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**THE RHYTHM OF THERAPY:
PSYCHOPHYSIOLOGICAL SYNCHRONIZATION
IN CLINICAL DYADS**

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Table of Contents

Abstract	V
Introduction	I
1. Mind-Body-Environment Epistemology	1
1.1 The Body as Epistemic Necessity in the Neurophenomenology Framework.....	1
1.2 The Mirror System: Mimicry as the Basis of Social Interaction	9
1.3 The Construct of Empathy: an Enigmatic Key to Understand Human Interaction	12
2. Systemic Model of Intersubjectivity	19
2.1. Different Languages to Co-construct the Self	19
2.2 Assumptions Underlying the Systemic Models	23
2.3 Dyad Systems	25
2.4 Psychotherapy.....	32
3. Dyadic Synchronization	37
3.1 Synchrony Measures.....	40
4. Study 1: Manipulating Synchronization	49
4.1 Participants and Procedure	50
4.2 Measures	51
4.3 Statistical Analysis	55
4.4 Results	56
4.5 Discussion.....	61
5. Study 2: the Clinician Effect	65
5.1 Participants and Procedure	66
5.2 Measures	68
5.3 Statistical Analysis	69

5.4 Results	71
5.5 Comparison to Study 1	76
5.6 Discussion.....	80
6. Study 3: Synchronization and Process	83
6.1 Participants and Method	85
6.2 Results	94
6.3 Discussion.....	107
7. Study 4: Entropy and Order in Psychotherapies' Verbal Content	113
7.1 Participants and Method	115
7.2 Results	119
7.3 Discussion.....	122
8. Conclusion	127
8.1 Context	127
8.2 Findings	132
8.3 Implications	138
Acknowledgements	141
Appendix A: Content Analysis	143
References	149

Abstract

Rhythmicity and synchronization are fundamental mechanisms employed by countless natural phenomena to communicate. Previous research has found evidence for synchronization in patients and therapists during clinical activity, for instance in their body movements (Ramseyer & Tschacher, 2011) and physiological activations (e.g. Marci et al, 2007; Kleinbub et al., 2012; Messina et al., 2013). While this phenomenon has been found associated with different important aspects of clinical relationship, such as empathy, rapport, and outcome, and many authors suggested that it may describe crucial dimensions of the therapeutic dyad interaction and change, a clear explanation of its meaning is still lacking. The goals of the present work were to:

1) Provide a solid theoretical and epistemological background, in which to inscribe the phenomenon. This was pursued by crossing neurophenomenology's sophisticated ideas on mind-body integration (Varela, 1996) and Infant Research's detailed observations on development of infants' Self through their relationships. The common ground for this connection was the complex systems theory (von Bertalanffy, 1968; Haken, 2006).

2) Contribute to literature through two replications of existing studies (Kleinbub et al., 2012; Messina et al., 2013) on skin conductance (SC) synchronization. In addition to the original designs, secure attachment priming (Mikulincer & Shaver, 2007) was introduced to explore if observed SC linkage was susceptible to manipulation, accordingly to the developmental premises defined in the theoretical chapters. Study 1 focused on synchrony between students and psychotherapists in simulated clinical sessions; Study 2 reprised the same methodology with two principal changes: first the clinician's role was played by psychologists without further clinical trainings, and second, each psychologist was involved in two distinct interviews, in order to assess the impact of individual characteristics on SC synchrony.

3) Provide an ideographical exploration of the psychotherapy processes linked to matched SC activity. In study 3 the highest and lowest synchrony sequences of 6 sessions of psychodynamic psychotherapy were subject of a detailed phenomenological content analysis. These micro-categories were synthetized in more abstract ones, in order to attempt the recognizing of regularities that could shed light on the phenomenon.

4) To explore the pertinence of employing mathematical properties derived from the application of system theory in psychological contexts. In study 4, Shannon's entropy and order equations (1948) were applied on the transcribed verbal content of 12 depression psychotherapies, to assess both intra-personal and inter-personal (dyad) order in verbal categories.

Results from these studies provided further evidence for the existence of a synchronization mechanism in the clinical dyads. Furthermore the various findings were generally supporting the dyad system theoretical model, and its description of regulatory dynamics as a good explanation of the synchronization phenomena. Discrepancies with previous literature highlighted the need for further studies to embrace more methodological sophistication (such as employing lag analysis), and cautiousness in the interpretation of results.

Ritmo e sincronia sono meccanismi fondamentali alla base dello scambio di informazione in innumerevoli fenomeni naturali. Ricerche precedenti hanno evidenziato la presenza di meccanismi di sincronizzazione in pazienti e terapeuti durante la pratica clinica, ad esempio nei loro movimenti corporei (Ramseyer & Tschacher, 2011) e nelle attivazioni fisiologiche (es. Marci et al, 2007; Kleinbub et al., 2012; Messina et al., 2013). Nonostante tale fenomeno sia stato associato a diversi importanti aspetti della relazione terapeutica, quali l'empatia, il *rapport*, l'esito del percorso clinico, e nonostante molti di tali autori siano concordi nel suggerire che tale meccanismo possa descrivere dimensioni cruciali della relazione terapeutica e dei suoi processi di cambiamento, una chiara spiegazione e comprensione del suo significato è ancora assente. Pertanto gli obiettivi del presente lavoro sono:

1) Fornire un solido background teorico ed epistemologico nel quale inscrivere tale fenomeno. Tale obiettivo è stato perseguito tracciando un ideale filo rosso fra la sofisticata integrazione fra corpo e mente ad opera del pensiero neurofenomenologico (Varela, 1966), e le dettagliate osservazioni sull'evoluzione del Se nei bambini attraverso le loro relazioni primarie ad opera del movimento dell'Infant Research. Il terreno comune per operare tale connessione è stato fornito dalla teoria dei modelli complessi (von Bertalanffy, 1968; Haken, 2006).

2) Contribuire alla letteratura attraverso due replicazioni di studi precedenti (Kleinbub et al., 2012; Messina et al., 2013) sulla sincronizzazione della conduttanza cutanea (CC). In aggiunta ai disegni originali, è stata introdotta una tecnica di *priming* della sicurezza di attaccamento (Mikulincer & Shaver, 2007), per osservare se e come la coordinazione nella CC nella diade terapeutica fosse soggetta a manipolazione, e coerente col modello di sviluppo scelto per interpretare il fenomeno. Lo studio 1 si focalizza sulla sincronia fra studenti e psicoterapeuti durante simulazioni di colloqui clinici; lo studio 2 riprende tale metodo con due differenze significative: il ruolo di clinico è stato ricoperto da psicologi senza ulteriore formazione, ed ogni psicologo ha condotto due colloqui, al fine di investigare l'impatto delle caratteristiche individuali sulla sincronia.

3) Fornire una esplorazione ideografica dei processi terapeutici connessi all'attivazione CC simultanea. Nello studio 3 le sequenze di maggiore e minore sincronia di 6 sessioni di psicoterapia psicodinamica sono state analizzate attraverso una dettagliata analisi del contenuto fenomenologica. Le micro-categorie da essa ottenute sono poi state sintetizzate in categorie più astratte al fine di cercare di riconoscere la presenza di regolarità che potessero gettare luce sul fenomeno.

4) Esplorare la pertinenza dell'utilizzo di proprietà matematiche derivate dall'applicazione della teoria sistemica nei contesti psicologici. Nello studio 4, le formule di entropia e ordine di Shannon (1948), sono state applicate sui trascritti del contenuto verbale di 12 psicoterapie di pazienti depressi, per investigare la presenza di ordine nelle categorie verbali sia intra-personali, che inter-personali (diade).

Gli esiti di tali studi hanno rivelato ulteriore evidenza rispetto all'esistenza di meccanismi di sincronizzazione nella diade clinica. Inoltre i vari risultati erano generalmente in supporto al modello sistemico diadico e la sua descrizione delle dinamiche di regolazione si è rivelata una buona spiegazione dei processi di sincronizzazione. Discrepanze minori rispetto alla letteratura sottolineano il bisogno di proseguire la ricerca in questo settore attraverso una maggiore accortezza metodologica (ad esempio tramite *lag-analysis*), e cautela nell'interpretazione dei risultati

Introduction

Synchronization is a widespread phenomenon in nature. Hundreds of animals in flocks of birds and schools of fishes moves apparently as one single entity when facing a predator, and bioluminescence of some species of fireflies can flash in synchronized patterns among many individuals during mating seasons. At the cellular level, synchronization of the activity of individual neurons generates macro-oscillations in neural ensembles, a behaviour through which many of the central nervous system functions rise. At particles scale, perfectly synchronized (“coherent”, in physical terms) light waves give form to lasers, and at macroscopic level, synchrony of individuals’ actions determines the movement of masses and fluctuations of markets.

Synchrony can be defined as sharing a same rhythm, i.e. repetitions of patterns in time. Far from being a niche phenomenon, rhythmicity is instead an almost ubiquitous property of natural systems and central to life. From reproduction cycles of cells to the beating of the hearth, the coordination of walking, the rhythms of hormones that regulates many bodily functions such as metabolism, digestion, and growth, the cycles of sleep and wake and the menstrual cycle, all are examples of how rhythmic processes are at the hearth of our biological life. Furthermore, these rhythms interact with each other and with the environment, (e.g., the body to the cells, the seasonal variation on climate to the body, etc.), “*under the control of innumerable feedback systems that provide an orderly function that enables life*” (Glass, 2001). The good functioning of our body strictly depends from these rhythms and the smooth interaction between systems at different levels, from atoms to social contexts.

The present work is devoted to the idea that synchronization and rhythm are key properties of human interaction as well, and, as such, play a pivotal role during psychotherapy. This idea has

periodically emerged in literature since the Fifties, showing associations between synchrony and psychological constructs such as empathy, attachment, rapport, therapy outcome, but also with negative interactions such as marital conflicts, and while the field is steadily growing, the comprehension of synchronization phenomena in the clinical setting is still in its infancy. Problems in this literature includes the spread diversity of methodologies used, a few rate of replications, and a predominant employment of nomothetic designs aimed more at connecting interpersonal synchronization to various other constructs than trying to understand the phenomenon per se.

In the following chapters, four new studies on this fascinating topic will be presented in the attempt of dealing with these issues. The first three are focused on the synchronization of skin conductance, a phenomenon firstly observed by Robinson and colleagues in 1982, whereas the last one explores a novel approach through structures of entropy and order in verbal content.

The theoretical context in which I chose to locate this research draws from two primary sources: neurophenomenology and the dyad system model.

Chapter 1 will report the epistemological foundations necessary to discuss these topics in an integrated framework that overcomes the conceptual separations between mind, body and environment. Mainly following the thought of Chilean neuroscientist Francisco Varela, a path will be drawn through different neurophenomenology concepts with a threefold goal. First, conducting psychophysiological research in psychotherapy is an operation that requires the connection of two quite distant levels of observation, a process that entails the constant danger of drifting into reductionisms. Situating my own theoretical standing point concerning how these connections are interpreted was, thus, a fundamental necessity prior to begin any other action. The concept of embodied cognition served as the perfect bridge in order to assess the physiological dimensions of interaction without refuting the value of experience. The second main goal of this epistemological section was to introduce the main ideas underlying system theory. Concepts such as autopoiesis and emergency are crucial to understand the dynamics of complexity that bridge between different levels of observation of reality, as could be atoms to cells, brains to societies, or, as will be explored in the second chapter, individuals in dyads. The third goal of the chapter was to demonstrate the applications of the aforementioned concepts by projecting the multiple facets of empathy into a common framework, encompassing both biological and experiential dimensions, and laying the foundations for the empirical research.

Drawing from Infant Research's ethological observations as well as from general system theory and cybernetics, Luis Sander initially defined the dyad system model of interaction. In chapter 2, its key concepts will be summarized, specifically focusing on the mechanisms that rule interaction and change. First, through the reciprocal feedback system of interactive and self-

regulation, the model describes how (and partially, why), the pursuit of homeostasis is a powerful descriptor of low level dyad dynamics, with high level repercussions and behaviours such as facial mirroring. Second, the dynamic between organizing these interactions in patterns and breaking those patterns to develop new and more sophisticated ones is proposed as the key mechanism through which the Self develops and psychotherapy acts change.

The vision of the dyad as not only a good framework, but also one necessary for the very existence of each individual, led Edward Tronick, to coin the expression of “dyadically expanded states of consciousness” that, in the theoretical implications that will be discussed, provides the thorough background needed for the exploration of interpersonal synchronization.

Finally, chapter 3 will provide a brief overview of previous research in the field of dyad synchronization, focusing on the methodologies employed for verbal, movements, and physiological behaviours.

Building upon these premises, the four empirical researches are presented. Chapters 4 and 5 will report two successive replications of previous literature (Kleinbub, 2011; Kleinbub et al., 2012; Messina et al., 2013) by assessing simultaneous skin conductance (SC) in 20-minutes simulations of a first clinical session. Specific focus of the studies was to assess the effect of attachment manipulation (Mikulincer et al., 2001; 2005) on SC synchronization in each dyad. If the linkage phenomena are effectively a manifestation of those early mechanisms hypothesized in previous chapters, priming the inter Study 1’s dyads were composed by volunteering students and psychotherapists, whereas the role of the clinicians in study 2 was performed by psychologists without further training. Chapter 5 will as well discuss the comparison between these two groups’ results, in order to highlight the differences in clinicians training on the observed physiological linkage.

Chapter 6 will present the main research effort of the present work. Previous research focused principally on associating behavioural synchronization to other constructs such as empathy, attachment, therapy outcome, etc., mostly through nomothetic designs. In order to answer the question of which psychotherapy processes are effectively represented by the linkage of physiological activations, a single-case idiographic exploration of a psychodynamic psychotherapy was designed. An in-depth content analysis was performed on the highest and lowest synchronization sequences of the first, middle, and last two sessions, by phenomenologically assessing the therapy material through different perspectives, including verbal and non-verbal contents. Macro-categories were later extrapolated from this material in order to infer regularities and patterns between the SC synchronization and the therapeutic process. The results will be discussed in the light of dyad system’s regulations model.

The fourth and last study, which will be reported in chapter 7, addresses synchronization in 12 clinical dyads through a very different perspective. Stemming from the collaboration on a larger research with Professor Omar Gelo and colleagues (2016), the research explores the internal coherence of verbal contents both internally to each participants' discourse, and considering the interaction between patients and therapists of each dyad. The innovative methodological approach lies in employing system properties in a direct way, specifically by assessing this coordination not through a time series approach, but through Shannon's classical equations of entropy and order.

The eighth chapter will sum up the four studies' findings and highlight their contributions to the literature. The implications in both clinical and methodological domains will be discussed together with directions for future research and limitations of the reported data.

1. Mind-Body-Environment Epistemology

1.1 The Body as Epistemic Necessity in the Neurophenomenology Framework

Although traditional “standard” models of cognition have succeeded to explain a large number of psychological behaviours, in the last decades a broad range of observed phenomena and scientific discoveries has started to highlight the limits of these mainstream frameworks based on a linear input – processing – output metaphor. Simple examples of such borderline processes could be the observation that the typical gestures performed during human conversation facilitates not only conversation but language processing itself (McNeill, 1992); that vision is often action-guiding and the bodily feedbacks are preferentially integrated into visual processing in comparison to central nervous system processing (O'Regan and Noë, 2001); the discovery, that will be more exhaustively described later in this chapter, of mirror-neurons which fire both when an action is undertaken and when it is seen performed (Rizzolatti and Craighero, 2004); or, lastly, the common experience of using body parts and the environment to simplify cognitive processes, such as off-loading storage in memory tasks.

The red string connecting these examples is the simple, and yet game-changing, idea that the physical dimension of human beings is not only an experiential by-product of brain processing, or a mere interface that provides inputs to an unspecified *res extensa* and its neural correlates, it is instead an active and inseparable component of the whole experience, from perception to abstract cognition. This framework, actively discussed, researched and developed in the last thirty years, has been defined under multiple labels, among which the most encompassing is “embodied cognition” (Wilson & Foglia, 2015).

Although the intuition of the ontological, instead of functional, dependency between mind and body is present in many eastern Buddhist's schools of thought, the roots of the concept in

western culture are much more recent. Some of the underlying problems were actually already touched in Descartes' famous VI meditation: "*Nature also teaches me (...), that I am not only lodged in my body as a pilot in a vessel, but that I am very closely united to it, and so to speak so intermingled with it that I seem to compose with it one whole*" (Descartes, 1641, *Meditations on first philosophy*, p.29). Yet his overall thought was mostly in contrast with such sentence, and it was not until the seminal works of Edmund Husserl (1913, 1931), Martin Heidegger (1927), and Jean-Paul Sartre (1943) that the field was mature for an explicit assessment of embodiment reasons and core concepts, which was masterfully achieved in the book writings of Maurice Merleau-Ponty (1945).

Before phenomenology, both scientific and philosophic epistemologies were mainly (with some notable exceptions) directed toward a reductive positivism, where the ontological supremacy of the observer was not under discussion. In such a framework, the scientist or the philosopher, or more specifically, their mind or human essence, objectively observed an external, and independent world, in which such a subject was navigating. During the course of the XX century this radical confidence started to collapse. The phenomenological framework started to insinuate its core idea of a knowledge obtainable only in a subjective first-person way, thus opening the way to the study of all the processes that influence such first-person experience not as the study of errors and biases but as the study of the very building blocks of reality.

In other words, phenomenology started studying conscious experience as experienced, analysing the structure of perception, thought, imagination, emotion, and volition and action (Smith, 2013). This line of thought allowed to further analyse the intertwining of all these different processes, up to the social level. Merleau-Ponty, for instance proposed a gestural theory of language, just as we would point our finger to an object he describes words to be like acoustic gestures pointing to objects of an abstract world. In his words, when I speak: "I reach back for the word, as my hand reaches toward a part of my body which is being pricked; the word has a certain location in my linguistic world and is a part of my equipment" (Merleau-Ponty, 1945, p. 180). However, while the physical gesture is referred to a world made of intersubjective visual perceptions, it is usually considered that linguistic worlds are multiple and do not share a natural substratum; instead Merleau-Ponty argues that there is a shared linguistic world, one that is the product of sedimentation of an intersubjective practice.

Phenomenological inquiry allowed thus to cut through many levels of knowledge, inextricably connecting bodily, psychical and interpersonal phenomena into the explanation. This achieving reveals the two most ground-breaking innovations of such approach. The first being placing the body, and specifically perception, at the imaginary head of the experiencing process, and the second, in some ways not even completely acknowledged by the same authors, was to place

scientific observation in an embryonic context of complexity, specifically into an embryonic systemic framework.

Regarding the sketched “primacy of perception” (Merleau-Ponty, 1964), drawing both from Husserl’s *epoché* (bracketing) and Gestalt psychology findings, Merleau-Ponty puts perception as his epistemological *arche*, suggestively stating that “matter is "pregnant" with its form, which is to say that in the final analysis every perception takes place within a certain horizon and ultimately in the "world." We experience a perception and its horizon "in action" rather than by "posing" them or explicitly "knowing" them”. The author extends this reasoning in two directions, on one hand there is the main phenomenological approach, but on the other hand, a much more critical rejection of the representational model of the mind. For instance the author, describing the perception of a lamp, or a cube, hypothetically standing on a table in front of an observer, states that the hidden sides of such an object are not just filled out of a mental representation, by an intellectual synthesis based on memories of previous experiences or geometrical knowledge. Instead Merleau-Ponty hypothesized that such hidden sides are actually perceived, not through the visual stimuli itself (the sides are effectively hidden) but through what he calls the *entourage* of perception, that is, its setting. The *entourage* is neither ideal nor necessary or true, it is the form of which matter is pregnant, it is a pre-conscious, ante-representational expectation on reality which, as Merleau-Ponty only hints, is strictly bound together with the sensorimotor functions; indeed he defines this awareness of the hidden side of the lamp as a Husserlian passive synthesis: “I anticipate the unseen side of the lamp because I can touch it” or alternatively “as visible from another standpoint, at once given but only immanently”, insights that many years later found strong neuroscientific evidences. Whereas an intellectual act would grasp those grey zone of experience either as probable (basing on previous experience) or necessary (basing for instance on geometrical or physical knowledge), perception grasps it as reality, “as the infinite sum on an indefinite series of perspectival views in each of which the object is given but in none of which is it given exhaustively”.

