moves but is not active. Moreover, if the FC-user is entirely passive, one might expect to see similar patterns of activation in cases where the same facilitator is supporting different FC users (such as for example the facilitator who supported P1, P2, P5 and P6). None of this was the case. Furthermore, P9, for example, wrote with two different facilitators, one of whom was much more active than the second. Nevertheless, P9's pattern of movements does not seem to deviate much in the video and or in the histograms across facilitators.

Another option would be that the FC-user is writing all the content independently, and the need for a facilitator would only be at a touch and emotional level. In this case it would be difficult to explain the different activation profiles of the facilitator. Moreover, it was shown in a parallel analysis that these same participants did not perform equally when facilitated versus being just touched (Nicoli, 2016).

There is obviously the hypothesis to consider that the writing resulted from an influencing and prompting phenomenon on behalf of the facilitator that is then wrongly attributed to the FC-user as their writing (Wegner et al., 2003). This hypothesis does have a number of shortcomings. First of all, the users of the technique would need to have the intellectual ability to perceive subtle stimuli, interpret them, and then the motor ability to act very precisely on them.

Moreover, this seems somewhat unlikely considering that most FC-users write with multiple facilitators who all facilitate in different ways. FC-users would have quite a task to effectively utilise the different priming cues of different styles of support. Furthermore, it would imply an unlikely capacity for attention which it might not be realistic to expect in a clinical population known to have sensory and attentive difficulties. Finally, how would one explain all the cases (such as for example, P4 or P11) where the facilitator appears to be doing extremely little?

In addition, how would the cases where the facilitator is highly active be explained? Are they finding opposition from the FC-user? Are they finding a person who has less desire to work at that moment? It seems likely that any of these more black and white explanations will not be able to describe with satisfaction the phenomenon of facilitation. On the other hand, an hypothesis of co-acting, in which both people involved are present and contribute to the action, seems more

reasonable and in line with the data presented. It seems there is a consistency with which the activation patterns found reflect the type of facilitation described via video and the individual motor needs of the FC-user.

Moreover, facilitator and FC-user also very often share a pattern of activation which would be expected in cases where a low point of facilitation is used (since, the movements performed must be substantially similar in contrast to a high point of facilitation point where the facilitator's hand would remain still on the shoulder and not move with the FC-user's hand), but it seems less obvious in cases of higher facilitation at the level, for example, of the elbow, arm or shoulder where in reality the movements done are quite different, especially in amplitude. Yet we find very similar patterns of activation.

Mutual influence and co-acting is not a new and surprising phenomenon in the field of human communication, especially in helping or educational relationships (Beebe et al., 2015) and should actually be expected in every dyadic human interaction.

6. General Discussion

In this PhD project a message passing test and training, a collection of texts by FC-users and their thematic analysis, two studies in the general populations of the effect of touch on attention and on writing, and a complex laboratory data collection aimed to achieve a preliminary understanding of the underlying mechanisms of facilitated communication, were undertaken.

In the message passing study, it was shown that FC-users are, in fact, able to pass the large majority of messages, even when they are unpredictable, if a specific training is set in place that supports specifically working memory (in addition to familiarization of the procedure, management of performance anxiety and so on). FC-users, indeed, described a sense of disorganization in their thinking and reasoning, and difficulties with body awareness and voluntary movements, that can benefit generously from the physical contact of another person (Chapter 2).

FC-users reported often having issues in disentangling their thoughts and maintaining adequate body awareness, to the point of having difficulties in performing everyday actions. FC-users also reported that supportive physical contact and assumption of their competence can partially compensate for these issues, allowing them a better awareness of their physical self, and in consequence, better control of their movements (Chapter 3).

In the touch studies, touch was shown to increase attention in non-automatic tasks and to be associated with a more analytical line of writing. Certainly, touch affects cognition, and this effect might be even stronger for individuals with working memory issues who are more subject to Cognitive Motor Interference (Hollands et al., 2017).

Finally, the observation and analysis of the myograph recordings paint a quite mixed picture after each person appears to have an individual action and motor impairment profile. A recurring feature seems to be the difficulty of closing the movement, in the motor close loop phase (Adams, 1971). However, with the exception of this feature, it is evident that a simple explanation, such as "the facilitator guides the hand of the FC-user" will not fit even one FC session, much less FC as a whole (Chapter 5).

6.1. A comprehensive description of FC functioning

It seems to me there is a continuum between independent typing, typing with a “simple touch” and typing with facilitation, which might include a number of added support and/or influence and/or priming, from withholding of the movement, to counterbalancing various jerks (for example lateral movements), to support in closing the movement when the person has the finger a few millimeters

from the key, to support in the return gesture. It appears evident, from the data of the EMG study, that almost all FC-users (although presenting very different motor profiles and diagnoses) seem to have difficulty in closing the movement. How much can a facilitator influence the choice of key when the person's index finger is now less than one cm from the key? It is not a straightforward answer. Surely there are situations where two or maybe even three neighboring keys are linguistically plausible options. Many other times, especially once the word and sentence have begun, the choice seems quite forced.

I remember once I asked precisely this question to an FC-user, who replied that it happens from time to time that a less experienced facilitator ends up leading him towards one key rather than another, but that this does not particularly disturb him because his writing followed a fairly loose syntax and therefore, he was still able, in the end, to convey the contents he wanted. I remember him also pointing out that this happens in almost all human exchanges, in one way or another, from the way questions are phrased to people's facial expressions, to their tones of voice, to their choice of vocabulary. The opportunities to influence the responses of others are endless, even in the absence of physical contact, and communication mostly works just fine.

Taking up the initial metaphor of the duck and the rabbit, I believe that the key lies on a continuum of co-acting. When it is difficult to find a single explanation that works for everything, perhaps it is because such an explanation does not exist, and we are presented with a more complex phenomenon. It does not seem reasonable to think that there is an explanation that can be applied to every situation, instead, we are indeed faced with a fluid phenomenon whereby the co-acting of FC-user and facilitator can move on this continuum from moment to moment.

Complementary actions are actions that occur within a social interaction between two individuals that imply the ability to (1) prompt the other person’s movements, (2) understand in advance what the goal of the other person’s actions is, (3) produce a movement, different from that of the other, which serves to facilitate the movement of the other, (4) take into account how one's actions will affect the other's movement (Sartori & Betti, 2015). Coordination between the two individual’s actions, motor planning and motivations must be parallel for a joint action to occur, which are actions that might not be incongruent but that still need both individuals in order to achieve a common goal (Curioni et al., 2019).