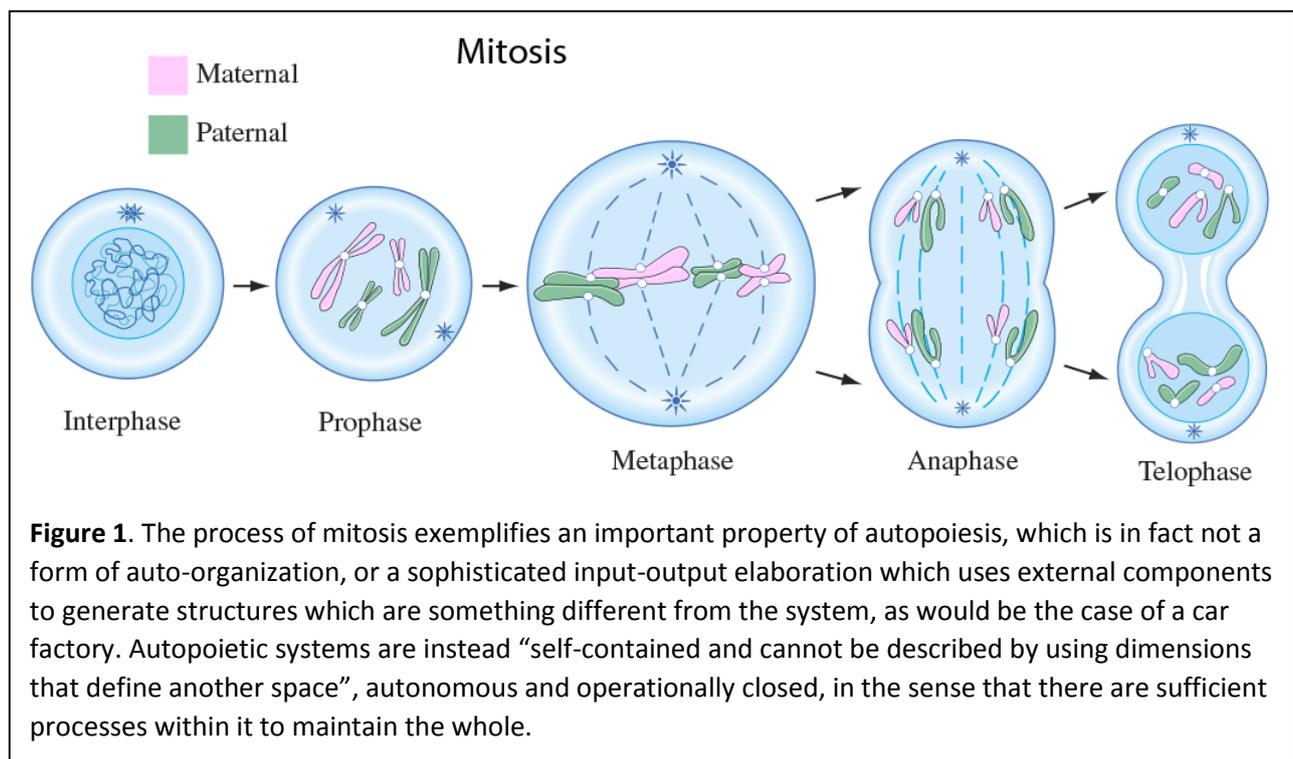
It is straightforward that such perspective change, while proposed as a full-fledged epistemological paradigm shift, had more to relate with psychology than with hard sciences such as physics or chemistry. With the notable exception of quantum physics, that in the second half of the XX century started to find suggestive evidences of observer effects, at least in the subatomic scale of matter, the biggest legacy of phenomenology was collected in the field of the theory of mind, and specifically in Varela’s neuro-phenomenology perspective.

Drawing to the exponential development of brain imaging technologies and to the emergence of an interdisciplinary matrix of cognitive sciences, connecting the fields of neurology, psychoanalysis, experimental psychology, which in the first times of phenomenology were still fragmented disciplines not communicating with each other, Varela in his most influential book *The*

Embodied Mind, aimed to translate the vision of Merleau-Ponty into a programmatic methodology and framework for neuroscientists and psychology researchers.

1.1.1 Autopoiesis and emergence. One of the first concepts developed by Varela, together with the biologist Humberto Maturana, is that of autopoiesis, from the Greek: *αὐτο-* (*auto-*), meaning "self", and *ποίησις* (*poiesis*), meaning "creation, production". The term was originally coined to describe reflexive feedback mechanisms in the chemistry of living cells, and was rapidly adopted in other fields such as system theory, sociology and psychology. In the framework of the two Chilean scientists, the founding characteristic of the living is the disposition to act a peculiar dynamic and homeostatic equilibrium, founded on the mutual regenerative relationship between the whole organism and its constituent parts. That is, the whole grants the renewal of its parts, reproducing them, while the parts themselves grant the whole's functional unity. A simple example of such mechanism is the eukaryotic cell, which is composed by parts, such as nucleic acids and proteins, which compose structures like the nucleus, the cytoskeleton, and various membranes and organelles. These structures, intrinsically developed for and based on an external flow of energy and nutrients, produce the components, which, in turn, continue to maintain the organized bounded structure that gives rise to these components.

The key feature to understand the importance of autopoiesis in regard to cognition is the relationship that exists between an autopoietic system and its environment. Indeed in order to maintain its autonomy and auto sufficiency, such a system has to be "structurally coupled" with their medium in a dynamic process not much different, in concept, to the animals' sensory-motor coupling. Cell (as well as an individual) and its environment are reciprocally implied and

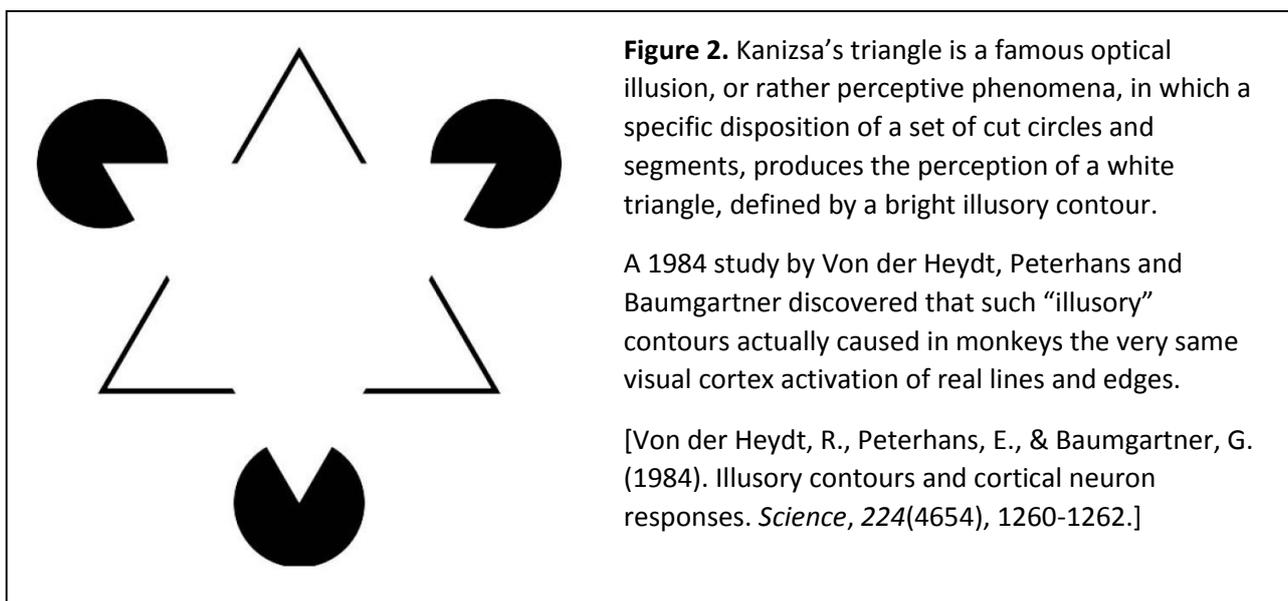


interdependent as they are both structurally moulded on their reciprocal shapes. This inextricable dependency does not allow to think at blood cells and plasma, observer and world, subject and object, as separate entities, dualistically split.

In a way the autopoietic property described by Maturana and Varela may be the ghostly “other” in the famous Koffka’s sentence: “the whole is other than the sum of the parts”, astonishingly evident through the Gestalt’s images (Figure 2) but not analytically exploited (indeed Gestalt theory and psychology developed from the very same School of Brentano that taught Husserl and influenced Freud, thus many phenomenological concepts and developments are strictly intertwined with Gestalt teachings), yet the implication of this most recent formulation of the concept has the strength to reach far wider conclusions. Indeed, extending the autopoietic property from a biological to a cognitive framework, would represent an elegant way to overcome the *tertium non datur* of the Cartesian dualism. Crucially, such a view of cognition would not be a representational process, limited in aim to the acquisition of knowledge, but instead an active process, an action, a movement, which reshapes the internal organization of the living toward its surrounding environment. Furthermore, it’s a somatic action, which requires a body to be performed, to interface the cognitive “nucleus” and “plasma”, a very important implication that opens to the developing of embodiment theory.

These ideas started to lead cognitive science from a “linear” computational model to the domains of complex systems, a transition that required another concept from Gestalt theory, used as a logical block in Varela’s theoretical building: the concept of emergence.

Emergence is the phenomenon in which, when adding complexity to a system, it manifests new properties and more specifically, these new properties or significant macro-phenomena are generated from a (usually large) number of simple elements with simple properties, and no central



coordination. A very simple example may be the molecule of water, H₂O, in which neither oxygen nor hydrogen presents the characteristics of water, but they do when they are coupled together (Figure 3).

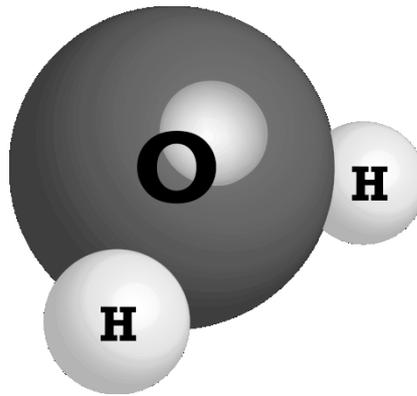


Figure 3. A molecule of water

A geometrical example, instead, would be a fractal, in which a simple shape (initiator) and a simple rule are combined and repeated multiple times, for instance in a Koch snowflake the rule is operating progressive additions to an equilateral triangle initiator by dividing in thirds each triangle's side and creating a new equilateral triangle on each middle third (figure 4). After many iteration of the simple rule, the system starts to acquire the appearance of a complex and sophisticated shape, as would be that of a real snowflake. In fact, fractals are the actual way through which many other natural shapes are formed: mountains, clouds, leafs, blood vessels, DNA folding, and many more.

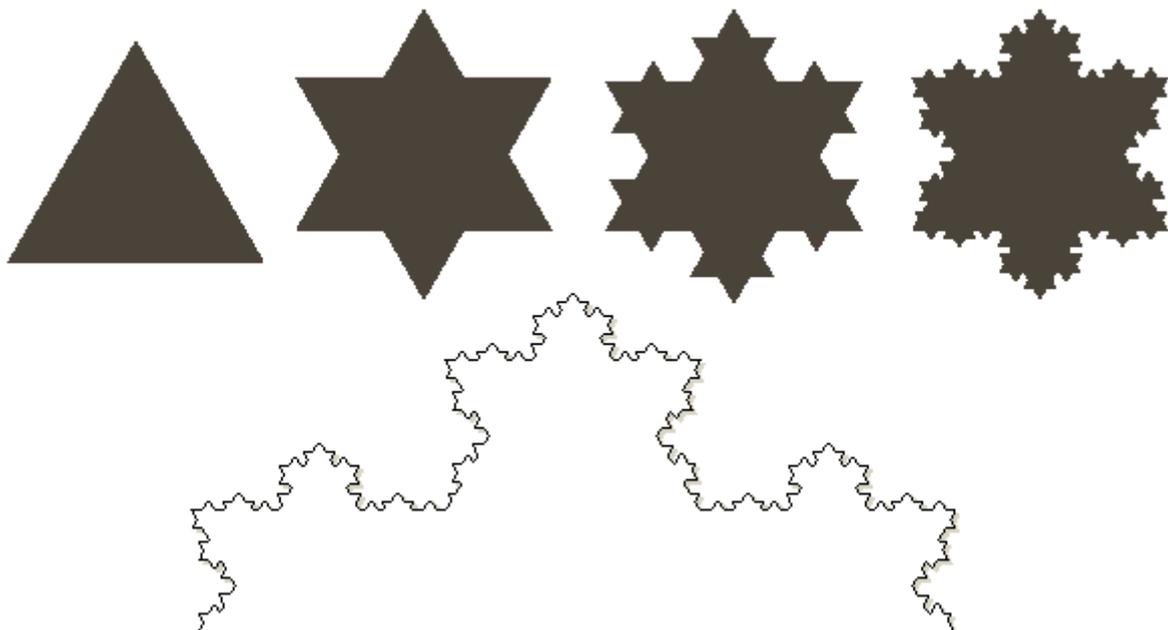


Figure 4. Koch snowflake fractal iterative construction. Starting from the upper left shape, the initiator, a simple rule is recursively applied at each subsequent step. After many iterations the increasing complexity leads to the emergence of new properties (e.g. from a triangle to a snowflake)

Furthermore, Gestalt psychology through its usual way of using pictures that provides intuitive evidence of sophisticated phenomena, showed how emergence is as well a property of perception. In figure 5 is shown a famous example of a picture in which through an analytical approach, i.e. just by trying to find a pattern in the black and white areas or following the lines, no relevant object appears portrayed against a background, instead, by watching the picture as a whole, the shape of a Dalmatian dog starts to take form from the seemingly random spray of black dots. Once the image of the dog has formed in the observer eye, it is almost impossible to “un-see” it, or more specifically to find another visual configuration of the image. The process of perceiving the Dalmatian dog, in this picture is not a symbolic reactivation of an inner visual representation, instead, in accordance with Merleau-Ponty’s theory, it is an active process of construction of the latent properties of each black dot, and their complex interactions in the visual field that give rise to the emergence of the object.



Figure 5. The famous “Dalmatian dog” perceptive phenomenon

One of the subtle implications of a radical implications of an emergentist model of cognition, is that the percept, and the perceiver, its mind and body, are not separate entities, they are not input, software and hardware, instead they represent different levels of complexity of the same

physical reality. As the energetic and chaotic spin and movement of subatomic particles self-organizes in stable matter, the global cognitive phenomena, although stable and apparently self-sufficient, may be an higher level of complexity of an auto-regulatory dynamic of simpler elements, of which neurons are the best candidate. Still this identity would not be ontological, factual, but rather relational, emergent, in the sense of a pattern of dynamic interactions between simple elements. While this may be and has been interpreted as a reductionist bottom-up model, Varela and Thompson remarks that a superior level of complexity of a system does not imply an inferior ontological status, or priority, and thus top-down processes in which the emergent global properties coordinates and direct the phenomena at lower levels of organization, are not only possible but even common and necessary to really order the local structures which would otherwise just be contingent. It is thus a circular co-determination model of reciprocal causes between different levels of organization, and even consciousness as an emergent global process is not just an epiphenomenon of a dense brain and has an active and crucial causal role to the coordination of cognitive processes. Finally there is no necessity whatsoever that these causal links between different scales of complexity may be evident at a local level; this implies that even knowing the exact state of each simpler element may not suffice to reconstruct or derive the uppermost phenomenon, which depends to the micro and macro variations due to the infinite peculiar characteristic that, unlike mathematical objects, characterizes physical ones. That means that it would be not only difficult, but “epistemologically impossible” to perfectly describe the finest and most complex shadings of an individual psychical life from his or hers neuronal configuration.

To briefly sum up, the Rylean ghost in the machine metaphor becomes a “ghostly machine”, or more properly, an embodied mind, which overcomes the classical dualistic view without resorting to reductionism, and retaining for consciousness a foundation that, playing with terms, Varela defines not only phenomenological, but *phénoménal*.

1.1.2 Enactive cognition to embodiment. The “shape of cognition to come” in Varela’s project was, as perfectly synthetized by Cappuccio (2006 p.23) , “ not more the abstract semantic of images scrolling on a screen, but getting such images in a bodily shape, through a pulsating movement, a dance that continuously alters the screen surface, reconfiguring the appearance of what lies on both sides of the screen”.

This radically constructive and active role of the subject, in Varela’s *The Embodied Mind* (1991) is fully developed in the conceptualization of *enactment* that in some way encompasses and formalizes all the previously outlined premises. Enactive approach to cognition is funded on the two concepts that perception is formed by actions perceptively guided, and that the cognitive structures emerges from recurrent sensorial schemes that allow action to be perceptively guided. In

such a view, the self and the world become reciprocally co-constructed and cognition, far from being the representation of an already given world, is the conjunct event of a world and a mind, starting from the history of the different actions acted by an Husserlian being-in-the-world. In other words, cognition in the enactive framework is a history of structural coupling that brings forth a world, through a network consisting of multiple levels of interconnected, sensorimotor subnetworks.

Summing up, enactive cognitivism places the whole experience into a sensory-motor domain, a carnal dimension of a situated subject, overcoming in this way the dichotomic distinction between internal and external, an embodied experience. Embodiment means that cognition and perception are two phenomena that are emergent from the subject's physicality and thus are "such stuff as the body is made on", and yet this individual extended sensory-motor abilities are inscribed in wider psychological and cultural contexts. While the word "body" appears to be central in Varela's thought, that does not mean that his is a body-centric perspective. Again, the different complexity levels have no importance priority on each other, and the choice of using "body" as the terminological root for his main theoretical contribution has probably more to relate to historical reasons linked to the state of the art of philosophy of mind and neuroscience of the late XX century.

Indeed, drawing again from Husserl and Merleau-Ponty, the term "body" can have a twofold meaning, which is expressed by the German words "Körper", the body as anatomical thing, object of medical sciences, and "Leib", the body as living thing. Such a living body forms a system together with the world, infusing it with perceptible life, animation, "experienceable experience". Embodiment's living body is thus permeable and dependent on its higher levels of complexity, such as consciousness, individual history, and culture, a dependency that, in the words of Andy Clark (2008), is composed of "inextricable tangles of feedback, feed-forward and feed-around loops: loops that promiscuously criss-cross the boundaries of brain, body and world".

In conclusion, Varela's neuro-phenomenological perspective offered an open epistemological framework to study the human being as a complex system, without the need for dualism and reductionism, and still with a very pragmatic and research-oriented attitude, that allowed for impressive advancements and comprehension in both neuroscience and cognitive psychology.

1.2 The Mirror System: Mimicry as the Basis of Social Interaction

Varela's seminal work were further expanded and verified by many modern neuropsychological discoveries shedding light on the relationships between body, movement and cognition. With surprising evidence, such research has shown that our brain is hardwired to privilege, among the incredibly vast amount of data impacting our perceptive system any moment, two categories of stimuli: social information, such as other people's facial expressions and rhythmic information from circadian cycles to perception of music and speech. Although this latter preference for rhythms might be relatively unsurprising, as the whole brain is in fact a complex oscillatory system, the consequences of these preferential routes are striking, with the most notable observation that social interaction has built upon rhythmic processes, and still retains many rhythmic properties.

One of the most influential neuroscientific discoveries of the XX century, fascinating and inspiring scholars, philosophers, and the public as well, is that of the mirror neurons by the research group led by Professor Giacomo Rizzolatti, from the Parma University. The original discovery, on macacus rhesus monkeys, concerned the description of what seemed like a selective class of multimodal neurons with a very peculiar behaviour: besides activating themselves when an action was performed by the specimen, such neurons would fire also while observing other monkey performing the same action. This indirect activation was later elicited also by acoustic (Kohler et al., 2002) and tactile (Keysers et al., 2004) hints of actions. The mirror property has been classically described as an effective internal simulation of others' actions, called by Gallese "embodied simulation" (Gallese e Goldman, 1998; Gallese e Sinigaglia, 2011), which would consist in a form of mimicry, an unconscious and automatic "cerebral imitation", lacking an active form (the brain behaviour is the same as if the action would be really performed, yet the musculoskeletal apparatus needed to do it is not activated).

It is important to highlight that from a neural point of view, it is not the action tout-court to ignite the mirror neurons activation, but the objective, the intention of such action (Iacoboni et al., 2005, Fogassi et al., 2005). In other words, the gesture of picking a cup to drink its content, activates different areas as those involved in the same prehensile movement aimed instead to reorder a desk. The intensity of this mirror activation results thus to be modulated by different factors, as the localization in the space of the observed action (the "field" in Gestalt's theory), the observer's perspective and, crucially for the higher aspects of psychological functioning, the values attributed to such action (Rizzolatti e Fogassi, 2014; Rizzolatti et al., 2015).

The mirror activation of the right inferior parietal lobule, among the first areas to be described as characterized by mirror properties, would mediate the discrimination between actor and observer in regard to the source of the action (Decety e Jackson, 2004) thus regulating the

different agency valence on which the mirror system is based. In the animal model, based on observations in chimpanzees (Rizzolatti et al., 1996; Gallese et al., 1996) and in birds (Keller e Hahnloser, 2009), it initially seemed that mirror neurons had a stable, constant and well-defined localization. Homologous areas were searched in the human brain and originally identified in the inferior sector of the already mentioned parietal lobule (Buccino et al., 2001). After the original discovery, the amount of research in this topic expanded exponentially, and by the end of the first decade of the new century, mirror properties had been observed in a large number of cerebral areas¹, such as the anterior cingulate cortex (Critchley 2003), and in other neuroanatomical structures involved in the representation of the self and the other (Singer, 2009; Wicker et al., 2003).

Due to this increasingly evident pervasiveness in the brain and its perceptive modalities, as well as, obviously, for its ability to respond to relatively sophisticate social stimuli, the mirror system has been extensively looked at as the possible neural foundation of many intersubjective phenomena in which the comprehension of the other is crucial, such as the neonatal caregiver imitation (Simpson et al., 2014), comprehension of others' emotions from their facial expressions (Carr et al., 2003), learning (Catmur et al, 2007), language development (Fadiga et al, 2002), and obviously, empathy. Consequently, dysfunctions to the mirror system have been associated to mental conditions associated to poor or altered empathy, mostly in its affective connotation (Dziobek et al., 2008; Lee et al., 2004), but also autism (Dapretto et al., 2006) and schizophrenia (McCormick et al., 2012).

Neuropsychologist Vittorio Gallese, also from Parma's group, has become one of the main interpreters of the mirror system in human interaction, and unsurprisingly his interpretation is deeply rooted in the phenomenological approach. In his view, it is the body, and not a "pre-established platonic world made of ideals and eternal truths", to constitute the first source of signification: the body does not only experience reality, but builds with it a semantical dimension. In the thought of Gallese, thus, the mirror system is the neural underpinning of the "intentional consonance", i.e. the shared signification of sensorimotor behaviours which takes form in the intersubjective space, and which is our first immediate source of comprehension of others, and by extension, of the social context in which we are situated. Furthermore the author hypothesizes how embodied simulation and intentional consonance, founded on mirror mechanisms, may be maximally active in the psychoanalytic setting, mediating partially or totally unconscious processes such as projective identification, transference and counter-transference (Gallese, 2009).

¹ For an in-depth review on the manifold cerebral areas that showed mirror properties, please refer to Rizzolatti and Fogassi, 2014 and to Urgesi, Candidi and Avenanti, 2014.

Although the mirror functioning in the human brain has been confirmed by many studies (Kilner e Lemon, 2013, Arbib, 2015, Rizzolatti e Sinigaglia, 2015), the topic has been, and still is, object of strong controversies by different authors which even claim that mirror neurons do not exist (Lingnau et al., 2009; Hickok et al., 2009, Hickock, 2014). In the aftermath of this academic conflict, while definitive evidences are still not available, two main position are taking shape. One approach is to shrink the weight of the mirror system, and thus its theoretical explanatory strength, while the other most recent interpretation is to acknowledge that eventually the discovery is even more relevant than what originally thought and that it may be conceivable that each neuron in the brain has mirror properties. In this view, mirror mechanism would be at the hearth of any intersubjective psychological process. This latter perspective is also endorsed by Giacomo Rizzolatti, which in a very recent paper redefines his own position and original interpretation, stating that it might be wrong to talk about individual mirror areas or a mirror system, and it should instead talk about “mirror mechanism”, which would connote the whole cerebral behaviour (Rizzolatti e Sinigaglia, 2015).

Besides the explicitly mirror system, recently Luisa Sartori from Padova University has discovered what she calls the “complementary system”, that is a neuronal system involving the motor and pre-motor areas and regarding the automatic and preconscious activations of areas designated to control a movement complementary to that observed (Sartori, 2014). In a recent study for example, she and her co-authors observed different MEP modulation for social actions, which required reciprocity, and non-social actions. Most notably the observed difference were recorded in the very first milliseconds since the beginning of the actions, that for example were pouring coffee in mugs, either near the experimenter or the subject (Sartori, Buccioni & Castiello, 2013). This result suggests that humans are able to code an action as social or non-social even before the action becomes explicit. In her experiments the complementary system seems to be alternative to the mirror mechanism, elicited selectively in non-social stimuli.

It is noteworthy how all these recent exploration and discoveries are compatible with the original Merlau-Ponty conception of perception and Varela’s enactive cognition. What research on the mirror mechanisms of the brain surely states with today’s evidences, independently to which neuron population presents this property, or even if the observed phenomena are to ascribe to a completely different interpretation, is that the brain is hardwired to understand others’ actions, without resorting to any higher level abstract or representational processing, it is the very same process of perception to already colour the world with its meaning exactly as theoretically postulated by phenomenology. Furthermore, getting to the core concepts of the present work, the understanding of others seems to pass through a sensorimotor imitation. In the next chapters the many ways in which imitation and mimicry consolidates interaction will be discussed.

1.3 The Construct of Empathy: an Enigmatic Key to Understand Human Interaction

While research and discussion on consciousness, phenomenology and the human being as a complex system dynamic constantly evolved in the last hundred years, a vast share of psychological researchers started to investigate human relationships' feature under many epistemological and theoretical perspectives. Among the great sprout of theorizations, one concept managed to mesmerize and apparently seemed to find a collective agreement between social and cognitive psychologists, psychotherapists and neuroscientists: the construct of empathy. Such popularity, though, has shown to be both a blessing and a curse as the term has started to be employed to describe an increasingly vast spectrum of behaviours and processes and nowadays is a word that may mean very different things depending to the context, branch of study or theoretical frameworks. Yet, even as an umbrella term, or an academic buzzword, empathy still represent the categorical label under which a great share of research on intersubjectivity has been conducted, and thus cannot be simply avoided as a cultural phenomenon, but has to be reviewed and understood to proceed in the exploration of human interaction. It is metaphorically a Gordian knot that has to be cut open, and its individual twines assessed as specific phenomena with specific intersections that can, and should, be observed and described into the epistemological paradigm previously presented.

1.3.1 Disentangling empathy. Empathy (from the Greek “in” meaning “inside” and “pathos” meaning “to feel”²), in its wider acceptation is “the ability to understand and appreciate another person's feelings, experience, etc.” (Oxford English Dictionary, 2014)³. To begin with the dissection of this concept, a fundamental distinction, which is pretty much consolidated in most literatures, is that of two modality of empathy. The first is a pre-verbal, sensorimotor, affective component, thus belonging to that area of psychic functioning diversely defined as primary or pre-reflective thinking, or automatic, implicit processes (Gallese, 2007). This first modality being what most probably is to be associated to the mirror mechanisms and other processes related to the same level of organization.

Yet, considering human interaction only in the light of a memetic mechanism would be almost as reductionist as considering consciousness the mere sum of a person's neurons, and would ignore the sophisticated power of higher levels of complexity of which the human nature is able, such as abstraction and rationality. A complex real-world interaction between adults, as for instance any psychotherapy session, requires (and is the demonstration of) the existence of a formal and

² More on the etymological history of empathy can be found in Wispè, 1987.

³ Merriam-Webster online dictionary's definition encompasses more of the complexity that lies behind the term: “the action of understanding, being aware of, being sensitive to, and vicariously experiencing the feelings, thoughts, and experience of another of either the past or present without having the feelings, thoughts, and experience fully communicated in an objectively explicit manner; also : the capacity for this”

elaborated processing of implicit and explicit, emotional and cognitive exchanges, that in literature has been studied through many different models, such as the Theory of Mind (ToM) of Baron-Cohen (1995). Furthermore atop to these two main modalities, there is a whole dimension connected to the intentionality and motivation to get in touch, to listen to the others, that encompasses prosocial behaviour, sympathy, altruism, and operates cultural and intrapsychic modulation to the empathic response with a bidirectional top-down and bottom-up causal direction.

Yet in most research contexts, these different dimension have been studied either as independent factors, neglecting the necessarily complex interactions intercurring between them, or as an undifferentiated *unicum*, under the vague empathic label, without recognizing their specificity and often without even pointing to a theoretical background or definition, or in the worst case scenario, referring to a layperson general meaning, which is furthermore shaded with ethical and moral connotations. In a relatively short time, the hype for empathy transformed it in a sort of scientific Lernaean Hydra, with the only common denominator of “making experience of the other”, and the debate on the real meaning of the word is still unsettled. As a consequence of this uncontrolled blooming of the concept, also the measure instruments are manifold and hardly comparable. In psychology for instance, the study on this phenomenon was mainly performed through self-report assessments such as questionnaires and scales, or through the observation of independent judges on audio-video material, but except some recent attempt (the Toronto Empathy Questionnaire, for instance, tried to overcome this plurality by empirically combining many of the most influential instruments and retaining the most statistically powerful items; Spreng, McKinnon, Mar, & Levine, 2009), these measures were each based on a different theoretical construct (Stepien & Baernstein, 2006), causing a paradoxical situation in which different studies’ results on empathy were not comparable, or even present contradictory assumptions to each other (Preston & de Waal, 2002).

In the neuroscientific field, instead, the availability of self-evident results such as the activation map of the brain, led into an even more dangerous conceptual grey zone. Indeed most studies are performed by administering extremely simplified stimuli, in comparison to those encountered in the real social life, often without a context, as individual and unrelated facial expressions or movements. While the results of these basic process measured under extremely controlled (and thus also specific and limited) experimental conditions, are important evidences and building blocks in the scientific process, they were often reported under the very same conceptual labels used by psychologist with only marginal overlapping of the concepts.

Zaki and Ochsner, in an influential review in 2012, reported how this lack of communication between behavioural and neuroscientific data, has heavily undermined the confidence for

neuroscientists to clearly describe the function of each area or system of the brain, as well as the possibility to build interdisciplinary evidence-based models of empathy.

One of the leading researchers of the topic, Mark H. Davis, stated that “empathy is an umbrella term masked as a single concept” and expressed scepticism on the possibility of a real neuropsychological model (Davis, 2002). Some year later, in 2009, another influential author, Batson, came to the same conclusions, observing how at that time empathy was a term “*actually used to describe more than half a dozen phenomena*” with fuzzy borders. In his paper, attempting to put some order into this complex field, he thoroughly reviewed the literature and evidenced eight different non overlapping domains of the word empathy:

- Knowing another person’s internal state, including his or her thoughts and feelings
- Adopting the posture or matching the neural responses of an observed other
- Coming to feel as another person feels
- Intuiting or projecting oneself into another’s situation
- Imagining how another is thinking and feeling
- Imagining how one would think and feel in the other’s place
- Feeling distress at witnessing another person’s suffering
- Feeling for another person who is suffering

Acknowledging that empathy is a “wrong word” and a “painful riddle” (in the words of Husserl), is a necessary step to proceed to a more structured theorization of the processes that guides human comprehension and interaction.

Today there are many attempts to overcome and systematize this complexity, by accounting for the multitude of data of different disciplines.

1.3.2 The perception-action model. The intuition that the first step of the empathic process is based on an individual replication of others’ state is not new. Among those above suspicion, the philosopher Nietzsche gave one of the most striking description of this mechanism stating how there is an “ancient association between movement and sensation” which gives birth to analogous feelings through a process of internal imitation. This concept has been incorporated in many later philosophical systems, such as those of Theodor Lipps (1903) and the already drafted one of Merleau-Ponty, but the first mention of it in psychology can be attributed to Ax whom in 1964 described empathy as a function of the autonomous nervous system tending to imitate that of other people. The beginning of the ethological studies on infants offered a wide contribution, for instance after the first year, children start to show helping behaviours, even when they have become distressed. They also imitate the distress behaviours of the other, possibly “trying on” the

expressions to better understand them (Zahn-Waxler, Radke-Yarrow, & King, 1977, in Thompson 1987). Infant research results will be more thoroughly described in the next chapter.

The most influential contribution on this topic still was that of Preston and De Waal (2002) who introduced the perception-action model (PAM; Figure 6) of empathy, by collecting all the evidences coming from different scientific branch, and specifically building upon the mirror neuron discovery. In the authors words (Idem, p.4): “a Perception-Action Model of empathy specifically states that *attended perception of the object’s state automatically activates the subject’s representations of the state, situation, and object, and that activation of these representations automatically primes or generates he associated autonomic and somatic responses, unless inhibited.*”

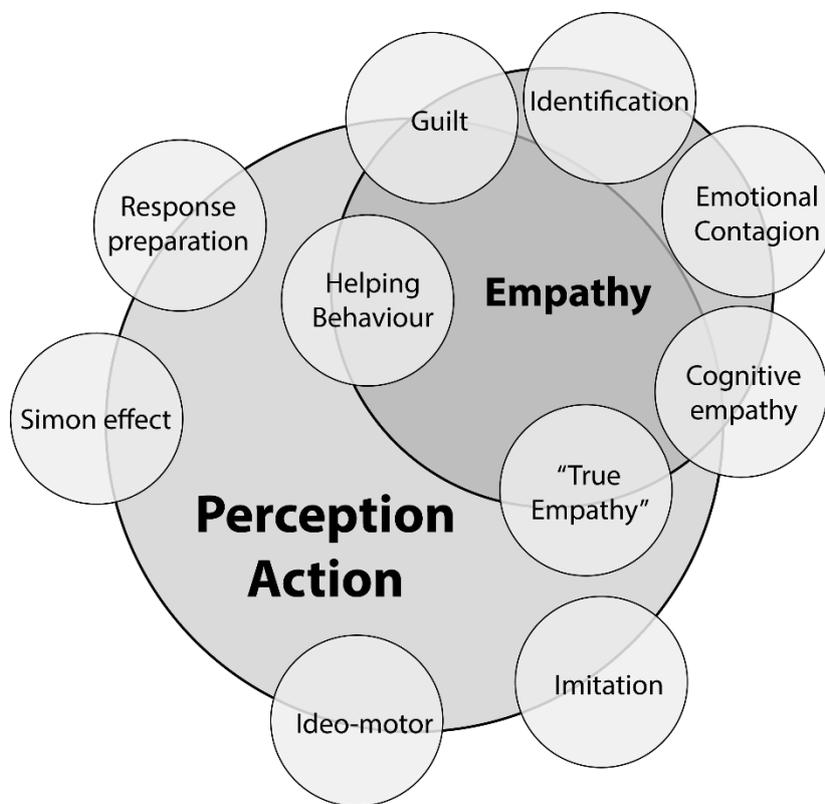


Figure 6. Topographical representation of PAM (Adapted from Preston & De Waal, 2002, p.4).

For instance, watching another person biting an apple, would activate in us the cerebral systems involved in such an action, from the motor activation to the emotional ones. And by understanding this way the scope of the action, we might as well start salivating just as we would be the ones biting. The model, attempting to encompass all the phenomena in the empathy box, considers this primitive layer of interaction as sufficient to most of the sharing of sensations and

emotions. It is a direct comprehension, a perception through action, as that postulated by phenomenological authors, or a un-mediated resonance (Goldman & Sripada, 2005), in many ways analogous to Gallese's embodied simulation: it is an experience that anticipates cognitive and linguistic moderation, that allows to perceive the other more as an alter-ego than as a really different-from-self entity. In PAM's framework the perception-action link is "the ultimate basis of empathy", and as its object is an automatic and pre-symbolic process, many of its empirical foundations are based on neurological and psychophysiological measurements, and ethological observations.

2. Systemic Model of Intersubjectivity

In the previous chapter the most relevant dimensions, mechanisms and processes on which interpersonal interaction can be built were outlined. Yet the neural correlates, not much differently to functional models of specific processes such as the empathic one, remains mute without a proper comprehension of the quintessential psychological object: the self.

Including a theory of the self in this work is not a matter of attempting to build an omnicomprehensive theory of everything, and it may seem an unneeded digression from an already vast web of theoretical coordinates presented in the previous chapter. Still, since the present work is aimed to investigate the interpersonal coordination in psychotherapy, and not just in an experimentally controlled sterile laboratory, understanding at least at the very basics the mechanisms underlying the psychotherapy's subject of intervention is crucial to give proper explanations to the observed phenomena. Furthermore, as will become evident later in the chapter, the very same process of formation of the self requires coregulatory processes that are most probably reiterated in a successful psychological intervention.

2.1. Different Languages to Co-construct the Self

While “what the self is?” is another troublesome question, unlike empathy, this is a much more theoretical question, and so the answers can be drawn from specific theoretical contexts. Furthermore, the nature of the self has been researched since much longer, and in literature there are pretty strong evidences on which to start a line of thought.