The coordination needed between two individuals to produce a joint action, is not always conscious or intentional and can be based on a number of strategies such as a rhythmic synchronization

of movement (Keller et al., 2014), shared emotions (Michael, 2011), focus on each other's attention (Kourtis et al., 2014), and joint configuration of the joint action (Kourtis et al., 2019).

Neuroimaging studies of complementary actions define at least two separate steps that would take place for every complementary action (Etzel et al., 2008; Kokal et al., 2009; Sartori & Betti, 2015). First, the action of the other person would be observed in order to predict the intention, the goal behind that action. Second, the individual would then program their own motor action that would be suitable for supporting that first goal. In the hypothesis of conceptualizing FC as a sort of continuous complementary action, this model would explain why there is a need for the facilitator to look at the FC-user's movements (Vesper et al., 2016). It would also explain at a more neurofunctional level why FC does not work if one of the individuals in the couple is not aligned from a motivational point of view.

Moreover, when trying to define at what time do individuals become aware of their counterpart's action goals and therefore switch from step 1 to step 2, it was shown that participants would pick up on kinematic cues even when the action goal was not explicit at that time (see for a review, Sartori et al., 2013). Likely this first step would happen at a motor resonance level (Gallese, 2001; Gallese & Sinigaglia, 2011). Specific movement parameters, such as direction, speed, extension, amplitude and the like are all modulated depending on the action's goal (Ansuini et al., 2014). This might explain why often facilitators struggle to properly articulate argument how they know at a very early stage what movement the FC-users might be shortly doing.

Not surprisingly, the ability to produce complementary actions for a joint goal relies also on the level of social "relevancy", for example, how much a scenario is practiced (such as giving your right hand to shake hands even if you are left-handed) or based on the requests of the other person for a joint action (Sartori & Betti, 2015). This might then explain why there is a different ability from facilitator to facilitator even in cases where it might look like the facilitator is just holding a hand on the FC-user shoulder, and therefore by all means, one might wonder why trained facilitators could not be substituted by anyone. Sensorimotor communication is fundamental as it provides all the kinematic details the co-acting individual needs to perform a joint or complementary action.

The fact that there is a clear individuality of movement pattern and mV activation for each couple (but not for each facilitator), and that in the large majority of cases FC-users and facilitators do in fact mirror each other's movements, seems to point to a joint or complementary action narrative. A time series analysis would be necessary to confirm the relationship between the couple's movements in specific progressive times series. Given the scope of empirical work that has been undertaken, a times series analysis was determined to be beyond the scope of this thesis.

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Facilitated Communication could be conceptualized as a sensorimotor communication joint action technique. FC-users would likely be more subjected than the general population to Cognitive Motor Interference (Bayot et al., 2018a) and touch would provide additional trunk position feedback to increase spatial orientation. Certainly, touch has also an effect on cognition, and perhaps on working memory, most likely *because* of fewer resources being allocated to motor functions (Bayot et al., 2018a).

This is how I believe Facilitated Communication unfolds. FC-users would find themselves incapable of communicating on their own as most of their resources would be dedicated to maintaining the physical-self and dealing with any perceptive, sensory, relational-communicative problems and general medical issues (as see in Chapter 3). The physically supportive contact of their facilitator would strengthen the FC-user's physical self, freeing up mental resources to be allocated to cognitive tasks such as working memory, communicating, reasoning and so on (as see in Chapter 4). The touch would immediately affect the cognitive and motor ability of the FC-users, and this alone would place the FC-user in a more favorable situation for writing and communication.

FC by its nature constitutes a noteworthy reduction of the complexity of picking up a pen or typing on the keyboard with two hands, to the simplest gesture, namely individual indicative pointing. Therefore, the rhythm given by the return gesture would reduce the complexity of the movement by standardizing the starting point of each movement. The facilitator would also help the person to close the movement once the text choice has been made and the index finger of the FC-user had arrived close to the key (as see in Chapter 5). All of this would be placed in a bubble of emotional support and assumptions of competence in the FC-user as a sine qua non condition of using any AAC techniques (if the practitioner does not believe that the person can do it and/or that s/he does not have the intellect to understand and use the instrument, failure is likely).

In some cases, especially in those of high point of facilitation and low dyspraxia, in my opinion, this is what happens. Is it possible for the facilitator to influence the FC-user anyway? Absolutely! The risk is always around the corner and FC should always be used in parallel with other AAC tools, with multiple facilitators, in different contexts and with long structured training where facilitators come to understand

not only the risk of influence but how this is unavoidable in a relationship, and how to keep it under control by formulating questions a certain way and monitoring the relationship and writing by expert trainers.

This is the simplest possible scenario. In many cases, the FC-user's dyspraxia and motor issues require for the facilitator to provide support not only by touching the shoulder and helping with the return gesture but also by moving toward the keyboard. I hypothesize that the facilitator will observe and feel the action intention of the FC-user and adjust their own action to accompany that movement. This might include holding back impulsive and perseverative gestures, bringing the arm or hand back towards the body when the movement does not appear voluntary, supporting the extension of the index finger, counterbalancing jerks or lateral tendencies, placing force against the movement to compensate for alterations in muscle tone and so on.

Is it more likely in these cases for the facilitator to influence the FC-user? It is probable, especially in the case of insecure or novice facilitators. I am convinced that for well-trained facilitators with years of experience behind them, a very refined mechanism for reading the motor intentionality of the other person develops, which is nothing but a highly trained ability to serve the other on a complementary level. The risk of influence, however, is neither a reason to avoid using FC, nor to deny the skills of individuals who do not speak, just because joint action with another is a necessary precondition for their deployment of their communication skills.

A joint action perspective on FC means that the FC user is an integral part of the more complex whole that produces the communication. Authors and organizations (APA, ASHA, ISAAC) that have written in opposition to FC do recognize that facilitators are likely unaware of their influence and are probably genuine in believing that they are just supporting the movements, not deciding the keys to-be-pressed (Duchan, 2018; ISAAC, 2014; Wegner et al., 2003). If we assume then that the facilitators are in good faith trying to support and facilitate the communication of FC-users, and that, as in all forms of dual communication and relationships, especially in helping ones, there are forms of mutual influence and co-production, then the aim should be to help facilitators do their job better, and not to dismiss a technique outright, especially where there are so few viable alternatives.

Many psychotherapy training schools require psychotherapists to undergo psychotherapy themselves as the therapeutic relationship with the user is the main working tool, therefore it is essential to know oneself, recognize transference and understand how one's vision of the world, and personality can influence the relationship with the other and ultimately the other itself (Clarkson & Pokorny, 2013). This is a sound principle that should be applied, even if perhaps at different levels, in all

helping relationships and especially where there is an imbalance of power, such as the unbalanced, co-acting, and close relationships within which FC occurs. Facilitators should undergo psychological supervision or psychotherapy to understand their own personal risk of influencing the other person, not mainly in the physical sense of influencing (as motor priming), but influencing within the therapeutic alliance that develops between FC-users and their facilitators.