One of the major contributions in the theorization of self comes from Herbert Mead who, expanding the thought of William James, stated with extreme clarity and explanatory power how a mind cannot exist without other minds, that is, as a social construction. In his words: “The self is something which has a development; it is not initially there, at birth, but arises in the process of social experience and activity, that is, develops in the given individual as a result of his relations to that process as a whole and to other individuals within that process” (Mead, 1934). Mead draws the background of the origin of the self in the most basic ethologic scenario, that of communication between collaborating animals; there each individual’s action is a stimulus for the other individual’s response. In turn, the beginning of such response, constitute a stimulus for the first animal, which it can use to adjust its action to the oncoming response. Such dynamical patterns can easily be seen during play or fight. The difference between this interplay and the self is the form of the language through which this communication happens. From physical gestures, passing through words and up to social constructs, the increasing abstraction of the symbols generates a cognitive distance between the direct experience and the language. And it is inside the space generated by such distance that reflexivity becomes possible: “We may sit down in a chair without thinking about what we are doing, that is, the approach to the chair is presumably already aroused in our experience, so that the meaning is there. But if one is thinking about the chair he must have some sort of a symbol for it. It may be the form of the chair, it may be the attitude that somebody else takes in sitting down, but it is more apt to be some language symbol that arouses this response. In a thought process there has to be some sort of a symbol that can refer to this meaning, that is, tend to call out this response, and also serve this purpose for other persons as well. It would not be a thought process if that were not the case.” Thus, for Mead, the self can be described as the reflexive space around a very specific object, or set of unmediated experiences, which are enclosed into a symbolic frame, or category, which fits the loose label of “things that I am”. More specifically in the author’s theorization, the reflexive space of the self, and its cohesive unity, stems from another categorization, that he defines as “the generalized other”, whose nature and attitude is that of the whole social community (referring to each specific context). For instance, a child’s play (not dissimilar, in this phase, to the aforementioned animal interaction) may eventually start to manifest rules, which in turn defines roles that can be directly experienced and, ultimately, represented as abstract concepts. Through the knowledge of all the roles, the child can make assumptions on other roles’ behaviour, and recursively, on other roles’ assumptions on his own behaviour. The generalized other, in this example, would be the condensation of the representation of the whole game’s team, which determines, by contrast and expectations, the individual actions and representation of self.

As the “other” reveals as an epistemic necessity for the self, the whole psychological perspective has to be shifted from an individual centre to a collective one. Going back to the complex systems depicted in the previous chapter, the simple individual humans interacts as grain of sands or cells, to see the emergence of higher levels of autopoietic organization. Like in a sophisticated fractal structure, socialization is the operative rule that allows rich phenomena such as self and culture. Once again these different levels of complexity: brain, mind, self, and society, are ultimately different perspectives of a relational process, differentiated as different objects only in retrospect, through the use of different categorization rules.

Whether acknowledged or not, these insights, along with the whole Meadian theoretical model, had a very strong influence on last century’s psychology, even in those domains that are traditionally refractory to change, such as the psychoanalytic ecosystem. Yet the idea of this dynamic interactive process, which progressively gives rise to a recursive representation, which in turn becomes a main psychological instance, was able to penetrate even such theoretical stronghold. The success of this model does not only comes from its intuitive power or Mead’s clear writing style but, much more relevantly, by a great amount of empirical validations done by the “infant research” movement. The detailed ethological observation of infants behaviour, the discovery of their impressive innate cognitive abilities and their interactional aptitude, allowed authors such as Stern, Sander, Beebe and Tronick, to radically change the established vision of the human development and, crucially, to directly observe the mechanisms theorized by social construction at work. While psychoanalysis classically approached intersubjectivity mainly in the explicit and verbal domain, Infant Research opened up the door of procedural knowledge.

2.1.1 Systemic models. In 1954 Luis Sander started a research project called “Boston University Longitudinal Project”, in which he monitored infants movements, heart-beat, breathing rate, crying rate and a lot of other information, with the goal of collecting data on newborn children and their mothers. This huge amount of behavioural data led him to hypothesize that mothers and children were forming a mutually regulating system. One of the crucial steps that led him to such a systemic model perspective was the observation of the wake-sleep patterns in two infants’ samples, differentiated by different nutrition rules. In one sample, the children were nourished at fixed intervals, while in the other on the children’s request. In this latter sample, in the second or fourth day, the children started to manifest one or two longer sleep periods during the 24 hours arc and, successively, between the fourth and sixth day, these longer sleep period started to get spontaneously concentrated during nighttime. In contrast to the fixed intervals nutrition sample, the spontaneous one extended the wake-sleep pattern periodicity over a longer time span.

This apparently simple observation had two crucial implications: on one hand, this demonstrated that the cyclical states of the newborn, his biorhythm, could be influenced by the kind of environmental care offered; on the other hand, this showed how supporting the spontaneous biorhythmicity of children had the effect of favouring not only their requests but their initiative as well. The primitive interaction of asking for food and receiving it represented a prototypical experience of self-agency in the autoregulation, in comparison to the fixed-intervals nutrition samples in which infants were completely regulated by the environment.

It appeared then evident that even newborns' sleep patterns were not only a natural effect of development, but an interaction between physiological biorhythms and social variables. A construction in which the organizing rules were neither internal nor external, but there were two dialoguing processes, one in the infant and one in the caregiver, which were not only interacting through a co-regulation, but they were co-created, reciprocally constructed (Rodini, 2008).

2.1.2 Crossing boundaries. While not explicitly referenced by Sander, it is easy to see the parallelism between Mead's theory and the beginning of the dyadic systemic models that, in this light, can definitely be considered as constructionist models. Drawing this connection between infant research and social constructionism is not only an exercise in syncretism. Historically the major influences of infant research discoveries were absorbed by the psychoanalytical world, which found in the study of children a natural haven of scientific consolidation. This interaction, along with the theoretical "contamination" by existentialism and phenomenology, led to what is called the "relational shift in psychoanalysis" by authors such as Loewald, Sullivan, Fairbairn, Greenberg, and Mitchell. The core concept developed by relational psychoanalysis is that of intersubjectivity, which is a relational, social and cultural (with as special focus on language) matrix in which the human being is placed from the very beginning of his life, and inside which the mind evolves and is self-discovered (Mitchell, 2000). The acknowledgement that such evolution is factually a construction, in the most radical social constructionist acceptance of the word, is in my opinion a generally understated fact. It can be concluded that this acknowledgement is a fact, as these concepts, and even the "construction" word is used by these aforementioned authors, as well as by the strict convergence between infant research observations and constructionists' theories, such as those previously reported. Yet most of these authors seems to mostly neglect the long tradition of social constructionism, most probably for historical reasons connected to the dogmatism of psychoanalytic societies, which for example led to the longstanding refutation of Bowlby and his attachment theory. The knowledge and language of researchers is often in contrast with the clinical traditional knowledge, based on reconstructions of development built a-posteriori from the adult, as well as conflictual it is the merging of different theoretical models. Nevertheless the whole (ongoing)

process of the relational shift, consists in “a integration of a scientific paradigm based on constructivist assumptions and on a non-deterministic conception of development, and the linear understandings that we [psychoanalysts] have inherited” (Rodini, 2008).

2.2 Assumptions Underlying the Systemic Models.

In one of his most influential essays, Sander defined seven different principles, which he called “assumptions” that are still actual in their definition of the conceptual foundation behind systemic models. These are “starting points” used by the author to project a conceptualization of the regulation in a biological system on the ontogenesis of the exchange between the infant and its caretaker. It is important to briefly explore these concepts, as they not only provide a still solid theoretical framework, but most importantly the epistemological bridge, rooted in empirical observation, between neurophenomenology, and the study of intersubjectivity.

The first two of such points are a statement of complexity: *“by examining vital processes, the organism is always considered together the environment that allows for life. When we speak about child and its caring environment, we are tempted to theorize the entity, and the apparently relatively stable organization of its different parts and functions, as a thing, a separate creation; it is observed for the only goal of thinking it, abstracting it from any complex matrix. (...) Organism, surrounding environment and exchanges between them can anyways be represented, or discussed, as a system that comprehends the whole, its parts, and the relationships between them. In the biological context, it is possible to identify a vast hierarchy of systems, that comprehends all of the complexity levels, from the subcellular to the planetary, and where each unit constitute the context for both its components and for the content of the exchanges between them.”* (Sander, 1977).

Studying children, concludes Sander, cannot exempt to study its context, always remembering that what we consider polarities and transactions (e.g. self-other, individual-environment, etc.) is just a specific viewpoint among infinite other context-content-complexity level combinations, and such a choice should be done only for the ease of investigation, but without the arrogance of considering a factual distinction. Furthermore, in the second assumption, Sander states that the biological processes shows increasing levels of order, complexity, integration, and ultimately synthesis. This is exemplified in the adaptive process, in which the exchanges between the interacting components of a system modify themselves up to being able to coordinate harmoniously, i.e. to join themselves into a system, to become one on a higher complexity level of observation.

The second conceptual category on which the systemic models are built, encompassing Sander’s third and fourth assumptions, is that of time and of temporal organization of the events in

the life of the organism, the topic that really gets to the heart of the present work. All the aforementioned exchanges and regulation need to be placed in a temporal dimension in order to work properly. A system shows in time both simultaneous and contingent processes, which are both continuously present in the subsystems interplay, in forms such as synchronization and entrainment, which can occur even at surprisingly high frequencies.

For instance Cohn and Beebe (1990), studying the contingency level (amount of coordination) of facial expressions between mothers and children, observed mirroring as fast as 330 milliseconds for infants and 170 milliseconds for adults. To understand the scale of these reaction times it is relevant to note that the time needed to perceive a single stimulus and to react to it, is of about 700ms for an infant, and 400 ms for an adult (Karmel, reported in Beebe & Lachmann, 2002, p. 90). The explanation of these apparently impossible speeds lies in the temporal structure of systems. In the case of facial expressions, mother and infants resorts to anticipatory visual schemes, in the general case the elements of a system employs expected sequences, in a way in which the environmental information is not a sequence of independent discrete stimuli to react to; instead it is a historical series of intercorrelated inputs, organized in relatively stable and repeating patterns. Such patterns, once learned, allows making predictions on future behaviour of the partner or the environment, allowing consequently to perfectly synchronize or even anticipate the reactions. Sander specifically explains how biorhythmicity plays an essential role in the regulation of the system's components exchanges: "within certain limits, a very specific stimulus, bounded to the phase variations of a rhythmic component of the system may cause a phase transition in a second rhythmic component, receptive to that specific stimulation, in this way synchrony between the two components is activated". These mechanisms, underlying the biorhythms, thus allow both to understand simultaneity as a rhythmic epiphenomenon of contingency and, similarly, to harmonize complexity and specificity in the temporal domain.

While these temporal structures helps to understand reciprocity, and mirroring phenomena, it does not account for a parallel characteristic observed in human development, which is the tendency to separation. The latter three points in Sanders' checklist help to define the process of differentiation, which ultimately overlays with the development of the self and of self-awareness.

One crucial theoretical instrument used by Sander in this context is Ashby's cybernetic model (1952), which implies feedback loop mechanism in a system. For instance the representation of a goal may already include the behavioural changes needed to achieve it, in a similar fashion to the complementary system exposed in the previous chapter.

The continuum of the drive between the two polarities of union and separation, which has evidently a strong psychodynamic echo, is crucial and transactional between the generic discussion on systems and the human psychologic development. In Ashby's model, (1952, pp164-166) a

complex model with many balanced subsystems manifests stability, which endures even if the interaction with the environment disturbs the individual subsystem. This holds true while the whole system manifests equilibrium and cohesiveness. If the disturbance exceeds a threshold level, the whole system changes state and has to find a new balance, through new or already appraised strategies, including internal and external regulation. For instance, an infant in state of full wake, cleaned and nurtured, in a safe environment, can explore new objects or stimuli, i.e. disturb a limited subsystem of its organization, without compromising the global state of integration (Sander defines this as “temporary independence”). If the novelty of the stimuli would prove instead overwhelming, the child would have to resort to regulatory processes such as avoidance, or crying for help. Field in 1981, while measuring heart rate frequency during mother and infant face to face interactions, noted how the children looks briefly away from the mother to regulate its level of activation. In the five seconds that precede such diversion, its heart beat frequency significantly accelerates in comparison to its baseline, pointing to a protective reaction aimed to reduce the amount or intensity of the information. In the following 5 seconds, the physiological activation returns to baseline levels, and the children gaze returns toward the mother. This dialogue between equilibrium and disturbance in limited subsystems draws a scenario in which differentiation is the necessary outcome of the interaction between the ever-changing environment and an autopoietic system. If the differentiation process is sufficiently gradual and keeps under the threshold of system instability, its outcome would be good development, appraisal of new strategies and self-agency. A crucial theoretical step, which, generalizing from the biosocial sphere to the psychosocial sphere, describes nothing less than the development of self, and self-awareness, processes that, crossing these models with ethological data, can now be established to emerge at around 15-20 months, in the infant. More on this process will be discussed in the following paragraphs, describing in detail the systemic model.

2.3 Dyad Systems.

While psychoanalysis traditionally focused only on the organization of the internal states, building on the work of Sander, and many other contributors from psychology and other disciplines such as physics and biology, the conceptual framework in which to understand the human being started to turn from being organism-centred to a more sophisticated field or system focus, that is, (dyadic) systems models in psychology are those that integrate both the contribution of the individual and that of the dyad to the organization of experience and behaviour.

As outlined by James Miller (Rioch & Weinstein, 1964) through many observed homologous information processing between different levels of biological organisms organization, such as cells, neurons, organisms, human beings, and social organizations, it is possible to extrapolate a common system behaviour. Each level of such a system keeps its integrity in an environment in continuous transformation, by a constant process of regulation of the input and output of matter, energy or information as well as though the monitoring of its own sub-systems.

In development psychology's level of observation, a system is made of three principal units involved in dynamical interaction. The first two are the infant and its parent, and both these units are considered as autopoietic self-organizing and self-regulatory entities, and thirdly, the dyad as the interactive field with its own peculiar, emergent organization. It is important to note that none of these three units can be thoroughly described without referring to the other two.

Without strictly implying a causal relationship, in such a system, the behaviour of a partner is strongly predictable from the previous (or simultaneous) behaviour of the other, as each verbal production, or non-verbal action represents an influent input for the regulation of the other member of the dyad. Especially at the non-verbal level of affects and gestures, mothers and children continuously coordinates their behavioural rhythms, and crucially, being this mechanism at the hearth of the social behaviour, is as well true in the dyad composed by a therapist and a patient (Beebe & Lachmann, 2002).

2.3.1 A two way regulation. The crucial novelty of the dyadic systems model could thus be this integration between regulating processes stemming from the own system feedbacks, called "self-regulation" and regulating processes built upon the information coming from the other dyad's member, called "interactive regulation" (Figure 1), two movement of the same body that yet were mostly studied in separate fashions (Fogel, 1993a, b). While most of the concepts underlying these two mechanisms have already been point out, it is important to formally define them in order to clarify the terminology.

The term self-regulation is thus used to define the capacity of the partners to regulate their respective states. During the whole life of the person, this process manages the control of the activation levels, the upkeep of the state of vigilance and the ability to inhibit behavioural expressions. It includes the alterations to the quickness to react and in the external visibility of the internal states. In the infant, for instance, self-regulation controls how evident the needs for food, sleep, or caretaker proximity are from his behaviour. Examples of self-regulatory processes aimed to reduce the activation level can be touching oneself, looking away, and inhibit facial expressions. While in the infant this kind of regulation has to resort to physical processes, in the adult can take the form of unconscious processes such as fantasies, daydreaming, symbolic elaboration and,

generally, defence mechanisms, as well as conscious and active processes, such as humour, cognitive strategies, respiration control, etc.

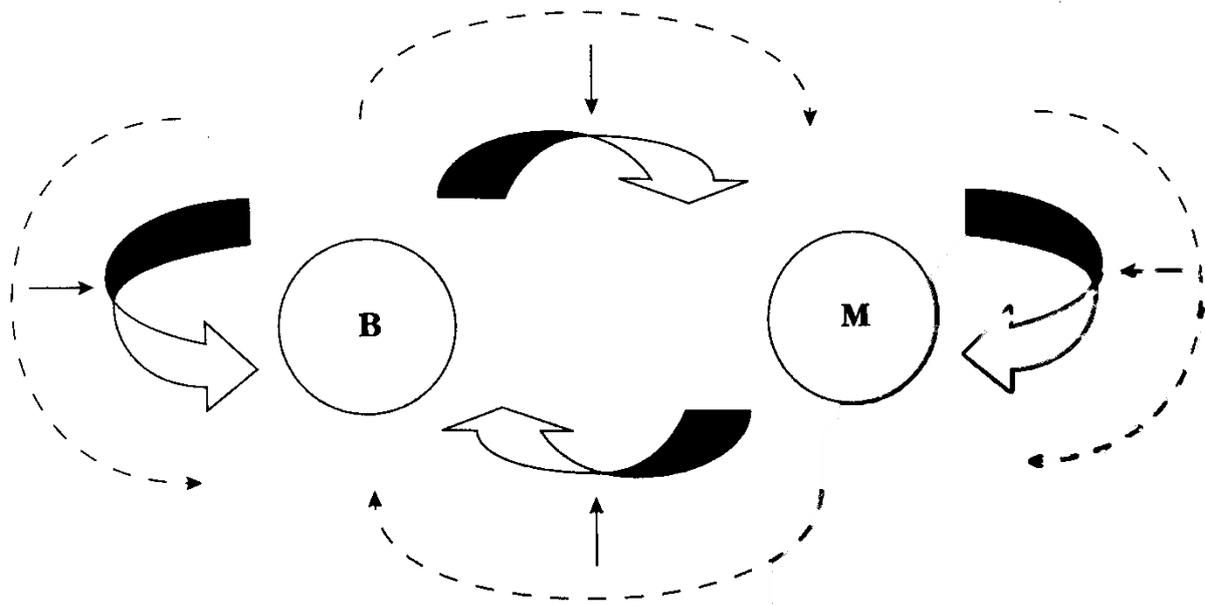


Figure 1. Dyadic systemic model of interaction (Adapted from Beebe & Lachmann, 2002).

Interactive regulation, instead defines the ways in which both partner in a dyad, begin a negotiation originating from each own needs and self-regulated components, through multi-modal forms of communication, verbal and non-verbal, conscious and unconscious. This negotiation is often organized by means of co-constructed interactional pattern, which may eventually become relational routines that increase the stability in the system. For instance in the mother-child dyad, such patterns can be about daily activities, such as the meal, or bathing, in which their exchange in connection to that task may follow guides or track in regard to the management of attention, sharing of affective states, interaction with physical objects, and so on.

In a dyadic regulatory process both members necessarily contribute to the interactive regulation, although not necessarily in equal parts and with different modalities, and through this communication dynamics they share an integrated package of action sequences and emotions that gets consolidated, stabilized (or even crystalized, although that's not a desirable outcome) as a factual dyad's subsystem which are called schemes of "being-with" by Stern (1995) or "frames" by Fogel (1993), and have the function of informing both dyad's members on the co-regulated and sensible actions to perform in order to achieve the most efficient or functional way (among those available to the dyad) to relate with the other, during the development of the task.

In other words, interactive regulation is a process of reciprocal adaptation that requires both members to create correspondences on spatial, temporal and motor dimensions, attuning (in Stern's acceptance) the individual subsystems and allowing the emergence of coherent unity.

Sander reports an example of interactive regulation from a frame-by-frame analysis of an interaction between a crying eight-days girl and his father, who is holding his daughter while talking with an interlocutor with which he had started a conversation. In few minutes, the child gets asleep. Based on the video analysis Sander reports: “it can be seen the father giving a brief look to the child’s face. Strange to say, in the very same frames, the girl looks the face of the father. Afterwards the left arm of the girl, which was resting on hers father left arm starts moving upwards. Frame by frame the hand of the child and that of hers father moves upwards in the same time. In the end, just when the two hands meet on the girl’s belly, her left hand grabs the pinkie of her father. In that moment the eyes of the infant close, and she gets asleep while the fathers keep talking, apparently unaware of the little miracle of time, space and motor specificity and coordination that happened in his arms.” (Sander, 2002, p.7)

Aside from theoretical needs it is impossible to really separate (and thus to find pure examples of) self-regulation and interactive regulation, as they are two sides of the same coin. In a dyad the exchanges are bi-directional, and each member has to monitor the other while he regulates his own internal states. This coordination of two systems gives rise, in an autopoietic way, to a higher level system that contains them and represent the dyad.