Having said all this, what conclusions can we draw about Facilitated Communication at the end of this thesis? First of all, the mainstream narrative on taking positions to extremes and looking for simple all or nothing understandings of this technique is harmful and also has little scientific relevance. A study on prompting revealed that individuals with disabilities looked for other forms of communication after no significant results from 13.60 (!) years of speech therapy (Jaswal et al., 2020). In over 10 years in the field as a clinical psychologist, I have never met a family in which the parents directly went to FC as a first choice. There are normally years of more traditional therapies (such as ABA and more conventional techniques from speech therapy) that result in no or little benefits in communication. That is the point at which these parents start searching for option B.

I believe that this is the most constructive and scientifically justified way of conceptualizing FC. It carries a significant presence of, and dependence on, the facilitator as co-actor and should never be the first option. Nonetheless, where more traditional forms of intervention have yielded little to no beneficial effects and in particular, have not allowed the individual to communicate at an age-appropriate level, it is reasonable for parents to search for alternatives, even complex and controversial ones like FC.

6.2. Why such polarization of opinion around FC?

There are a number of reasons that can help understand why we have reached the levels of polarization that we have today. On the one side, there have been cases of FC's misuse that have resulted in very public and media-covered scandals that should have never happened. These are not representative of the technique as a whole, and indeed such events are not unique to FC. Unfortunately, it is a common phenomenon to form opinions, especially in the public eye, not from complex bodies of evidence but from highly visible cases that trigger strong emotions (Slovic et al., 2007). In fact, the availability heuristic shows that the more salient a stimulus (such as a media-covered scandal) the more easily it will be available to retrieve from memory (Tversky & Kahneman, 1974).

Moreover, it is widely known that individuals with disability are subjected to social prejudice and stigmatization (Coleman et al., 2015), which can lead to considerable discrimination and lack of inclusion (Morin et al., 2013). Ableism, the social oppression of people with disabilities, is a widely studied phenomenon (Friedman, 2019). PWD are evidently devalued, as seen in the ways they are characterized and discussed (Carlson, 2009).

This prejudice, often resulting in people with disabilities being considered less intelligent and capable, might ironically be even stronger in health care professionals, who might correlate language production impairment and/or physical disability with intellectual disability (Borthwick & Crossley, 1999; Mirenda, 2003). In general, it seems there is a historical tendency to equate lack of speech to lack of thinking and, therefore, mental competence, as can be seen by the ancient Greek word "kofòs", which means both "deaf" and "stupid", or in the linguistic racism phenomenon (Dovchin, 2020).

There is a wide literature on how people make assumptions in less than a few seconds about an individual's personality traits and capabilities, based on minimal information, such as looking at a face (Olivola & Todorov, 2010; Todorov et al., 2015; Todorov & Oh, 2021). One study, in particular, has linked the judgments made of FC-users and the implicit evaluation of their faces, confirming the presence of a stereotype of literacy incompetence which is activated automatically by looking at a photograph of an individual with a disability (Pavon et al., 2022).

On the other hand, the experience that many families have is an apparently endless search for a way to communicate with their children, if such a way is not provided by mainstream speech and language therapy interventions. Families are often told that their children are probably not as competent or as capable as they might think or wish them to be, and that is the reason for their limitations in communication. When they find FC the whole family dynamic changes, and their son or daughter becomes a smart, all-round individual, that they can communicate with (Biklen et al., 1992; Biklen & Burke, 2006).

Moreover, there seems to be beneficial effect on behavioural issues with the introduction of FC (Emerson, 2010). These might be due to the fact that the individuals are treated in a different way or that they are actually able to communicate and express their wants, needs, and emotions. Whatever the reason, a reduction of problematic behaviour will likely be very welcome within the family. It is understandable why FC-users and their family members would protect the use of the technique so fiercely. Whenever there is no conclusive scientific evidence, as in the case of FC, choices should be made on the basis of the "least dangerous assumption" (Donnellan, 1984). In the

cases of FC-users it seems to me more dangerous to treat potentially understanding individuals as non-intelligent individuals (not speaking to them or speaking to them in a not age-appropriate way) than treating individuals as more competent than they actually are.

There is also, in my opinion, an issue specifically with the diagnosis of Intellectual Disability. Without going into all the precautions and limitations of the diagnostic tool that Binet himself had advised (Binet & Simon, 1905), it is evident that if a person is not able to speak or pick up a pen or to indicate responses autonomously (or untrained) the tools used to carry out the diagnosis should be considered unsuitable tools for individuals with these impairments. Unfortunately, this is not what usually happens, and indeed individuals usually receive very low scores on these tests, which then lead to a diagnosis of significant intellectual disability that they will carry with them for life, the diagnosis itself preventing and limiting access to a whole range of tools, opportunities and therapies (Biklen & Duchan, 1994).

7. Conclusion, critique, and future research

There is a need, in my opinion, to further understand how joint and complementary actions happen in FC. I am confident that the research project carried out as the basis for this thesis, and the continuing work of Giovanni Nicoli, moves us further in that direction. A time series analysis is needed to build on the results of chapter 5, with the aim to further analyze the pattern recognition and classification of the FC-user and the facilitator's mV activation, specifically in relation to the FC-user movements. Further knowledge and understanding on the couple's joint movements will then create the basis to explore the eye movements and gaze behaviors. It is possible that facilitators will initial look at the FC-user's arm to judge the action's intention and only later during the movement, after a certain time 't', move to the keyboard. It could also be that the perception of the FC-user's intentions happens completely at a tactile/movement level and therefore the gaze behavior will show the facilitator looking initially at the keyboard and then to the to-be-pressed-key only after that specific 't' time where the movement's intention becomes clear.

To continue testing the validity of FC one future step would be to investigate the capability of facilitators to read motor intentions of other individuals, compared to the general population. It would also further our understanding if a study on the effects of touch on a pointing task were to be undertaken, both in automatic and non-automatic tasks (see Chapter 4) in the general population. From a clinical point of view, facilitators should consider promoting message passing training (Chapter 2) for all FC-users and facilitators, not necessarily with the aim of performing a MP test, but as a tool to decrease the dependency of the FC-user on the facilitator, and help facilitators refine their own skills in understanding the action goal of the FC-user.

I insisted on doing a message passing study and introducing it right at the start of the thesis because I felt that without that, I almost did not have the right to say, write and do things toward the development and understanding of FC. When I talk with other fellow PhD students about having terabytes and terabytes of video recording, they struggle to understand why I need proof of everything that I have done, and they normally tell me scientific research ethics and procedures should be enough.