2.3.2 Expectations and development. The dyad system is thus built on mutual exchanges, which implies mutual adaptation, covering each interactional process between the two members as well as monitoring processes needed to trigger specific routines, such as the children nourishment. All these dynamics are open and intersected, and most relevantly, are repetitive. Repetition of states and events, with their corresponding recursive adaptive strategies, previously negotiated by the dyad’s members, generates expectations in the partners that Sander calls “interactive configurations recurrence models”, that prepare one member to the immediate and future other’s actions, giving to both a sense of meaning of what is going to happen.

This expectation are built upon a relation knowledge that, in the beginning (i.e. in the infant), is prevalently implicit (Lyons-Ruth, 1999) and dependent upon micro-variations in the spatio-temporal coordinates of the interactions. Trevarthen studied this dependence through an experiment (1979) in which mothers and their very young children were placed in two separate rooms. The couples could interact between audio and video monitors, and the experimenter could add some delay to the communication. Immediately when even a minimal lag was introduced in the transmission, the children reacted interrupting the exchange. The infant’s reliance on coordination is crucial for his self-regulation, the experiment clearly demonstrates how in this development stage the relational expectations are based on temporal cues. In adulthood these expectation may become more abstract in nature and gain more tolerance thanks to much more sophisticated self-regulatory

strategies, but they will not lose their fundamental role in building intersubjectivity, and by reflex, the self. This strong reliance on patterns is called “ongoing regulation” (Beebe & Lachmann, 2002). This basic principle is underpinned by strong biological predisposition: Haith’s research suggests that infants in the early months are able to detect and change behaviour according to perceived regularities in visual stimuli (Fagen, 1989); Gazzaniga and Ledoux (1978), among many others (e.g. Cormier, 1981, Hadley, 1989), found neurophysiological evidence that expectancy and repetition underlie the most powerful organizing principles of neural functioning.

The question of what happens when ongoing regulation fails leads to a second essential principle, that of disruptions and repairs. Disconfirmation of the expectancies from the other partner can be of different extent, spanning from small discrepancies that are quickly adapted, typical of successful interactions (or even purposely acted to avoid habituation in positive affects contexts such as play), up to major failures of the relational process, often leading to trauma, such as in case of abandonment or violence. Such a violation of ones expected pattern of behaviour is called a disruption (Beebe & Lachmann, 2002) and is associated with negative affect in children (DeCasper & Carstens, 1980; Weinberg & Tronick, 1998). Relational disruptions can subsequently be “repaired”, which means that through a conjunct effort by the two dyad’s partners, it is possible to restructure the expected pattern either by reconfirming its previous structure, or, crucially, by introducing a small novelty. A very stripped down example could be that of a child with the expectation (built on previous experience) that whenever he cries, the mother immediately comforts it; with the child growing older, the mother may feel less urgency in reacting to her child’s cry, or she might have some temporarily hindrance impeding her an immediate care. The first occurrence of a delayed intervention might prove a distressing disruption for the child, because not only it is not being comforted (or satisfied in whatever its need might be), but the novelty left it in an unpredictable environment. If, after a short while, the mother would come to care for the child, such relational “crisis” could be repaired: the infant’s new experience indeed is that its construction of the world has not collapsed, its physical survival was not endangered and its needs were ultimately fulfilled, even though the delay. The mother’s new experience is that even without an immediate reaction the child can still be comforted and cared. If such an interaction successfully repeats itself multiple times, the relationship will ultimately keep working, and most relevantly the reciprocal expectations can be updated to a more functional or efficient version, in this case, that of delayed caring, which concurs to a more sophisticated, developed, independent (or individualized) self.

The last fundamental organizing principle is that of “supercharged moments” (Beebe, 1973; Beebe & Lachmann, 2002). These are episodes characterized by a peculiar affective activation often in conjunction with an intense bodily activation such as a strong crying or an “open-mouth smile”. Pine (1981) considers that such supercharged moments have a crucial role in the psychical

organization, as well as in the organization of memories and of perception. Examples of supercharged moments are described by Pine as the “fusional” moments between mother and child, such as when they talk or vocalize at unison, or when the infant falls asleep on its mother’s chest, or, alternatively as those moments of intense negative activation lacking comfort and gratification. Supercharged moments plays an organizing role as they represent prototypical experiences. As affective apexes, these experiences can easily be categorized at the most extreme polarities of what is good or bad, what has to be sought and what to avoid. Furthermore, in regard to the systemic model, the strong magnitude of these experiences is most often than not one of those perturbations that overcomes the system stability, pushing toward a state transformation, just alike disruptions and reparations, early state transformations have the ability to radically alter previous expectations, or even to create strong new ones.

2.3.3 Dyadically expanded states of consciousness. Among the most interesting concept evolved from the dyad system models, is Tronick’s description of dyadically expanded states of consciousness, a theoretical hypothesis aimed to answer the question of why, and how, connectedness or intersubjectivity such a powerful force in adults’ and children’s everyday life. In an influential paper (Tronick, 1998) he presents that theory starting with a slightly alternative metaphor to describe the regulatory processes in comparison to Sander’s. The author develops an analogy between affective regulation and homeostatic processes; in the biological systems, homeostasis is the primary task of an organism. When an infant is not in homeostatic balance, by having a too low core body temperature, for instance, it must reinstate a normal homeostatic balance by using all its regulatory capacity. Tronick’s clear prose describes how this maintenance of homeostasis, in humans, is a dyadic collaborative process, in the infant’s temperature example, the adult is part of the infant’s homeostatic regulatory system: “of course, the infant is a bounded organism and obviously the adult is external to the infant’s (anatomical) boundaries. Nonetheless, the adult is part of the infant’s homeostatic regulatory system; as much a part as any internal regulatory process. What is meant by the idea that temperature regulation is a dyadic process? While Bernard⁴ did not see it, successful regulation of the core body temperature cannot be accomplished solely by the infant. While the infant has mechanisms to regulate temperature on her own by, for example, changing her posture and increasing her activity level, these processes will eventually fail depending on the surrounding conditions. But her temperature can also be regulated externally by her caretaker, for example by being held in ventral contact with the caretaker’s body. These processes, internal and external, are functionally equivalent processes for regulating the

⁴ Tronick refers to Claude Bernard, the eminent physiologist who originally developed the idea of homeostasis.

infant's temperature. The internal and external mechanisms form a single system made up of two component systems (i.e., infant and mother)—a dyadic system.”

Being the individual (and by reflex the species' as well) survival dependent on such a collaborative process, it is not surprising that all the levels and subsystems of the dyad, have evolved to communicate: “Internally generated adjustments are guided by central and peripheral nervous system mechanisms, which respond to signals from central and peripheral sites. Changes in the holding patterns of caretakers are guided by active (e.g., crying) and passive (e.g., color changes) signals from the infant. Thus the infant's physiological state is always in some part dyadically regulated with the caregiver an external component of the infant's regulatory system.”

The crucial logical passage of this reasoning is that for a socially distributed homeostatic regulation to work, it is necessary that, at a certain point, the other “comes to know” the individual internal state and unbalance. If for instance the mother of the “cold-infant” of the previous example would merely consider the child as irritable, or, again, in a situation where the child is self-regulating by avoiding the gaze or covering his face the mother would misinterpret it as a playful attitude, and increase the interaction, the homeostatic, as well as the emotional reparation will fail.

This relative increase in knowledge, which importantly does not have to be a symbolic abstract knowledge, but can also be procedural, constitutes then a necessary injection of information in the dyad's members systems. As previously stated, in system theory a human being is an open system, which continuously incorporates increasing amounts of information and organizes it and integrates it into more coherent states through self-organizing mechanisms. The necessity of including, and integrating into one's own system, information of the dyadic partner, information that has regulatory meaning, constitute factually an extension of the own state of consciousness.

The process is obviously more evident in development age, as the infant's nervous system still shows limited resources that constrain the complexity of state that the infant can self-generate. Through intersubjectivity, instead, he can expand his basic state through the representations that the manifestations of such state generates in the caretaker, which through both cognitive and emotional scaffolding (Bruner, 1975), can “expand the complexity and coherence of the infant's state of brain organization” (Tronick, 1998).

The emergent property of this mechanism is that of the generation of a gestalt that, through this two minds interaction, contains more components, organization, complexity and coherence than what would be possible by either the mother or the child endogenous states of consciousness alone. If we consider, although naively, the neural correlates of such a process, we may infer that in order to constitute a dyad, both member have to mutually map some of the elements of the other partner's state(s) of consciousness into their own (plastic!) brains. Tronick's answer to his paper's original question, thus, is that: “*at the moment when the dyadic system is created both partners experience*

an expansion of their own state of consciousness (brain organization). Their states' of consciousness become dyadic and expand to incorporate elements of consciousness of the other in a new and more coherent form. At this moment of forming a dyadic state of consciousness, and for the duration of its existence, there must be something akin to a powerful experience of fulfilment as one paradoxically becomes larger than oneself.

To rephrase Descartes, I interact, therefore I am.” (Tronick, 1998, p. 296).

2.4 Psychotherapy

According to many authors (e.g.: Mitchell, 2000; Beebe & Lachmann, 2002; Stern, 2004; Carli & Rodini, 2008), the most relevant contribution of infant research to psychoanalysis, is the discovery that, contrary to the previous conception that in psychotherapy, is possible to recapitulate previous stages or states of life, the fundamental processes regulating the nonverbal interaction, and the connected mechanism of regulation and development remain the same and active (although at varying degrees) through the whole life.

In other words, what has been said in regard to the prototypical dyad composed by the infant and the parent, is also valid for adult couples, such as those composed by two romantic partners or by a patient and a therapist. This latter context, psychotherapy, is of special interest for more than the simple reason that the clinical relationship is the object of the present work, indeed, while all the aforementioned mechanisms (homeostasis, mutual regulation, disruptions and repairs, etc.) are active in any adult dyad system, the clinical setting shares a crucial likeness with the first stages of life: its goal is the development.

Just like an evolving infant, a patient has to update previous (and in this case dysfunctional) behavioural patterns and expectations, and just as an evolving infant, he cannot achieve such goal alone. In these terms, psychotherapy is the process of co-construction of a new dyad system, in which, not through the chirurgical intervention of an almighty therapist, but through the patient's and the therapist intersubjective process, change starts to become possible.

Yet there are also some not-irrelevant differences between adults and infants. In contrast to the developmental stage, an adult (accordingly to his organization level, or kind of pathology) usually already has a very sophisticated and complex structure of self, characterized by many abstract concepts, introjected characters and generally much more mature defence styles. This has two major consequences, the most obvious one is that of reduced plasticity. Whereas the relatively simple *Weltanschauung* of an infant is much more fragile but also extremely flexible to change and open to resilience, the adults construction of self, others and society is usually much more sound

and refractory to modifications. In the last decades, neuroscience has discovered that the brain does not lose much plasticity through aging, as previously thought, but the way plasticity works, originates a trailing behaviour. The more a synaptic network is used, the stronger its connections becomes (see Cozolino, 2006 for details). It is easy to think, how a brain and a mind that relied for dozens of years on dysfunctional internal schemes, thus increasingly reinforcing those associations both psychically and somatically (and most probably also socially, although that dimension is not often described), will not respond as quickly to reparative interactions as would a three weeks old baby.

The second consequence is that while for the infant the fact that the great majority of consciousness states, expected patterns and regulatory process are procedural, somatic, sensorial and motoric is quite unproblematic, for the adult (and especially for an adult living in a modern society with high literacy rate and strong individualist focus, such as much of the “western” society), the identification with the psychoanalytical “secondary process”, or in other words an hypertrophic activity of the representational function (Kleinbub, 2008), creates a second layer of expectations, in which the whole relationality is projected on symbols and objects, governed by logical laws which are in conflict with the internal affects, that inconveniently keeps the individuals bounded to their physical substratum⁵.

Bypassing both these two limitations, psychotherapy manages to reactivate or to exploit the individual plasticity, and as state by Mitchell: “The analytical change starts in the modifications of the interpersonal field present between analyst and patient, when new relational patterns are co-created interactively and successively interiorized, generating in this way new experience both with others and in solitude.” (Mitchell, 2000, p. 86)

The ways in which change is originated in therapy are evidently one of the most crucial and debated topics. But following the outlined systemic model it is possible to isolate some promising hypothesis.

2.4.1 Crossmodal matchings. While development psychology such as Stern, Meltzoff, Habermas and Ryan, agree on the fact that early communication competence might be more fundamental than language itself, Trevarthen (1993, 1998) develops organically the concept. He claims that the linguistic forms of intersubjectivity are based on pre-linguistic forms and that intersubjectivity is initially preverbal and dialogical, with two major implications: on one hand this means that the therapeutic dyad is able to access communication modalities even when the

⁵ Note that the reflexive perception of the self as bounded to a physical entity is reported here dialectically as a common experience and dominant cultural dogma, definitely not as an epistemological statement. The relationship between body and mind that I endorse, and which is fully compatible with the systemic models and relational psychoanalysis, is that reported in the first chapter.

linguistic forms fails, and on the other hand, that as any linguistic form of intersubjectivity keeps relying on non-verbal and pre-verbal forms, every psychotherapy (even those with high-functioning patients) depends on those earlier communication skills.

One of the mechanisms that allows for such complex meanings and importance of relatively simple pre-symbolic processes is the human ability called “crossmodality”. Crossmodality is the process of instantaneously translating the information across different encodings that may be sensory-motor, cognitive or affective. This phenomenon is already present in the infant, who is able to “convert” the rhythmic flash of some lights in an acoustic rhythm (Lewkowicz, Turkewitz, 1980). In an experiment by Meltzoff and Borton (1979), some blindfolded children had to keep in the mouth a little rubber ball, either with or without small nubs on them. Afterwards, when the children removed the blindfold and could choose between both rubber balls, they tended to prefer the one they kept in the mouth. Necessarily the children were able to transform the tactile information from the tongue to a visuospatial information. This basic ability, somehow similar to synaesthesia, allows the individuals to abstract a single representation from many perceptive sources, both proprioceptive and from the environment.

Put in the relational context, crossmodal perception (Meltzoff, 1985) allows a matching between the internal state, the own behaviour and that of the partner. In the psychotherapeutic dyad, the crossmodal matchings allows the patient or the therapist to attune each own internal process and behaviour to that of the partner. It is likely that these matchings are created below the threshold of awareness and are susceptible of the many transferal influences of the dyad’s members.

Crossmodal matching has been observed in many aspects of the mother-infant interaction: facial expressions, vocal states, affective states, motor schemes, and more. All these components of interaction can be observed to be crossmodally translated and coordinated in the dyad. Trevarthen (1993, 1998), together with many other authors (e.g. Jaffe, Feldstein, 1970; Cappella, Planalp, 1981; Beebe et al., 1985; Warner, 1988; Cappella, 1990; Jaffe et al., 2001) considers that the key feature behind the matching between communicative expression is a rhythmic coordination initialized by reciprocal imitation.

Behavioural timing is the level of correspondence between the partners’ temporal schemes, and conveys fundamental interpersonal messages through factors such as rhythm, speed, pauses, reaction times, interruptions, turn taking, and so on. Plenty of research has observed how these aspects constitute a backbone of human interaction. For instance, in a series of experiments (Jaffe, Feldstein, 1970; Feldstein, Welkowitz, 1978; Feldstein, 1998), adult subjects talking about neutral subjects, showed spontaneous adaptation of the dialogue rhythms, independently from the discussed topics; furthermore dialogue rhythms were found to be associated with levels of empathy and reciprocal affects: when the rhythms were matching, the subjects declared to like each other more.

These data showed that, as in the children, small variation in the timing, such as small hesitations or pauses, could influence the relational experience. “In adult conversation we depend on the matching of temporal patterns to know that the other is «tuned in» and to take turns smoothly” (Beebe & Lachmann, 2002, p.99).

The process that leads from the temporal timings to the affective matching needs a more in-depth discussion, as it requires a certain amount of theoretical inference to link a traditionally psychodynamic perspective (i.e. how the self and the object are *lived*) to the more ethological one presented in these pages (i.e. what the relational partners *do*).

In the mother-child interaction it is assumed that, at least in the first six months of the infant’s life, its actions do correspond in large part to its experience, that is to say that its every emotion or state is manifest, and open for the mother to (eventually) correspond to it. Now the correspondence to a manifest behaviour, if matched, generates a certain degree of similar affective state in the partner. The research of Ekman (1983) and Zajonc (1985), later followed by many other experimental evidence, showed that the sole external and unconscious reproduction of the motor configuration of affective states was able to elicit them. The intersection of these knowledge and the observation of the fast paced mirroring, attuning, synchronizing, (etc.) processes in both adult-adult and adult-infant dyads, seems a plausible working model.

In other words, a big part of reciprocal comprehension works through non-verbal attunement with the other. In order to keep this attunement possible, just as musicians in an orchestra, neurons in a brain, or a huge amount of other biological systems, the exchanges are organized through rhythms. Through the direct connections between other’s and own behaviour, and between one own behaviour and affective state, it is possible to understand how, at least the most basic (although most pervasive) building block of intersubjectivity, affective sharing, can emerge from the interpersonal timing. Beebe and Lachmann call this a “crossmodal translation”: “*when we reproduce the spatiotemporal schemes of somebody else’s facial expression, we perceive in correspondence and activation of the autonomic nervous system on our face and in the whole body. In other words it happen a crossmodal transfer of an external image or an external temporal pattern to a proprioceptive internal experience.*” (Beebe & Lachmann, 2002 p. 102).

3. Dyadic synchronization

Given these theoretical premises, it appears evident how relevant is to study the conscious and unconscious micro-interactions, taking place during a sophisticated intersubjective context such as psychotherapy, and to investigate the kind of relationship intercurring between the two dyad's members, among which the most straightforward is synchronization. Synchronization answers to the question: "is the other doing the same as I am doing?", and such question can subsequently expanded vastly, for instance by asking who is leading this coordination process and who is pacing or following. Furthermore, the speed at which synchronization takes place can explain a lot of the mechanism though which synchronization happens, if it is a slow cognitively mediated process, or a fast automatic sensorimotor and/or affective reaction, and even more if it is a patterned process or just a reciprocal response to the interactive stimuli.

Many empirical researches have already collected quite convincing evidence in support of a strong bond between dyadic synchronization and rapport, and automatic mirroring of others' behaviour has taken many names in literature, spanning from "interpersonal physiology", "synchronization", "coupling", "entrainment", "coordination", "linkage", etc., and has been reported in many intersubjective phenomena such as prosodic and dialogic rhythms (Jaffe & Feldstein, 1970; Feldstein & Welkowitz, 1978; Feldstein, 1998; Jaffe et al., 2001), on various nonverbal behaviour (Bernieri, 1988; Gregory et al., 1993; Kelso, 1995, Ramsyer & Tschacher, 2011), on the coordination of facial expression in mothers and infants (Cohn, Tronick, 1988), on skin conductance synchronization (Marci, 2007; Kleinbub et al., 2012; Messina et al., 2013; Karvonen et al., 2016) and hearth beat (Dimascio, 1957).