When advertising conferences or events where I presented the results of these studied, I found fellow academics looking at the flyers, telling me they simply did not believe in such topic. It struck me the word they always used was "believe", as if this matter was about a religion or a political affiliation. Hence, my hope and my advice for future FC research is that the field reverts to

one of genuinely scientific research and not one of semi-religious political debate, and that there is an increasing realization when considering such a complex topic, mixed results are in themselves an important part of the whole picture.

As seen in the thematic analysis (Chapter 3), several individuals have reported having a visual based way on thinking. One interesting yet anecdotal report, is that after a certain amount of time of regularly using typing to communicate, FC-users who have previously never spoken before or who have previously only very marginally used functional language start producing more and more functional and intentional speech. Why would that happen? From EEG studies on preterm babies we know that from 24-week gestation (maybe even prior) there are cognitive processes involved (Alix et al., 2017; Vanhatalo & Kaila, 2006; Vecchierini et al., 2007). It seems reasonable to me to assume that when fetuses and babies start thinking, the thinking processes are likely sensory based and not linguistic. Baby likely thinks in sensations, tactile, auditory, some lights and shadows, the rhythm of the heart and so on. When the child is born, it is reasonable to assume that the cognitive processes remain primarily sensory-based, as their experiences expand to the voice of the parents, the feeling of being touched, held, feeling of thirst, warmth, and the like.

It is probably the actual language production that, sometime between the age of 2 and 3, creates a shift in the thinking toward a more linguistic process. Parents start asking more questions and requiring a verbal response, which they then reinforce, on top of pointing and gesturing. Parents and children shift the type of play, including more and more symbolic play, assigning meaning to actions and acting out semantically significant movements, stimulating thus the development of speech and language (Quinn et al., 2018). The 'language-as-skill' viewpoint suggests that language acquisition is not based on a biological ability that would allow a child to extract rules and acquire knowledge of the abstract structure of the language itself. Quite the opposite. Language should be seen as a skill that has mostly practical challenges and that results from practicing conversational interaction (Chater & Christiansen, 2018).

Children, likely, develop language by acquiring a set of action meanings and practicing reciprocity. An interesting example is the 'why' phase, which explodes between the age of two and four. Most lay explanations of this rely on the idea that toddlers need to understand a lot about the complexity of the world surrounding them. Although, it seems that children tend to continue asking the question 'why' even when there is no more meaning to be explored. Another explanation, instead, could be that children learn quickly that by continuing asking the question 'why' they keep alive a conversational

back-and-forth interaction with adults. Children practice using their inner speech to accompany their action (Vygotsky, 2012), and in doing so might start to create a bridge.

While acquiring language, children will likely start to think of their mother as “mom” instead of her body's physical shape, the quality of her smile, smell, and voice. It seems logical that the more children produce speech, the more they will start to use those words in their heads as well. Eventually, arriving to a point in which the usage of language in their mind is the predominant way of thinking, as described by many adults as a succession of sentences, internal narration, inside voice or subvocal speech (Dewey, 2022; Goldie, 2012).

What happens then when certain children do not start speaking? It seems reasonable to assume that without speech production, the thinking would remain mostly sensory based, in particular visual, considering that the number of neural circuits and neurons involved in the vision process vastly exceeds the ones of all the other sensory sensations. As reported by individuals with autism (including people who are independent in their communication), their way of thinking is, in fact, mostly visual-imaged based (Grandin, 2009), and it is not rare to find that in order to comprehend abstract concepts, they need a visual image or even a practical action, like walking through a door, to process that concept.

It might be the case that FC is the first, and sometimes only, instrument for visual thinking individuals to use language as their own. Being immersed in a world of speakers (between parents, school, TV and so on) it is sensible that all FC-user learn to understand verbal language, but I wonder if never using it themselves and just understanding it is not enough to trigger a linguistic thinking development. As seen for other AAC practices, as in the case of Makaton for example, the usage of a means to communicate has a significant beneficial effect on language production (Rubina, 2010). FC could therefore act as a bridge, allowing the FC-users to create themselves a linguistic production for the first time.

The FC-user would therefore get used to using verbal language and to think in verbal language in order to be able to write it. If this were a fairly frequent event with important relational repercussions, it is possible that this would also lead to the development of a linguistic type of thought which in turn could lead to, where there are no problems of dysarthria, to speech. It is important to start to record these cases in a systematic way and investigate this peculiar phenomenon.

Researching a complex topic such as FC poses several challenges from a methodological point of view. Analysis of the literature presents a picture of a limited, and reducing set of, methods that are being used to study FC (Hemsley et al., 2018), incurring a significant risk of methodological artefact and theoretical reductionism. Methodological artefact is a particular concern when, in the message passing

paradigm, there is a tendency to generalize results about messages, to inferences about FC-users, and to conclusions about FC as a whole. Moreover, at the risk of repeating myself, when reading the peer reviewed literature, it appears that the main goal of papers might often be to dispute results that are not compatible with the position adopted by that paper, instead of looking at contradictory results as an important part of the 'puzzle' in itself.

I tried to protect this project from these risks by using a multi-method approach, attempting to triangulate the complex, and frankly delicate-to-study, phenomenon that is FC. This has resulted in a program of research that reflects my understandings of FC as a complex, multi-layered phenomenon. The approach brings significant challenges. I have had to become sufficiently competent in a wider range of methods (PhD studies are often associated with the development of expertise in one method) from the analysis of qualitative data, through linguistic analysis, to experimental design and data collection employing specialistic techniques of measurements. My aim was to place down a strongly evidenced, descriptive basis for future work. Thorough description of a phenomenon is surely the first step in any program of scientific research, but it has often been ignored in this domain.

My research has also, necessarily, been conducted on a case-by-case basis, working much of the time inductively with evidence derived from complex and challenging FC-user-Facilitator partnerships. These partnerships are challenging because they are each, in so many respects, unique. We are not yet, in my view, at a stage where we can study a sample of FC-users who can legitimately be regarded as representative of a wider population of FC-users in any real, non-superficial sense.

7.1. Personal reflection on this journey

I appreciate that every PhD thesis is different. I also appreciate that most PhD thesis these days tend to focus on one, or maximum two methods of analysis. Looking at the path followed by many of my fellow students, I observed professionalism in the specialization towards a research method, a data collection technology, an analysis tool. I have chosen a different path and become competent in a range of methods. This strategy was particularly appropriate for such a complex domain of study.

Because my PhD has been so diverse, I had the opportunity to interact and collaborate with many individuals with different skills and vastly different professional backgrounds. I also had the opportunity to learn management skills, organizing a data collection across two countries with individuals with complex needs. I believe I have learned how to do research in an inclusive manner, thinking of FC-users in my mind and treating them as co-researchers instead of mere participants.

Most of all, I believe I managed to research a really complex and difficult-to-study technique in new ways, where scientific research had become somewhat stagnant. I hope I have created a slight shift in how FC can be researched and thought of. An enormous satisfaction lies in the fact that another person has taken over where I left off the project and is now carrying it forward in his doctorate.

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Appendix I

Words used in Message Passing Pilot's testing

Participant A

Source (at home)	Original stimula	Translated stimula
Book and words chosen by Pa	Sfamare	Feed
	Persi	Lose
	Prova	Trial
	Musicali	Musical
	Australia	Australia
Book chosen by researcher and words by Pa	Voce	Voice
	Coppia	Couple/Match
	Benedizione	Blessing
	Mente	Mind
	Genitori	Parents
Book and word chosen by researcher	Tempo	Time
	Guardavano	Watched
	Perchè	Why
	Finestra	Window
	Parola	Word
Complex images chosen by Pa all but the scientist one	Delfino	Dolphin
	Scienziata, chimica	Scientist, chemist
	Balena	Whale
	Fiori	Flowers
	Battaglia navale	Battleship
Simple images Chosen by Researcher	Stellina gialla	Small yellow star
	Luna	Moon
	Acquilone	kite
	Anello	ring
	Fiore	flower
Simple images Chosen by Pa	Cuore	Heart
	Labbra	Lips
Pa's poetry	Suoni	Sounds
	Ho nell'anima	I have in he soul
	Incantesimo	Magic spell
	Implora un sorso d'acqua	begs for a sip of water
	Il cuore e' felice	The heart is happy
	Fasce di colore	Colour bands
	Una scia luminosa	A luminous trail

	Di un tramonto	Of a sunset
	Fantasia	Fantasy
From a book, With a different facilitator Chosen by researcher	Consolle	Console
	Fortuna	Fortune
	Sognare	Dreaming
	Rimase	Remained
	Corpicino	Tiny body
	San Francesco	San Francisco
	Scrisse	Wrote
	Impallidiva	Paled

Participant b

Chosen by their dad pseudo-randomly from a dictionary	Forca	pitchfork
	Prima	Earlier/sooner
	Scarpe	Shoes
	Ragazza	Girl
	Pietro	Pietro
	Vienna	Vienna
Simple images (some images are missing)	Fisarmonica	Accordion
	Piede	Foot
	Fischietto	whistle
Words chosen from his thesis	Lavoro	Job
	Diritto	Straight
	Soddisfazione	Satisfaction
	Grande	Big
	Cattolica	Catolic
	Letteraria	literaly
	Famiglia	Family
	Domande	
	Libero	Free
	Fine	End
	Contro	Against
	Euro	Euro
	Fanale	Rear light
	Ferro	iron

Chosen by Pb's dad pseudo-randomly from a dictionary	Mica	At all
	Pila	battery
	Farina	Flour
	Festa	Party
	Tempo	Time
	Zucca	squash
	Panna	cream
	Diritto	Straight
	Gorilla	Gorila
	Piuma	feather
	Sito	site
	Tasto	key
	Fianco	Side/hip
	Fondo	bottom

Appendix II

List of meaningless phrases used in the MP study

Original Italian sentence	Translated sentence
Scioglimento astuto del governo	Astute dissolution of the government
Se stimassi lui farei un balletto	If I esteemed him I would do a ballet
Potenzialità retrograde	Retrograde potential
Seria salute seduta	Serious sitting health
Arredamento da puffi	Smurf decor
Saltassi l'ostacolo sarei rana	If I jumped the obstacle I would be frog
Banalmente sono un figo	Banally I am cool
Svolto il cerchio	Turn the cicle
Fronteggio l'invasione delle cavallette	I confront the invasion of the locusts
Sono favorevole alla mutanda blanda	I am in favour of the mild underwear
I campi di rane furono arati	The fields of frogs were ploughed
Con coraggio fronteggerò la nebbia	With courage I will face the fog
Ho scoperto la coperta	I have uncovered the blanket
I sederi rispecchiavano la luna	The butts reflected the moon
Mandò gentilmente a quel paese	He kindly sent them to hell
l'Orazio furioso	The furious Horace
Fermo in movimento	Stopped in motion
Biglietto blitterato	Stamped ticket
Apparentemente a testa in giù	Apparently upside down
Influsso di capelli	Hair infusion
Animale panciuto	Bellied animal
Cappello interessato	Interested hat
Abbiamo raddirizzato la luna	We straightened the moon
Culturalmente scemo	Culturally fool
Dalla brace al fango	From the embers to the mud
Finanzierebbero un pagliaccio	They would finance a clown
Artigiano lombrico	Earthworm craftsman
Cioccolato alla salsiccia	Sausage chocolate
Fiore puzzone	Stinky flower
Corazza di piume	Feather armor
Pazientemente antico	Patiently ancient
Altezza bassa	Ancient height

Appendix III

Complete cataloging of the type of errors in the PM

Pa

Pa errors were:

- 1 was an inversion: presi → persi [lost→ taken]
- 1 was an omission: guardavano → guardava [they looked → s/he looked]
- 1 was a redundancy: d'acqua → dell'acqua [of water → of the water]
- 1 was a phonetic inference: San Francesco → San Francisco
- 1 was a typo: impallidiva → impellideva [paled → paled with one wrong vowel"]

Image 5: Star

~~The star.~~ ~~The sky comes a star.~~ The star shines.

Image 6: Moon

The moon.

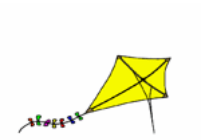

Image 7: Kite

The kite flies.

Image 8: Ring

The ring is put on the finger.

Image 9: flower

There is a flower in the grass.

Image 10: Heart

The heart beats fast

Image 11: Lips

~~The lips.~~ ~~The kiss.~~
~~Somebody~~ who kisses the lips.
The boy who kisses the lips ~~of~~
~~a lover~~ of a girlfriend

Pb	Word to be passed (IT)	Word written (IT)	Word to be passed (EN)	Word written (EN)
Typos	Prima	Promo	Before	promo
	Libero	Libro	Free	Book
	Tasto	Tato	key	norther dialect for kid
Simplification	Letteraria	Lettera	Literary	Letter
Phonetic interference	Pietro	Piero	Peter	Piero
Semantic anchorage	Festa	Finita	Party	Over
Phonetic anchorage	Diritto	Dietro	Right	behind
	Vienna	Vanna	Vienna	Vanna
	Fondo	Mondo	bottom	world
Mistakes	Soddisfazione	Stazione	Satisfaction	Station
	Contro	Cimitero	Against	Cemetery
	Mica	Manica	Mica	Channel
	Vienna	Vanna	Vienna	Vanna

Pb also passed 9 images, 7 correctly, 1 a complete mistake and 1 instead of writing *fischietto* [whistle, the instrument] he wrote fischio [whistle, the sound made by humans]. The word root is clearly the same.