For instance, in their greatly influential 1990 paper, Tickle-Degnen and Rosenthal, hypothesized that interpersonal phenomena such as attachment style development, physical attraction, relational satisfaction, are related to the degree of coordination in the relevant social interaction; an hypothesis that was later verified by a series of classical studies (Bernieri, 1988; Cappella, Palmer, 1990; Hall et al., 1995). For instance, in a 1983 paper, Harrigan, Jinni and Rosenthal, showed how the simple concordance of doctors' and patients' posture of the torso, the arms or the head, significantly improved the perceived general pleasantness as well as the score assigned from patients on a self-report scale assessing doctors' empathy. In another study, Erlich demonstrated how speaking in the mother language of the patient, or sharing his dialect, or other cultural or identity characteristics, (such as gender, ethnicity) proved to be a facilitating factor for the building of a satisfying rapport and therapeutic alliance, again boosting the perceived empathy, although these results could also be interpreted in the light of a more general ingroup-outgroup effect *outgroup* (Stürmer et al., 2006).

Miles, Nind e Macrae (2008) concluded as well that temporal coordination in behaviour (i.e. synchronization) is one of the foundations of an efficacious social exchange, noting how simultaneous actions increased the perception of rapport. The results of their study showed as well that this effect was associated not only to the degree but also to the stability of interpersonal coordination. In a later study (2009) the same authors demonstrated how a positive and stabile coordination, proved to enhance and promote a more efficacious remembering of the dialogic contributes of their interlocutors.

On a broader perspective, a vast body of literature has been published to demonstrate the association between coordination and improvement in social interactions, pleasantness, rapport, empathy, cooperation and prosocial behaviour, both when this coordination or imitation is intentional (Chartrand & Bargh, 1999; Lakin & Chartrand, 2003; van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009) and when it is implicit or automatic (Bernieri, 1988; Hove & Risen, 2009; LaFrance, 1979; Wiltermuth & Heath, 2009).

Unsurprisingly, such a pervasive and efficacious phenomenon has been known in the clinical settings since the first hypnotic experiments in the IX century, and is taught to many psychotherapy students as “staying with” the patients, widely included in “active listening” techniques, neurolinguistics programming, and many more. This attention to imitative behaviour has been conceptualized in various ways in clinical literature, such as “intersubjectivity” (Schore, 2003b), “mutual synchrony” (Schore, 2003b), "limbic resonance"(Lewis, Amini, & Lannon, 2000), or still “implicit relational knowledge” (Lyons- Ruth, 1998).

Finally, to further highlight the crucial role played by the concept of coordination in psychotherapy, there is strong evidence that an individual experience of dyadic resonance is able to influence the development of the attachment style in infants and to modulate that of adults (Beebe, 1998; Bugental, 2005; Schachner, Shaver & Mikulincer, 2005).

Yet, while the tradition of this research is long and well founded, a wide number of key questions have still not been answered. To begin with, it has not been studied what kind of individual characteristics promote the interpersonal synchronization, and if this attitude can be influenced, enhanced or even taught. The first research presented in this work will focus on these problems by observing how the manipulation of internal representations of safe attachment patterns influences the synchronization in dyads composed either by a trained psychotherapist or by a psychology student. Attachment style manipulation, also known as “security priming”, is a well-known procedure, which is supported by a large amount of evidence (Mikulincer & Shaver, 2010, 2015), effective in fostering prosocial behaviour, emotional care, stress reduction, self-esteem, and many other attachment-related phenomena. Since there is evidence for a possible link between interpersonal synchronization and attachment security, I hypothesized that successful security priming may lead to enhanced physiological linking. The possibility to modulate these beneficial and functional traits, which have proven to be so effective in improving therapeutic skills, may have important implications in crucial issues such as therapists and physicians training. While it may seem redundant to search for ways to improve clinicians relational skills, it is important to note that decline in medical students empathy is a broadly studied phenomenon with heavy repercussions on both patients and doctors health, with obvious economic implications and, in regard to psychotherapy, the present historical context sees a general fall in belief in psychotherapy (e.g. Johnsen & Friberg, 2015).

While these are relatively pragmatic concerns, there is a more fundamental research question still unanswered in interpersonal coordination literature. Specifically, the correlational effects of synchronization have been studied widely, on many psychological traits and relational outcomes, but the reasons underlying these correlations, have never been assessed.

The second research presented in this work assesses precisely that topic, by an extremely in-depth observation of therapeutic micro-processes in a single case psychotherapy. Verbal content, therapeutic processes, nonverbal behaviour and physiological linkage have been measured for each second of each of 16 sessions of a brief psychodynamic psychotherapy.

This unique and innovative approach to psychotherapy research merges the traditional domains of research on outcome and on process, allowing a rich and phenomenological analysis of

a psychotherapy, overlaying all the different semantic levels and putting the researcher in the privileged position of being able to observe their interaction, second after second.

3.1 Synchrony Measures

Since synchronized patterns of behaviour revealed to be such a good index of relational quality, it is not surprising that researchers have found a large number of methodologies to investigate this phenomenon. In synthesis, it is possible to organize them in three principal categories: coding of verbal and nonverbal behaviour by trained judges, automatic measurements of verbal and nonverbal behaviour and psychophysiological measures.

3.1.1 External judges' scorings. Measures in the first category, such as the Collaborative Interaction Scale (Colli & Lingardi, 2009), an assessment of relational ruptures, or Tronick's classical researches on infants facial expressions, are usually characterized by the highest explanatory power at the cost of many drawbacks. Firstly these procedures usually requires a great expense in terms of coding time and expertizing, furthermore they are usually based on strong theoretical foundations, which is a double edged knife, while being the reason of its explanatory strength, it also reduces the generalizability of the results. Also, these methods, employing categorical variables, usually have problems in determining the right resolutions, which can lead to an "atomization of behavioural units" (Grammer et al., 1998), or a sprouting of a too vast number of rarely appearing categories. The same is true in regard to temporal resolution, for instance Ramseyer and Tschacher (2006) has analysed through a time-series methodology data from self-report questionnaires obtained after each psychotherapy session, and yet preliminary results from another study (Schiepek, 2015) showed how administering the questionnaires each and every day, showed a completely different pattern of results. Finally, it can be very hard for human judges to find lagged synchronization phenomena, i.e. patterns of coordination that are not simultaneous, and judges are potential source of many cultural biases.

For these reasons, these kind of instruments are preferably used with small samples and in-depth designs, and preferably together with other more objective (and economical) measures.

3.1.2 Automatic assessment of nonverbal behaviour. Most of the limitations of measures relying on human evaluation can be overcome with automatic assessments. While these are obviously blind to the meaning of actions (aside from very limited and codified contexts) the technique based on algorithmic analysis of behavioural data, are fast, economical, and with

nowadays computational power, even very sophisticated processing is feasible on most personal computers.

The most interesting methodologies to automatically assess nonverbal behaviour are techniques derived from image differencing algorithms (Sonka et al., 1993; Bobick & Davis, 2001), differently called Motion Energy Image (MEI), or Motion Energy Analysis (MEA; Ramseyer Tschacher 2011). These methods are based on the concept that each frame of a digital video in greyscale is an image with a constant number of pixels that constitutes a numerical matrix of bytes, each storing an integer number ranging from a value of zero to represent black, up to a value of 255 to represent white. In its most basic implementation, the technique operates a mathematical byte by byte subtraction of each subsequent frame's matrix. This way, if two subsequent frames are identical, the differentiation will result to a value of zero in each cell of the matrix. If instead the two frames have even the slightest difference, for instance a blink of an eye of a person, the matrix subtraction will not only provide numbers representing the amount of movement, but since each value in the matrix represents a real pixel of the video, the position of the non-zero value also describe the location in the video where the movement took place. This convenient relationship between amount of movement and position of movement, allows the researchers to define different region of interest (ROI), that can be used to analyse only specific areas of the video (such as subjects head, for instance), or to split and perform separate analysis for different areas of the image (e.g. to compare a patient and a therapist videorecorded with a single camera), resulting in a very efficient, flexible and elegant analytic methodology. Figure 1 shows a practical example of MEA application on a psychotherapy video.

Minor drawbacks implied in MEA, are the need for a constant illumination source, and an intrinsic tendency to overestimate movement of ROI containing high contrasts elements (such as checkerboard patterns), whereas in very low contrast elements, only the movement of the object's external border can be mapped.

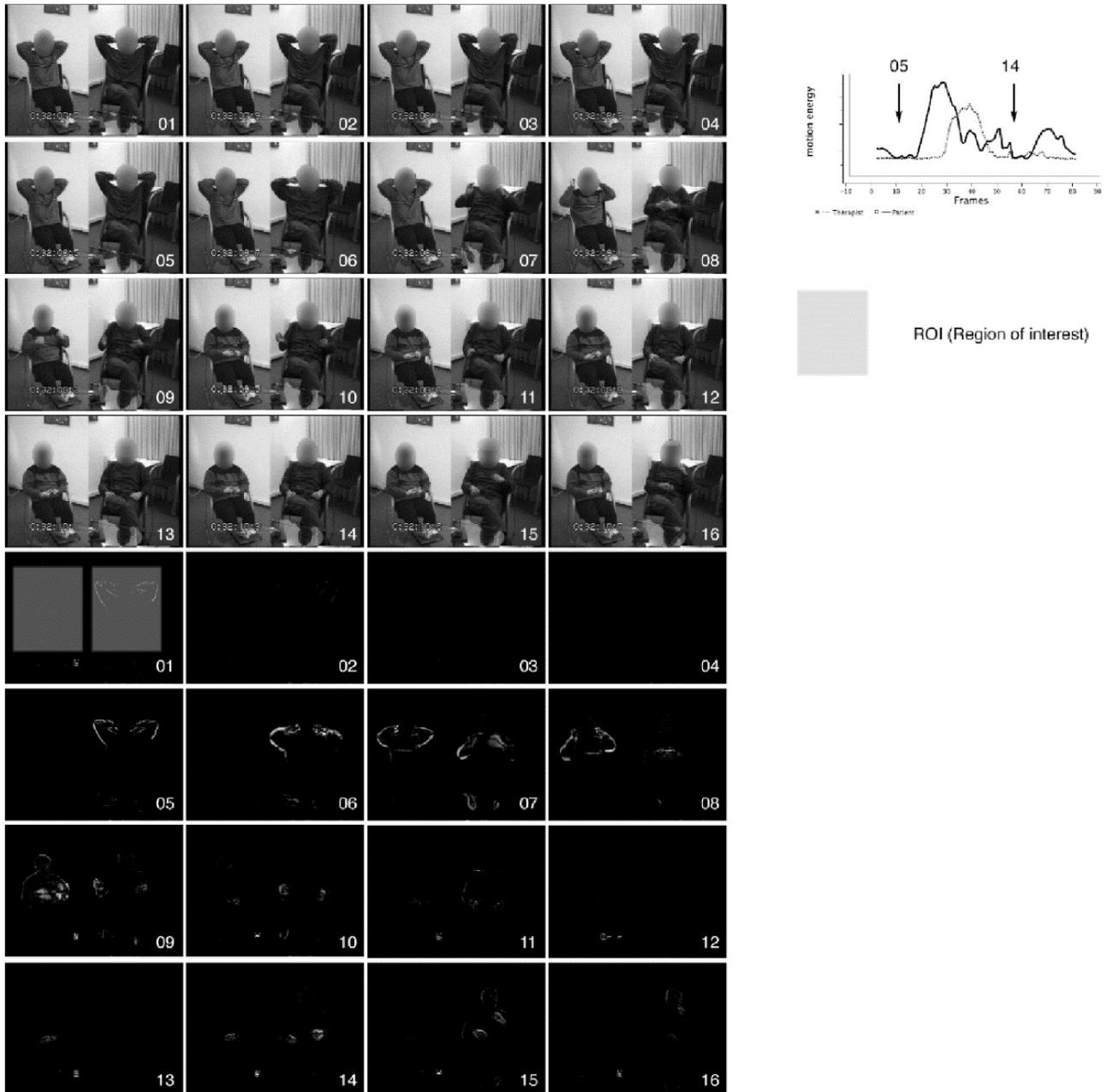


Figure 1. Motion Energy Analysis of 16 frames of a psychotherapy. The uppermost half of this picture shows the actual video images, while the second half shows MEA results overlaid to the very same frames. In the first MEA frame, the two considered region of interests are highlighted, in frame 5 the participant on the right starts a movement (white pixels), which is mirrored by the participant on the left almost immediately in frame 7 (accounting for a 200 ms lag)

Recently, new techniques based on innovative technologies are being tested in order to provide richer data. For instance motion capture techniques, developed from cinematographic special effects (figure 2), uses specific tracking devices (such as adhesive white dots) placed on real actors to extrapolate tridimensional movement from a simple video recording with an extremely

high degree of precision. While motion capture has the advantage of such an extremely high 3D spatial resolution, which may be great to study very precise facial micro-expressions, or subtle variations in wider movements, the need for physical markers on the subject reduces its employability in naturalistic contexts, such as psychotherapy. Still the use of motion capture in psychology is still in its infancy, and directed toward the increasingly advanced marker-less methodologies (figure 3), this time evolving from video-gaming hardware such as Microsoft Kinect (e.g. Girges, Spencer, O'Brien, 2015)



Figure 2. Motion capture technology developed from the need to use real acting to realistically animate digital characters. In panel A, a human actor is performing, the white dots on his head and body are markers used to extrapolate his tridimensional movement. In panel B the computed movements are assigned to a digital character.

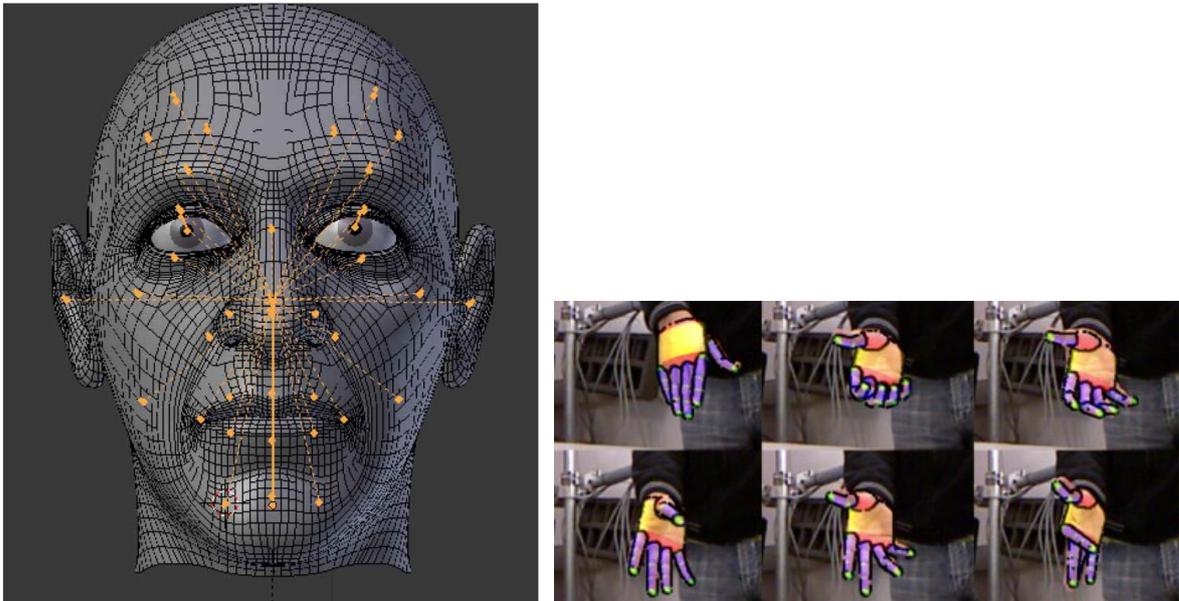


Figure 3. Advancement in computer vision technologies are trying to use only the human body characteristic features (eyes, mouth, phalanges etc.) as the only needed markers to track movement.

3.1.3 Automatic assessment of verbal behaviour. Just as video can be analysed for movement, the audio recordings can be thoroughly analysed, and the kind of data that can be extrapolated from it is even richer of information than video. Indeed, under the verbal behaviour label there are a lot of different phenomena. While automatized verbal content analysis (that is, speech-to-text, technology) is not still sufficiently reliable and available in every language, many physical and rhythmic properties of the voice can provide interesting data. Changes of pitch in the voice for instance have been found to be correlated to emotional states, such as distress and anxiety. Evidence has shown how specific lower dominant frequencies in the voice are able to calm while other may increase alertness and reduce attentional span.

As interesting as these phenomena are, they are also very specific for each individual; for the sake of synchronization analysis, the most relevant verbal property is the prosodic rhythm of dialogue. It is well known that conversational partners tend to coordinate their speech behaviours (Bernieri & Rosenthal, 1991). For example, over the course of an interaction interlocutors become more similar in the lengths of speaking turns and total speaking time (Cappella & Panalp, 1981; Street, 1984), adopt each other's accents (Giles, Coupland, & Coupland, 1991), and produce similar syntactic structures (Branigan et al., 2000). These forms of synchrony and coordination in language serve numerous purposes, including signalling active interest and involvement, enhancing rapport, and facilitating rapid processing and comprehension of language (Cappella & Panalp, 1981; Garrod & Pickering, 2009; Giles et al., 1991). Conversational synchrony is an important communicative process that facilitates development of social bonds.

Surprisingly, at the best of my knowledge, the most advanced technology ever used to assess dialogic coordination, the Automatic Vocal Transaction Analyzer (AVTA), was developed in the sixties (Cassotta, Feldstein, & Jaffe, 1964) and used in only a few studies, while most of recent research still employs by-hand scoring of the very same variables (e.g. Gordon, Tranel, & Duff, 2014) a process requiring great expenses in time and reduced precision.

AVTA was originally an analogue piece of hardware consisting in an electronic device of audio analysis and an IBM punched card writer, but its logic is based on a very simple algorithm.

The vocal behaviour of each member of a relational dyad is recorded on a different time-locked track, through the use of different microphones. The audio signal undergoes many filtering processes that are ultimately aimed to convert each audio data point of each participant to a value of 1 if there is speech, or 0 if there is silence. The original AVTA system was working with up to 10 punches per second, a sufficient sampling for human vocal behaviour, which have a minimum duration of about 250 ms.

From this level of abstraction it is possible to analyse most prosodic states and interactions, such as utterance durations, pauses duration, turns duration, interruptions and so on (figure 4).

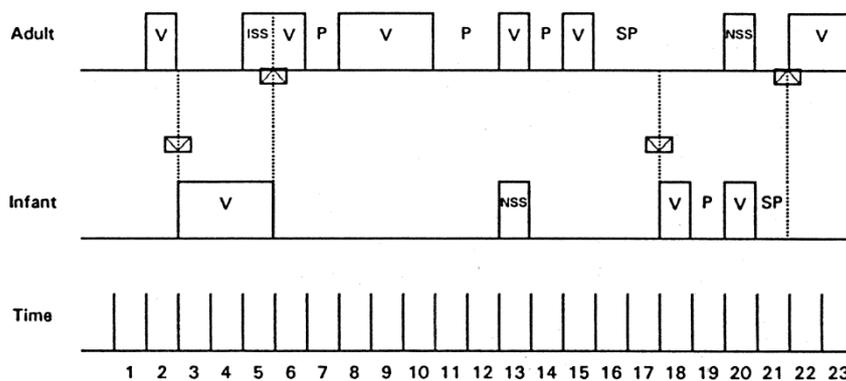


Figure 4. A graphical representation of AVTA output of 23 seconds of mother-infant interaction. The three rows represent respectively the mother’s and child’s vocal states, and the common timeline. V= vocalization; P = pause; SP = simultaneous pause; ISS= interrupting simultaneous speech; NSS = non-interrupting simultaneous speech. The dotted lines and arrows describe the turns dynamic.