Pc	Word to be passed (IT)	Word written (IT)	Word to be passed (EN)	Word written (EN)
Typos	Visito	Visto	I visit	seen/visa
	Trimeste	Temestre	trimester	no meaning
Mistakes	Alto	Romantico	Tall	Romantic
	Tingere	Tigre	to dye	tiger
	Chiave	Noutrosso	Key	No meaning
	Calciavano	Canecinanene	kicking	No meaning
With Phonetic anchorage	Spagnolo	Spigolo	Spanish	edge
	Mostra d'arte	Messo impegno	art show	put to use
Badly perceived	Sport	Sporta	Sport	bag
	Severamente	Serenamente	Severely	Serenely
(maybe typo)	Donazione	Danazione	Donation	no meaning
Semantic anchor	Scienza	Certezza	science	certainty
	Molto	Nessuno	nobody	many
	Buddista	Dubitare	buddista	(to) doubt
Phonetic anchor	Promessa	Protessa	Promise	No meaning
	Parolo arabo	Palo alto	(I) speak Arabic	Palo Alto/tall pole
	Sconfitta volute	Soffita a volta	desired defeat	vaulted attic
Double	Presa	Pressa	Grasp	Printing press
	Tunnel sotterraneo	Tunel sotterraneo	Underground tunnel	Underground tunel
	Immagine riflessa	Imagine riflessa	Reflected image	Reflected image
Contraction	Comunione	Comune	Reflected image	Reflected image

Pd	Word to be passed (IT)	Word written (IT)	Word to be passed (EN)	Word written (EN)
Typos	Intorno	Intonso	around	untouched
	Iscrivendo	Inscrivendo	enrolling	inscribing
	Apposito	Amposito	specific	no meaning
	maneggiò il martello	maneggio il martello	To handle the hamer	handle and the hamer

Mistakes	Tesi	Densità	thesis	density
	Rigando	Ricatto	streaking	blackmail
	Notizia sorprendente	Notizia progettuale	surprising new	project news
Badly perceived WM	Direttamente	intimamente	Directly	intimately
	Avevamo dettato	Avevamo dato	(we) dictated → we (gave)	(we) dictated → we (gave)
Redundancy	Marcatamente	Rimarcatamene	markedly	markedly
Phonetic anchor	Marcerai	Mangerai	(you will) march	(you will) eat
	Sarà avvenuto	Sarà venuto	it will have happened	he will come
	Infastidire	Infantile	to annoy	childish
	Scozzese	Scoscese	Scottish	abrupt
Synthesis	l'opinione è soggettiva	l'opinione soggettiva	The opinion is subjective	opinion subjective
(also connective and deictic)	zampa di elefante	zampa elefante	Elephant's paw	Elephant paw

Pe	Word to be passed (IT)	Word written (IT)	Word to be passed (EN)	Word written (EN)
Typos	Intorno	Intonso	around	untouched
	Iscrivendo	Inscrivendo	enrolling	inscribing
	Apposito	Amposito	specific	no meaning
	maneggiò il martello	maneggio il martello	To handle the hamer	handle and the hamer
Mistakes	Tesi	Densità	thesis	density
	Rigando	Ricatto	streaking	blackmail
	Notizia sorprendente	Notizia progettuale	surprising new	project news
Badly perceived WM	Direttamente	intimamente	Directly	intimately
	Avevamo dettato	Avevamo dato	(we) dictated → we (gave)	(we) dictated → we (gave)
Redundancy	Marcatamente	Rimarcatamene	markedly	markedly
Phonetic anchor	Marcerai	Mangerai	(you will) march	(you will) eat

	Sarà avvenuto	Sarà venuto	it will have happened	he will come
	Infastidire	Infantile	to annoy	childish
	Scozzese	Scoscese	Scottish	abrupt
Synthesis	l'opinione è soggettiva	l'opinione soggettiva	The opinion is subjective	opinion subjective
(also connective and deictic)	zampa di elefante	zampa elefante	Elephant's paw	Elephant paw

Pf	Word to be passed (IT)	Word written (IT)	Word to be passed (EN)	Word written (EN)
Typos	Primario	Premario	Primary	No meaning
	Sindacale	Sindacali	Residual	No meaning
	Coro misto	Coro misti	Mixed choir	Mixed choirs
	Membro della setta	Menbro della setta	Member of the sect	No meaning
	Potenzialita' retrograde	potenziolità retrograda	Retrograde potentiality	Retrogrades potentiality
	seria salute seduta	serie sedute salute	serious health sitting	series of health sitting
	mandò gentilmente a quel paese	mando gentilmente a quel paese	s/he kindly sent them to hell	I kindly send (them/you) to hell
	I sederi rispecchiavano la luna	I sederi rispecchiano la luna	The butts reflected the moon	The butts reflects the moon
Phonetic anchor	Gabbia	Cambia	change	cage
Badly perceived WM	Concretizammo	Concretizzano	had concrete	concretized
Doppia	Supplicheranno	Suplicheranno	Plead	No meaning
	Residuale	Ressiduale	residual	No meaning
redundancy	fronteggiò l'invasioni di cavallette	fronteggio l'invasioni delle cavallette	Faced the invasion of locusts	I front the invasion of the locusts

Pg	Word to be passed (IT)	Word written (IT)	Word to be passed (EN)	Word written (EN)
Typos	Calante	Calente	falling	No meaning

	Era stato retribuito	era stato ritribuito	He had been paid	No meaning
	apparentemente a testa in giù	apparentemente al testa in giù	apparently upside down	apparently l upside down

Image errors:

Image 21: crocodile/alligator

Pg wrote “denti” [teeth], a cognitive synecdoche.

Image 23: artichoke

Pg wrote “caco” [persimmon].

Image 24: axe

Pg wrote “massaggiatore” [masseur].

Appendix IV

Complete list of stimuli used in the word recognition task

	word	length	realword	action
1.	admiring	8	1	0
2.	advancing	9	1	1
3.	agreeing	8	1	0
4.	applauding	10	1	1
5.	assuming	8	1	0
6.	attacking	9	1	1
7.	battling	8	1	1
8.	believing	9	1	0
9.	belonging	9	1	0
10.	bending	7	1	1
11.	blooming	8	1	0
12.	blossoming	10	1	0
13.	bucking	7	1	0
14.	burning	7	1	0
15.	carrying	8	1	1
16.	catching	8	1	1
17.	chirping	8	1	0
18.	combating	9	1	1
19.	comparing	9	1	0
20.	concluding	10	1	0
21.	considering	11	1	0
22.	contemplating	13	1	0
23.	cooking	7	1	1
24.	cooling	7	1	0
25.	corresponding	13	1	0
26.	costing	7	1	0
27.	coughing	8	1	1
28.	crawling	8	1	1
29.	crumbling	9	1	0
30.	cutting	7	1	1
31.	dancing	7	1	1
32.	deducing	8	1	0
33.	detesting	9	1	0
34.	diving	6	1	1
35.	doubting	8	1	0
36.	dragging	8	1	1
37.	drawing	7	1	1
38.	drinking	8	1	1
39.	driving	7	1	1
40.	ducking	7	1	1
41.	eating	6	1	1
42.	embroidering	12	1	1
43.	entering	8	1	1
44.	envying	7	1	0
45.	equating	8	1	0

46.	erupting	8	1	0
47.	escaping	8	1	1
48.	estimating	10	1	0
49.	evaluating	10	1	0
50.	expecting	9	1	0
51.	falling	7	1	1
52.	feeling	7	1	0
53.	floating	8	1	0
54.	flying	6	1	0
55.	following	9	1	1
56.	forgetting	10	1	0
57.	freezing	8	1	0
58.	gesticulating	13	1	1
59.	grieving	8	1	0
60.	guessing	8	1	0
61.	hailing	7	1	0
62.	harrying	8	1	1
63.	hating	6	1	0
64.	heating	7	1	0
65.	hiking	6	1	1
66.	hitting	7	1	1
67.	hobbling	8	1	1
68.	holding	7	1	1
69.	hopping	7	1	1
70.	hovering	8	1	0
71.	impacting	9	1	1
72.	implying	8	1	0
73.	indicating	10	1	1
74.	inferring	9	1	0
75.	ironing	7	1	1
76.	jumping	7	1	1
77.	kicking	7	1	1
78.	kissing	7	1	1
79.	knowing	7	1	0
80.	leaning	7	1	1
81.	leaping	7	1	1
82.	lifting	7	1	1
83.	liking	6	1	0
84.	looking	7	1	0
85.	loving	6	1	0
86.	lying	5	1	1
87.	marching	8	1	1
88.	mashing	7	1	1
89.	mattering	9	1	0
90.	meaning	7	1	0
91.	melting	7	1	0
92.	miaowing	8	1	0
93.	modeling	8	1	1
94.	needing	7	1	0
95.	neighing	8	1	0
96.	owing	5	1	0
97.	pedalling	9	1	1

98.	piloting	8	1	1
99.	pinching	8	1	1
100.	possessing	10	1	0
101.	pouring	7	1	1
102.	preferring	10	1	0
103.	presuming	9	1	0
104.	pulling	7	1	1
105.	punching	8	1	1
106.	pushing	7	1	1
107.	raining	7	1	0
108.	realizing	9	1	0
109.	reasoning	9	1	0
110.	recollecting	12	1	0
111.	reflecting	10	1	0
112.	regretting	10	1	0
113.	remembering	11	1	0
114.	roaring	7	1	0
115.	running	7	1	1
116.	seeing	6	1	0
117.	seeming	7	1	0
118.	shining	7	1	0
119.	signifying	10	1	0
120.	signing	7	1	1
121.	singing	7	1	1
122.	skating	7	1	1
123.	skipping	8	1	1
124.	slapping	8	1	1
125.	smelling	8	1	0
126.	snorkelling	11	1	1
127.	snowing	7	1	0
128.	sounding	8	1	0
129.	speaking	8	1	1
130.	spilling	8	1	1
131.	sprouting	9	1	0
132.	squatting	9	1	1
133.	squeaking	9	1	0
134.	squeezing	9	1	1
135.	stamping	8	1	1
136.	standing	8	1	1
137.	stretching	10	1	1
138.	stumbling	9	1	1
139.	supposing	9	1	0
140.	suspecting	10	1	0
141.	sweeping	8	1	1
142.	swimming	8	1	1
143.	symbolising	11	1	0
144.	talking	7	1	1
145.	thinking	8	1	0
146.	throwing	8	1	1
147.	thundering	10	1	0
148.	tidying	7	1	1
149.	tiptoeing	9	1	1

150.	trampling	9	1	1
151.	trotting	8	1	0
152.	trusting	8	1	0
153.	turning	7	1	1
154.	unbuttoning	11	1	1
155.	uncapping	9	1	1
156.	unscrewing	10	1	1
157.	walking	7	1	1
158.	watering	8	1	1
159.	withering	9	1	0
160.	wondering	9	1	0
161.	worrying	8	1	0
162.	wringing	8	1	1
163.	colshing	8	0	NA
164.	splathing	9	0	NA
165.	progging	8	0	NA
166.	ornagering	10	0	NA
167.	gloaking	8	0	NA
168.	proporing	9	0	NA
169.	everling	8	0	NA
170.	argarding	9	0	NA
171.	unarthing	9	0	NA
172.	cooring	7	0	NA
173.	agracing	8	0	NA
174.	operything	10	0	NA
175.	malking	7	0	NA
176.	spoling	7	0	NA
177.	recoring	8	0	NA
178.	chinging	8	0	NA
179.	flarming	8	0	NA
180.	dishering	9	0	NA
181.	countring	9	0	NA
182.	afterlying	10	0	NA
183.	immembering	11	0	NA
184.	advespearding	13	0	NA
185.	studing	7	0	NA
186.	aganing	7	0	NA
187.	possiderating	13	0	NA
188.	nurring	7	0	NA
189.	militing	8	0	NA
190.	ecotting	8	0	NA
191.	cometring	9	0	NA
192.	carring	7	0	NA
193.	sembing	7	0	NA
194.	sibeding	8	0	NA
195.	yestaling	9	0	NA
196.	puring	6	0	NA
197.	equiling	8	0	NA
198.	accasing	8	0	NA
199.	avening	7	0	NA
200.	memeling	8	0	NA
201.	wheting	7	0	NA