These measures of verbal rhythms have been associated to various psychological characteristics, for instance the ratio between utterances and pauses in one persons’ discourse has been found to be a marker of a relative arousal or inhibition (Feldstein, Crown, Jaffe, 1991). This index , a traditional verbal fluency indicator, is also associated to measures of introversion and extroversion of personality (Feldstein, 1998), while instead the convergence of interlocutors’

average utterance and pauses durations, has been found predictive of higher rapport (Winfree, 1975).

Jaffe and colleagues (2001), in an important monography, successfully used AVTA system to automatically code the amount of vocal rhythm coordination between 4-months infants and their mothers. Their most relevant result is that the amount of coordination was able to predict the development of attachment style and cognitive performance in the same children at 12-months.

3.1.4 Psychophysiological measures. Another important methodological chapter in the assessment of synchronic behaviour is that of physiological indexes. Psychophysiology has a long history of providing insights into psychological research, and already Jung, in regard to skin conductance measurements, defined it “a magnifying glass for the unconscious”.

The study of shared psychophysiological activation in psychotherapy has begun in the second half of the XX century (Glucksman, 1981), and among the many different indexes, the most used are skin conductance, skin temperature, cardiovascular activity, respiratory rhythms, muscular tension, and electroencephalography.

Psychophysiological measures shares the advantages with other automatic measures of behaviour, and while they usually are somewhat more intrusive than audio & video recording, due to the need of electrodes and/or other sensors on the participants' body, they usually provide much stronger links between the measure and the psychological states.

Taking advantage of direct or indirect measures of both the central and the autonomic nervous system this family of measures can assess a wide range of emotional and cognitive processes. Furthermore, a large amount of research used psychophysiological assessments to investigate psychopathology (Keller, Hicks, & Miller, 2000). Two relevant and consistent results in this vein are depression and anxiety disorders. Depressed patients showed consistent changes in skin conductance level, such as reduced average tone, reduced stimulus response in both frequency and amplitude, in comparison to non-depressed patients (Iacono et al., 1983; Thorell, Kjellman, & D'Elia, 1987; Ward, Doerr, & Storrie, 1983).

On the side of anxiety, there is sound evidence of the fact that anxious patients have a higher arousal baseline of their autonomic systems, manifested as higher levels of skin conductance, more frequent spontaneous fluctuations, and higher stimulus response amplitude (Ashcroft, Guimaraes, Wang, & Deakin, 1991).

A paper reported that the number of spontaneous fluctuation in skin conductance was found to be associated with higher scores on the Hamilton Anxiety Scale (Pitman et al., 1987). In another study on a phobic patient's psychotherapy, the authors, measured higher skin conductance levels in

time periods characterized by higher self reported anxiety, reduced perception of symptoms control and generally negative affects (Glucksman, Quinlan, & Leigh, 1985).

While many of these studies did not directly assessed synchronic physiology, most of the results regarding empathy and rapport always noticed and reported levels of coordination and “reciprocal reactivity” during psychotherapy (Lacey, 1959). A restricted few study instead directly searched for synchronic phenomena. In 1960, for instance, Kaplan and Bloom found in three psychotherapeutic dyads measured during many sessions, that patients’ and therapists’ hearth beat rate varied often together. They discussed their results in term of an “empathic linking”, and opened the way for further replications which also found the convergence of other emotional processes in the clinical dyad (Busk et al., 1976; Stanek et al., 1973)

After a peak of interest in interpersonal synchronization in the Seventies and Eighties, the research in this field faded until the beginning of the new century, when the availability of more economical and practical polygraphs together with the exponential increase of computational power, allowed for a resurgence of this kind of designs.

One study in particular, by Marci and colleagues (2007) was particularly inspiring for my research. They measured the skin conductance (SC) levels in 20 unique psychotherapy dyads, composed by patient and therapist, during a whole session of an advanced phase of therapy (at least 20 sessions). The collected data was subsequently analysed through a temporal-series moving window cross correlation analysis to obtain a synchronization index. Furthermore, patients compiled the empathic comprehension subscale of the Barrett-Lennard Relationship Inventory, and the transcripts of the sessions were analysed through the Bales Interaction Coding System, by two trained referees.

The results showed that patient and therapists had a notable amount of synchrony that was correlated with the perceived empathy levels. Furthermore, the content analysis indicated that the moments of higher synchronization were generally characterized by more positive affects.

While this study provided extremely interesting and promising results, the choice of a cross-sectional design focused on an advanced moment in the therapeutic process left many questions opens. For this reason in my master thesis I conducted a replication of Marci’s team study, (Kleinbub, 2011; Kleinbub et al., 2012; Messina et al., 2013) on simulations of an hypothetical first psychotherapy session.

Furthermore, we analysed the different synchronization performance of three group of pseudo-clinicians: each pseudo-patient underwent a 20 minutes interview with three different people, a real psychotherapist, a junior psychologist, and an engineer or a member of other professions not involved with interpersonal caring. For each interview, pseudo-patients received a suggestion on an emotional topic they could talk about. The order of the different roles interviews

and the suggested topics were randomized. We recruited 13 pseudo-patients and 39 pseudo-clinicians for a total sample of 39 dyadic interviews.

In addition to Marci analytic procedure, we performed as well a lag-analysis of the synchronization, to investigate whether the clinicians were leading or pacing the coordination process. While we could not directly replicate Marci's lag-0 correlational result between synchrony index and perceived empathy, lag analysis showed that in our sample this relationship was present ($r=0.32$) considering 3 seconds lag. Most notably there was a strong association between lag and synchronization, which differentiated among clinician roles (Figure 5).

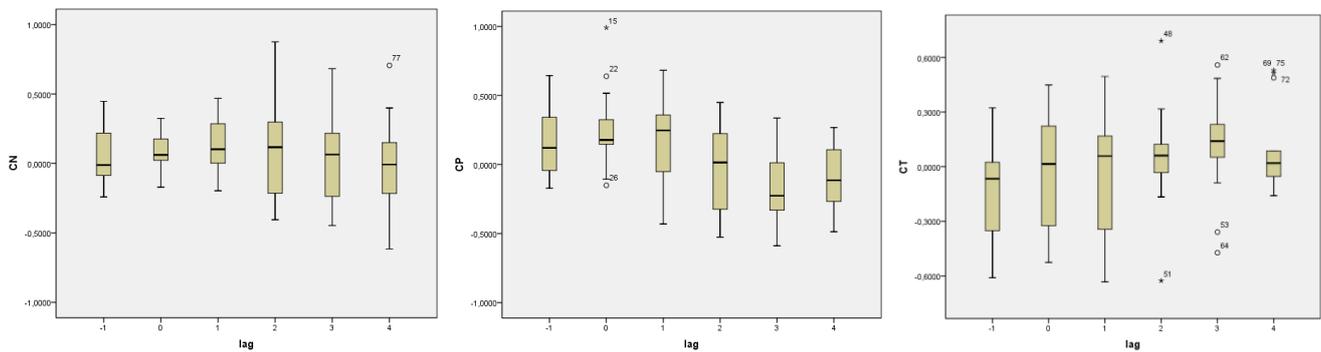


Figure 5. The three boxplot shows the synchronization amount at different lag values (-1, 0, 1, 2, 3, 4), respectively for engineers, psychologists and therapists. Engineers showed no relevant trend ($r=-0.05$), while the other two groups showed a negative ($r= -0.45$ for psychologists) and positive ($r=0.26$ for therapists) association between lag and synchrony.

4. Manipulating Synchronization

STUDY 1

As anticipated in the previous chapters, literature provided many results on interpersonal synchronization, and specifically it reported some evidence for skin conductance synchronization in psychotherapy or pseudo-psychotherapy settings. Yet no research had already answered some of the crucial questions stemming from this interesting phenomena, such as if this behaviour can be enhanced, by training or by priming, and what kind of relationship was present between synchronizing behaviour and other relational variables, such as alliance, empathy and other individual and interactional traits.

To answer this questions the present study attempts a replication of the previous one (Kleinbub et al., 2012; Messina et al., 2013) by introducing some new exploratory experimental manipulations, such as an attachment priming, and new questionnaires.

Furthermore, in order to focus on the current hypothesis the original design was simplified by comparing only psychotherapists involved in simulation dyads. The confirmatory research hypotheses were:

1. that a safe attachment priming could activate an internal representation of caring, thus enhancing the social predisposition, and finally the amount of synchronization
2. To replicate previous results in regard to the correlation between synchronization in SC and perceived empathy

Finally, many of the collected variables were aimed to an exploration of other research questions that can broadly be encompassed in:

- Does any peculiar combinations of attachment style, gender and other individual characteristics has an effect on synchrony regulation?

4.1 Participants and Procedure

To answer my research questions I organized 18 pseudo-clinical dyads composed by two participants each of one of two groups: 18 psychotherapist (THER) and 18 volunteering students participating as pseudo-patients (PAT). Gender matching in each dyad was pseudo-randomized.

The clinicians' group consisted of psychotherapist students (14 females, 4 males, mean age = 29.11, SD = 3.23), in their last year of training in a psychodynamic psychotherapy oriented to Transactional Analysis. Inclusion criteria to the THER group was having already conducted at least one therapy.

Finally participants of the PAT group were undergraduate university students (7 females, 11 males, mean age = 21.34, SD = 1.41) which participated as volunteers. Inclusion criteria for students were the lack of ongoing pharmacological medication of any kind, in order to avoid interference with the skin conductance measure, and the absence of previous or actual psychiatric conditions.

The procedure followed closely the design of previous research: each dyad underwent a 20 minutes simulation of a clinical interview, in which psychophysiological measures were continuously recorded.

One week before the experimental session (T0), both THER and PAT participants of each dyad were interviewed separately to confirm inclusion criteria and to collect baseline measures. In this context, participants were informed on the scope of the research, and after they expressed their participation consent, verbally and in written form, an appointment was taken for the experimental session. Additionally, during the interview, participants underwent an assessment of trait characteristics, such as attachment style, anxiety and avoidance. The full list of measures is reported in table 1.

At the experimental session date (T1), both the participants of each dyad, psychotherapist and pseudo-patient, were asked to wash their hands with water and soap. While soap does interfere with skin conductance measurement, that was the only way to even out each participant's skin conditions, and is a standard procedure (Blascovich, Vanman, Mendes, & Dickerson, 2011).

Afterward the two dyad's members had to read their instructions, which were dependent on their role. Specifically the THER group instructions stated to listen carefully to their interlocutor, and to freely interact, trying to get into his/her shoes and to understand he/she, and to put effort into building a good relationship.

Furthermore, the psychotherapists were asked to not reveal their professional status, in order to avoid as much as possible expectation biases in the PAT group members.

After having read the instructions, the therapist had to read a priming text. Half of the therapists were assigned to the SECURE group, and had to read a short story concerning memories of safe holding, and good relationship with the mother, aimed to activate internalized schemes of safe attachment. The other half of the therapists, instead, had to read another text, similar in length and sentence complexity, regarding a neutral episode of the same narrator during a holiday.

The pseudo-patients' instructions, instead, asked to share an episode or a situation, either actual or from a near past, connoted by emotional relevance, and which was or still is source of distress or discomfort. As also stated in the informed consent, all the information collected this way would have maintained confidential.

After this introduction, the two participants of each dyad were allowed to meet and to have a brief informal presentation; the experimenter proceeded then to set up the audio, video and physiologic measures. With all the settings ready, the experimenter left the room instructing the participants to begin the interview.

After 20 minutes, the experimenter knocked on the door before entering again to stop the recordings. In case that the interview was still in a crucial phase, some more minutes were allowed to the dyad to conclude the interaction, and removed from analysis afterwards.

After the session, PAT and THER participants had to fill some questionnaires to evaluate the quality of the interaction. This assessment was done in separate rooms to reduce compliance biases.

4.2 Measures

Following previous literature and this study's specific hypotheses, a wide range of instruments were employed to both directly assess the specific research questions and to provide exploratory information to deepen eventual peculiarities in the collected data.

4.2.1 Skin conductance level (SC). SC was continuously and simultaneously collected from both participants of each dyad through the BIOPAC MP-150 System, by using BIOPAC BioNomadix wireless amplifier (figure 1) and disposable electrodes predisposed with electrolyte gel attached to the distal phalange of the index and medium finger of the non-dominant hand, in compliance with classic SC guidelines (Cacioppo, Tassinari & Bernston, 2007)



Figure 1. The BioNomadix wireless amplifier used to record SC levels in participants.

Skin conductance data was collected with a sampling rate of 1 KHz, filtered with a 5 Hz low-pass filter to remove electric noise and motion artefacts. The SC signals were individually monitored for remaining artefacts, and deteriorated parts of the recording were either filtered (where possible) or flattened out. This strategy was chosen to preserve the time locking between the two participants' tracks, as well as audio and video recordings.

Finally, the data were downsampled to 100 Hz to proceed to further analysis.

4.2.2 The Relationships Questionnaire (RQ). The RQ was developed by Bartholomew and published by Bartholomew and Horowitz (1991). This self-report instrument is designed to assess adult attachment within Bartholomew's (1990) four-category framework. Styles A and B correspond to the secure and fearful-avoidant attachment patterns, respectively. Styles C and D correspond to the preoccupied and dismissing-avoidant attachment patterns respectively. As shown by Brennan, Shaver, and Tobey (1991), Styles A, B, and C correspond respectively to Hazan and Shaver's (1987, 1990) Secure, Avoidant, and Anxious/Ambivalent styles. Bartholomew's measure adds the dismissing-avoidant category and places the four categories into a two-dimensional model.

4.2.3 Experiences in Close Relationships (ECR). The ECR is a 36-item self-report attachment measure developed by Brennan et al. (1998). The items were derived from a factor analysis of most of the existing self-report measures of adult romantic attachment. The measure can be used to create two subscales, Avoidance (or Discomfort with Closeness and Discomfort Depending on Others) and Anxiety (or Fear of Rejection and Abandonment). Brennan et al. derived four type or style categories from the two dimensions, and the categories predicted certain construct validity variables better than the RQ.

4.2.4 The Interpersonal Reactivity Index (IRI). The IRI, developed by Davis (1980, 1983) is one of the most broadly used measures of empathy. The instrument, focusing on dispositional empathy builds on the notion that empathy consists of a set of separate but related constructs. The instrument contains four seven-item subscales, each assessing a separate facet of empathy. The perspective taking (PT) scale measures the reported tendency to spontaneously adopt the psychological point of view of others in everyday life ("I sometimes try to understand my friends better by imagining how things look from their perspective"). The empathic concern (EC) scale assesses the tendency to experience feelings of sympathy and compassion for unfortunate others ("I often have tender, concerned feelings for people less fortunate than me"). The personal distress (PD) scale taps the tendency to experience distress and discomfort in response to extreme distress in others ("Being in a tense emotional situation scares me"). The fantasy (FS) scale measures the tendency to imaginatively transpose oneself into fictional situations ("When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me").

4.2.5 Barrett-Lennard Relationship Inventory - Empathic Understanding subscale (EUS) Developed by Barrett-Lennard in 1986, in the context of a broader measure to assess relational quality in a clinical context, the EUS was originally made up of two parts: the "Myself-toward-the-Other" (EUS-MO) part, aiming to evaluate the empathy that the listener (therapist, psychologist, non-therapist) thinks he/she has conveyed to the other member of the dyad (e.g., "I want to understand how He/She sees things"); and the second part, the "Other-toward-Self" (EUS-OS) part, aiming to evaluate the empathy perceived by the patient (e.g., "He/She wants to understand how I see things"). Each part of the EUS is composed of 16 items with possible scores ranging from +3 ("strongly agree") to -3 ("strongly disagree"), with no zero option. The total score can range between -48 and +48, with higher score indicating higher perceived empathic understanding. Since previous research has shown that self-perceived empathy in psychotherapists is usually overestimated and not strongly associated with patients' own perception, we only used the EUS-OS part of the instrument.

4.2.6 The Inclusion of Other in the Self scale (IOS). The Inclusion of Other in the Self scale was originally designed by Dr. Art Aron and colleagues (Aron, Aron, & Smollan, 1992) as a measure of self-other inclusion and relationship closeness. It consists of seven graphical configurations of two circles, representing the self and the other (Figure 2).

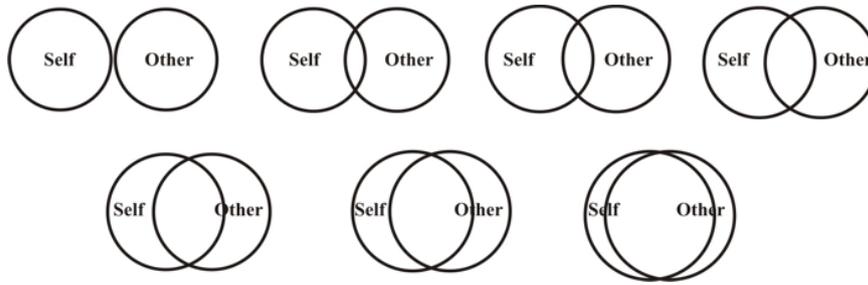


Figure 2. The Inclusion of Other in the Self scale items

4.2.7 Mental Representation of Caregiving Scale (MRC). Developed by Reizer and Mikulincer (2007), the MRC taps three major dimensions of individual differences in caregiving representations: working models of the self as a caregiver, working models of needy others, and motives for helping. Factor analysis validated this theoretical structure of the MRC and revealed five main factors that can be organized around the three major theoretical dimensions of caregiving representations. Two factors deal with working models of the self as a caregiver – perceived ability to recognize others’ needs and perceived ability to provide effective help to needy others. One factor deals with working models of others – appraisal of needy others as worthy of help. Finally, two factors deal with motives for helping – altruistic motives, egoistic (self-focused) motives. These factors were found to be highly reliable and showed theoretically-coherent associations with other caregiving-related constructs.

4.2.8 Counselor Rating Form – Short version (CRF-S). Developed by Corrigan and Schmidt (1983), the CRF-S, is a 12 items scale used to assess the qualities of a counsellor or therapists, as perceived by the client or patient. The CRF-S, extensively used in a vast amount of literature, assesses 3 major dimensions: expertness, trustworthiness, and attractiveness.

As mirroring and synchronizing behaviour has been reported in literature also as phenomena connected to physical attraction and sexual arousal, the CRF-S may discriminate if these processes are the main cause for the observed synchronization.

4.2.9 The Revised Helping Alliance Questionnaire (HAQ-II). The HAQ-II is a widely used 19-item questionnaire that measures the strength of the patient-therapist therapeutic alliance on two factors: “positive therapeutic alliance” and “negative therapeutic alliance”.

4.2.10 The State-Trait Anxiety Inventory (STAI). STAI is a commonly used measure of trait and state anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Form Y, its most popular version, has 20 items for assessing trait anxiety and 20 for state anxiety. In this research

only the trait anxiety. Trait anxiety items include: “I worry too much over something that really doesn’t matter” and “I am content; I am a steady person.” All items are rated on a 4-point scale (e.g., from “Almost Never” to “Almost Always”). Higher scores indicate greater anxiety.

4.3 Statistical Analysis

4.3.1 Synchronization index (SYNC1). In accordance with a procedure validated by Marci and colleagues (Marci & Orr, 2006; Marci et al., 2007), SC data was furthermore filtered with a 1.5 seconds window, moving average filter. Physiological concordance was estimated using the average slope of the EDA levels within 5-second mobile windows with 1-second increments. I.e. the average slope for the first 5 seconds was determined, then the window was moved forward 1 second and the average slope for the subsequent 5 seconds was calculated. To measure the concordance, Pearson’s correlations of the average slopes of the two components of each dyad were performed using 15-second windows. A total score of the entire session was obtained through the calculation of the ratio between the sum of the positive correlations across the session and the sum of the absolute value of negative correlations across the session. Due to the skewness of the ratios, a natural logarithmic transformation was applied to the result, obtaining a whole session index (SYNC1) ranging from +1 to -1. An index value of zero corresponds to an equal weight of positive and negative correlations in the session, a value greater than zero reflects the predominance of positive correlations, and thus the presence of a physiological concordance, and a value lower than zero corresponds to the predominance of negative correlations. This procedure was repeated for several 1-second interval temporal lag values, ranging from 0 to 5 seconds in both directions.