202.	relling	7	0	NA
203.	faming	6	0	NA
204.	hisinhelming	12	0	NA
205.	elocking	8	0	NA
206.	pudging	7	0	NA
207.	cocaling	8	0	NA
208.	buithing	8	0	NA
209.	omerying	8	0	NA
210.	remplening	10	0	NA
211.	devoloping	10	0	NA
212.	argaraing	9	0	NA
213.	couring	7	0	NA
214.	realing	7	0	NA
215.	disiging	8	0	NA
216.	gering	6	0	NA
217.	curlowing	9	0	NA
218.	bewspaying	10	0	NA
219.	quarning	8	0	NA
220.	sophistanding	13	0	NA
221.	freading	8	0	NA
222.	opeading	8	0	NA
223.	fooking	7	0	NA
224.	egypting	8	0	NA
225.	reging	6	0	NA
226.	griting	7	0	NA
227.	noving	6	0	NA
228.	hunding	7	0	NA
229.	preaking	8	0	NA
230.	worting	7	0	NA
231.	neiting	7	0	NA
232.	atteling	8	0	NA
233.	comewhing	9	0	NA
234.	quanning	8	0	NA
235.	eleatiting	10	0	NA
236.	expething	9	0	NA
237.	watting	7	0	NA
238.	qualing	7	0	NA
239.	poining	7	0	NA
240.	conting	7	0	NA
241.	natting	7	0	NA
242.	keeling	7	0	NA
243.	delling	7	0	NA
244.	croving	7	0	NA
245.	futing	6	0	NA
246.	withing	7	0	NA
247.	suping	6	0	NA
248.	oling	5	0	NA
249.	vehaving	8	0	NA
250.	pebuing	7	0	NA
251.	formuning	9	0	NA
252.	driting	7	0	NA
253.	vieting	7	0	NA

254.	swinking	8	0	NA
255.	extering	8	0	NA
256.	solding	7	0	NA
257.	pleaking	8	0	NA
258.	voing	5	0	NA
259.	pollowing	9	0	NA
260.	preeping	8	0	NA
261.	chirning	8	0	NA
262.	deficating	10	0	NA
263.	farling	7	0	NA
264.	undivaling	10	0	NA
265.	surniting	9	0	NA
266.	justing	7	0	NA
267.	combling	8	0	NA
268.	spining	7	0	NA
269.	aushing	7	0	NA
270.	irrishing	9	0	NA
271.	treacking	9	0	NA
272.	manundlizing	12	0	NA
273.	infalusing	10	0	NA
274.	commishing	10	0	NA
275.	cortnesting	11	0	NA
276.	addying	7	0	NA
277.	friting	7	0	NA
278.	adving	6	0	NA
279.	funning	7	0	NA
280.	hunning	7	0	NA
281.	partialing	10	0	NA
282.	harting	7	0	NA
283.	claying	7	0	NA
284.	kithing	7	0	NA
285.	witiving	8	0	NA
286.	wanading	8	0	NA
287.	hompaing	8	0	NA
288.	hignanating	11	0	NA
289.	brining	7	0	NA
290.	produing	8	0	NA
291.	bleaking	8	0	NA
292.	mortring	8	0	NA
293.	aerfering	9	0	NA
294.	comething	9	0	NA
295.	foopering	9	0	NA
296.	annouring	9	0	NA
297.	foodling	8	0	NA
298.	evercing	8	0	NA
299.	sublissing	10	0	NA
300.	sparening	9	0	NA
301.	senishing	9	0	NA
302.	ultivising	10	0	NA
303.	remaning	8	0	NA
304.	warthing	8	0	NA
305.	dissidering	11	0	NA

306.	surring	7	0	NA
307.	suroning	8	0	NA
308.	chanking	8	0	NA
309.	irrizoning	10	0	NA
310.	certing	7	0	NA
311.	sometring	9	0	NA
312.	bountring	9	0	NA
313.	chanding	8	0	NA
314.	flanning	8	0	NA
315.	furning	7	0	NA
316.	contranding	11	0	NA
317.	domething	9	0	NA
318.	evalything	10	0	NA
319.	tenging	7	0	NA
320.	bistling	8	0	NA
321.	relancing	9	0	NA
322.	forething	9	0	NA
323.	suddling	8	0	NA
324.	procking	8	0	NA

Appendix V

Vignette used in the experiment 'The role of touch on writing production'

Vignette 1 (Negative): Ariel is having a very tough time getting used to her new life in Athens. She feels lonely, has difficulties making new friends and getting used to the Greek culture. She is struggling with the language, the different alphabet and missing her friends.

Have you ever found yourself in the same (or similar) position as the protagonist of the vignette?

Never 1	2	3	4	5	6	Very often 7

Vignette 2(Negative): Michael is overwhelmed; he was not expecting that studying at the University would be so difficult, so demanding. He feels that he is falling behind compared to his classmates. He feels that every time he is studying something he is falling further behind in other courses.

Have you ever found yourself in the same (or similar) position as the protagonist of the vignette?

Never 1	2	3	4	5	6	Very often 7

Vignette 3 (positive): James was a little sad he would have to pass his birthday on his own, it was such a busy period of his life and he didn't have time to organize anything. After a hard day of work he came back home feeling lonely and when he opened the door all his friends jumped out of hiding and yelled *surprise*.

Have you ever found yourself in the same (or similar) position as the protagonist of the vignette?

Never 1	2	3	4	5	6	Very often 7

Vignette 4(positive): Robin is really excited about a date. Robin was having feelings for a classmate for months now and didn't think it would ever go anywhere. Out of the blue Robin got an invitation for dinner and a movie and is so excited about it.

Have you ever found yourself in the same (or similar) position as the protagonist of the vignette?

Never 1	2	3	4	5	6	Very often 7

Appendix VI

Questionnaire post writing in the experiment: 'The role of touch on writing production'

Age: _____
Sex: _____
Cultural background: _____
Native language:_____

How often do you have physical contact (as hugging or embracing in greetings, etc) with your partner/sibling/friend in daily life?

Never	Rarely	Sometimes	Often	Very often

Did you felt confortable writing with your partner/sibling/friend seeing what you were writing?

Not at all	Slightly	Moderately	Quite	Extremely

Considering the two texts you wrote, how would you consider the information you disclosed?

	Not at all	Slightly	Moderately	Quite	Extremely
Intimate					
Superficial					
Confidential					
Personal					
Detached					

Writing with a hand on your shoulder made the writing itself…

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Strange					
Comfortable					

Unfamiliar					
Cozy					
Confusing					
Protected					
Reassuring					
Awkward					
Easy					
Secure					
Odd					

Writing with a hand on my shoulder made it <u>easier or more difficult to</u>:

	much more difficult	more difficult	Neutral	easier	much easier
formulate thoughts in my mind					
start writing my thoughts					
keep writing my thoughts with ease					
maintaining concentration					
write in a continuous way					