4.3.2 Permutation t-test. To test the first hypothesis a two-sample permutation t-test was performed between the two groups composed by dyads which THER received a security priming or a neutral text. Permutation t-test are a more robust test when the data distributions are not normal. This analysis was performed through the R’s flip package v.2.4.3 (Finos et al., 2014) set with 1000 permutations.

4.3.3 Kendall rank correlation coefficient. Given the relatively small sample size, the correlations between synchrony indexes and questionnaires were computed through the Kendall tau, an association measure not relying on any assumption on the data distribution. Kendall tau has been described by different authors as having some advantages over the more often used Spearman’s Rho (Kendall & Gibbons, 1990; Gilpin, 1993)

4.3.5 Linear regression models. To further explore the data, linear regression models were performed and compared to assess the influence of other variables, such as gender matching, attractiveness, and clinician’s anxiety levels. Since the data points are relatively scarce to properly test such complex hypotheses, these analyses were performed only as an exploration.

4.4 Results

Prior to any further analysis, visual inspection of raw SC data revealed that in two dyads, at least one of the participants had too strong motion artefacts (or otherwise deteriorated signal) to reliably use the data. These whole dyads’ data were removed from further analyses.

4.4.1 Synchrony over chance. A first preliminary analysis was aimed to assess if synchrony was present in the observed dyads, and if such synchrony was significantly different from chance. To answer this question the SYNC1 index was computed for shuffled dyads, i.e. by pairing the signal of one participant with that of another one, different from his/her real partner. To assess if SECURE primed dyads and NEUTRAL primed dyads individual data came from the same distribution, the permutations from the whole group of participants were compared with the permutations of only the SECURE and NEUTRAL groups (figure 3).

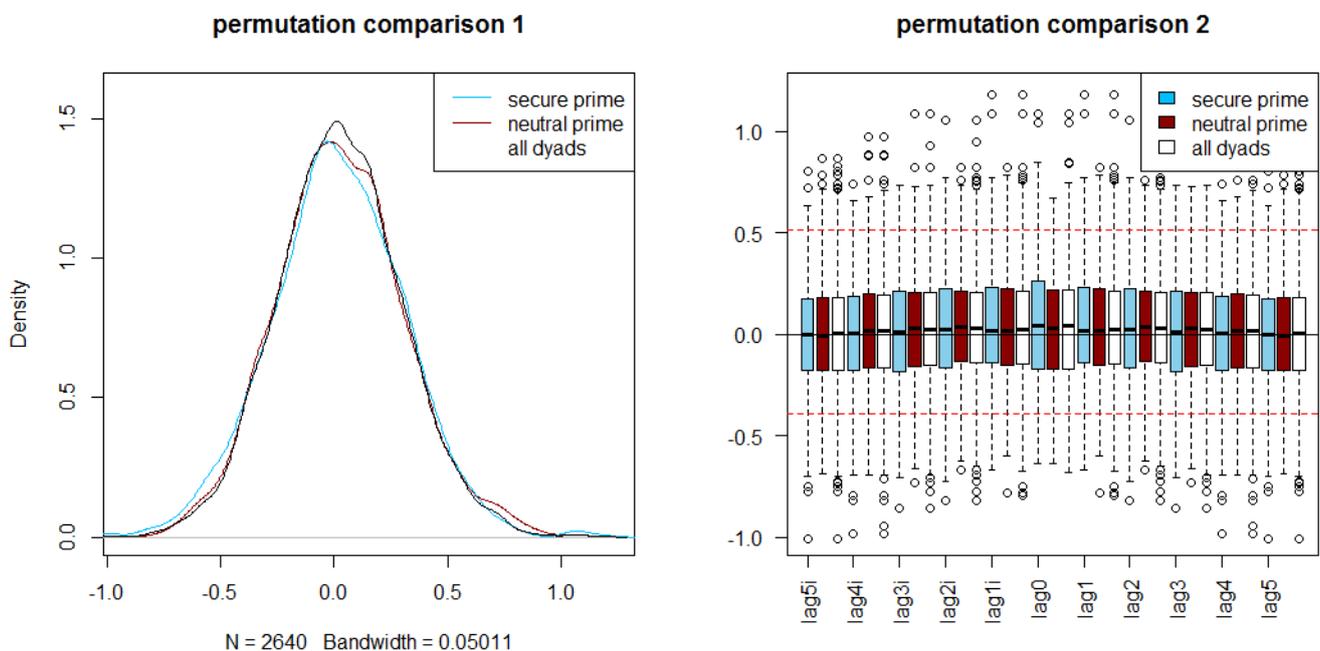


Figure 3. Permutation analysis obtained by reshuffling dyads either within the SECURE and NEUTRAL priming groups, or by considering both group as a single population showed no difference in the synchronization levels.

Since the three distributions were sufficiently similar, it was safe to conclude that if there was a difference in the SECURE and CONTROL conditions' synchrony, it did not depend from uncontrolled individual characteristics. Thus it was also safe to use all the 992 possible permutations without repetition to assess a distribution of random synchrony. The obtained random distribution was approximately normal, with mean = 0.052 and SD = 0.28. On this distribution, 5% confidence intervals were calculated as an interval of "chance synchrony".

4.4.2 Lag analysis. Next, SYNC1 for the 16 real dyads were computed. Results are showed in figure 4.

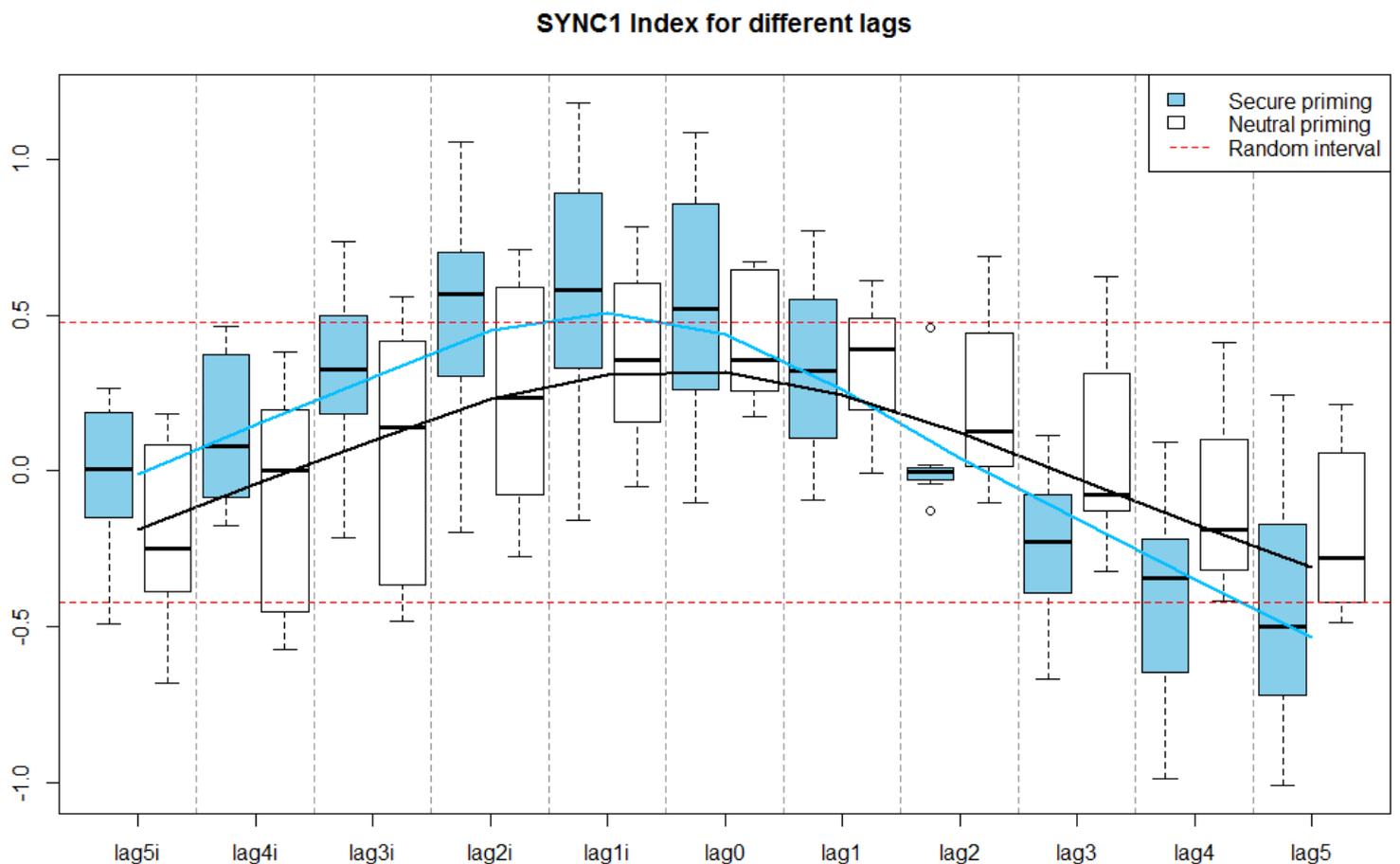


Figure 4. The boxplots represents the SYNC1 index at different lags for both conditions, the synchrony of dyads in the SECURE condition are in blue, and that of the NEUTRAL condition dyads in white. Lags labelled from 1 to 5 indicate the synchrony for the patient track anticipated from 1 to 5 seconds. High synchrony in this range means that the patient was leading and the therapist was synchronizing after him. The opposite is true for lags labelled from 1i to 5i. The horizontal red dotted lines indicate the "chance synchrony" confidence interval.

As emerged also in previous research (Kleinbub, 2011), visual inspection of the data confirmed the hypothesis that lag information is crucial in interpreting synchrony modulations. Indeed whereas the results in the middle range of Plot 1 panels does not present a relevant difference between the two groups, the more extreme lag values, and the overall shape of the data is relevantly different. Furthermore the group levels of synchrony appeared significantly different from chance only for the SECURE condition in the lag2i – lag0 frame.

To test this latter observation a permutation test for each condition and each lag point was performed. P-value for this tests (reported in table 1), were obtained as the ratio of the random values equal or more extreme than the average observed value for each condition, and the total number of observations.

lag	p-value SECURE	p-value NEUTRAL
lag5i	0.467	0.218
lag4i	0.339	0.343
lag3i	0.149	0.454
lag2i	0.049*	0.221
lag1i	0.032*	0.113
lag0	0.039*	0.082
lag1	0.14	0.126
lag2	0.482	0.238
lag3	0.165	0.439
lag4	0.053	0.329
lag5	0.056	0.221

Table 1. Permutation tests for real vs chance synchrony

The results clearly shows that only in the SECURE condition synchrony was higher than chance ($p < 0.05$) in the lag2i – lag0 frame. Although not reaching formal significance, the results for lag 4 ($p = 0.053$) and lag 5 ($p = 0.056$) can be considered relevantly different from chance as well, although smaller than chance, whereas at the inverted lag values the values for the SECURE condition were higher.

4.4.3 Questionnaires. A preliminary correlation analysis showed, confirming the hypotheses, a significant correlation between EUS patients’ perceived empathy scores and synchrony at lag3 ($r = 0.57$) and lag4 ($r = 0.55$), as well as patients’ perceived working alliance score (HAQ) with the clinician, also at lag3 ($r = 0.57$) and lag4 ($r = 0.52$). These two measures correlated instead negatively (EUS: $r = -0.64$; HAQ: $r = -0.56$) with negative 5 seconds lag synchrony (lag5i).

Furthermore synchrony correlated negatively with some therapists' caregiving model, specifically with the "perceived ability to recognize others' needs" scale at lag2 ($r = -0.65$) and lag3 ($r = -0.52$) and the "Egoistic motives for helping" scale at lag2 ($r = -0.49$).

Finally synchrony was found correlated with attachment measures such as therapists RQ's "model of self" score at lag0 ($r = 0.49$), and therapists ECR's anxiety score ($r = -0.53$).

None of the collected pseudo-patients personality measures correlated with synchrony, nor offered any other relevant insight.

4.4.4 Linear Mixed Models. To test whether security priming had an effect on the overall synchronization level, six different linear mixed models were fitted on the data through the "lme4" R package (Bates, Maechler, Bolker & Walker, 2014). As the chosen models are nested, model comparison was performed through the Akaike Information Criteria (AIC) and a likelihood ratio test (LRT).

All the models had the dyad's Id as a random factor, than in the first model, defined "full" the lag (LAG), the security priming condition (IND) and their interaction were considered as fixed factors, additionally the moderation effects of gender matching (GENDER) and therapists attachment anxiety (ECR_ANX) were considered in the model. The second model "interaction 1", considered the same predictors without the attachment measure; the "interaction 2" model considered only the priming, lag and their interaction, while the "additive" model loses the interaction term. Finally two null models were composed, the "lag" one only with the lag factor, and the "intercept" one, considering only the intercept as predictor. The results of the model comparison is shown in table 2. The "Attachment 1" model was chosen as the best model.

Model	formula	AIC	R ²	Likelihood ratio test against the simpler model			
				Chi sq	Df	p-value	sig
Full	y ~ LAG * LAG^2 * IND * ECR_ANX + GENDER + (1 ID)	76.60	0.63	5.15	2	0.076	.
Attachment 1	y ~ LAG * LAG^2 * IND * ECR_ANX + (1 ID)	77.75	0.63	35.81	7	<0.001	***
Attachment 2	y ~ LAG * LAG^2 * IND + ECR_ANX + (1 ID)	99.56	0.53	13.43	1	<0.001	***
Priming 1	y ~ LAG * LAG^2 * IND + (1 ID)	110.98	0.51	22.32	3	<0.001	***
Priming 2	y ~ LAG * LAG^2 + IND + (1 ID)	127.31	0.43	0.32	1	0.571	
Quadratic 1	y ~ LAG * LAG^2 + (1 ID)	125.63	0.43	2.97	1	0.085	.
Quadratic 2	y ~ LAG + LAG^2 + (1 ID)	126.60	0.42	67.32	1	<0.001	***
Lag	y ~ LAG + (1 ID)	191.92	0.09	6.60	1	0.010	*
Intercept	y ~ (1 ID)	196.52	0.05				

Table 2. ANOVA on the nested models. Both the Akaike Information Criteria, and the likelihood test ratio shows evidence in favour to the “full model”, explaining 63% of variance. The LRT also accounts for each predictor p-value, i.e. the p-value associated to the “GENDER” predictor, which reflects gender pairings in the dyad, is given by the comparison between the model “Full” and “Attachment 1”, and is equal to 0.076.

The estimated parameters and fit indexes for the chosen models are reported in table 3.

Parameter	Estimate	Std. Error	t value
(Intercept)	0.2822	0.2380	1.1860
LAG	0.3674	0.0934	3.9320
LAG^2	-0.0256	0.0130	-1.9750
IND	0.7905	0.3580	2.2080
ECR_ANX	0.0003	0.0031	0.1010
LAG:LAG^2	-0.0118	0.0048	-2.4280
LAG:IND	-0.4679	0.1406	-3.3290
LAG^2:IND	-0.0495	0.0195	-2.5350
LAG:ECR_ANX	-0.0047	0.0012	-3.7940
LAG^2:ECR_ANX	0.0001	0.0002	0.3260
PRIME:ECR_ANX	-0.0094	0.0049	-1.9150
LAG:LAG^2:IND	0.0200	0.0073	2.7530
LAG:LAG^2:ECR_ANX	0.0002	0.0001	2.4800
LAG:IND:ECR_ANX	0.0045	0.0019	2.3420
LAG^2:IND:ECR_ANX	0.0006	0.0003	2.2750
LAG:LAG^2:IND:ECR_ANX	-0.0002	0.0001	-2.3340

Table 3. “Attachment 1” model fixed factors estimated parameters.

Summing up, the selected model accounted for the 63% of the data variance, and showed an interaction effect of secure priming and lag on synchrony ($\chi^2(3) = 22.32, p < 0.001$). Secure priming enhanced synchrony up to about 0.79 ± 0.36 . The model selection process found no significant effect of gender matching ($\chi^2(2) = 5.15, p = 0.076$).

4.5 Discussion

Recent literature on synchronization, and specifically on skin conductance synchronization in clinical dyads (Marci et al., 2007; Kleinbub, 2011; Kleinbub et al., 2012; Messina et al., 2013) has shown that the physiological index activation, reflecting the autonomic nervous system activity, synchronizes between the two members of the clinical dyad.

This synchronization, interpreted into a vast domain of observations of interpersonal mimicry has been associated to empathy across many conceptual domains. Neuroscientific observation of the mirror properties of sensorimotor neurons, theoretical models of human interaction, mathematical models of communication, together with ethological observations on animals and humans, all converge to the conclusion that synchronous patterns are at the foundation level of any kind of intersubjectivity.

On a different level of observation, attachment theory, has gained strong momentum in infants and adults research, due to the many empirical results showing how Bowlby's "attachment behavioural system" categorization was able to discriminate response to new or stressful situations in infants and to predict their cognitive development. Resting on the assumption that the same motivational system that gives rise to the close emotional bond between parents and their children is responsible for the bond that develops between adults in emotionally intimate relationships, the attachment theory gave rise to many confirmatory research in support to the whole model, on adults as well.

In literature, some studies considered the relation between the caregiving system, attachment security and different types of empathy (Mikulincer & Shaver, 2007). In particular, several studies by Mikulincer and co-workers started from the assumption that attachment security is not only an individual stable characteristic, but could be contextually and temporarily activated. The main hypothesis underlying these studies is that people whose mental representations of attachment security have been contextually enhanced, through the activation of the caregiving system, would be more likely than relatively insecure people to empathize with and provide care to others. Using different priming techniques, it has been found that momentary activation of security has beneficial effects on compassionate responses to others' suffering, while inhibiting personal distress (e.g., Mikulincer et al., 2001; 2005). In psychotherapy research, several empirical evidences have established that psychotherapists' empathy is a predictive factor of positive treatment outcomes regardless of psychotherapists' approaches (Williams & Dazzi, 2006). Thereby relational abilities improvement is one of the most important goal of psychotherapy training (Angus & Kagan, 2007).

While the concept of synchronized behaviour, so strongly linked to empathy, is present into the attachment theorization, and many of the first observation of these peculiar patterns have been performed in the "infant research" context, the same scientific domain in which the attachment theory developed, the relationships between attachment and synchrony have never been studied (with the notable exception of Jaffe et al., 2001, which unfortunately was never replicated nor extended).

The aim of the present study, thus, was to investigate the connections between these two phenomena. Specifically, this main research question was split into the following hypotheses: 1) to observe a significant amount of synchronization between the two dyad's members SC signals; 2) to observe that a secure priming, enhancing the internal attachment working model, would have an effect on that synchronization level; 3) to observe a correlation between synchronization in SC and perceived empathy, and 4) to observe a moderation effect of the dyad attachment styles. To fulfill this objective, an improved replication of a previously published study (Messina et al., 2013) was designed, consisting of 20 minutes interviews between psychotherapists and volunteering students

on an emotionally relevant topic. Of the 18 dyads that participated to the study, 9 were randomly assigned to a “secure priming” group, and the other 9 to the “neutral priming” group.

Therapists in the “secure priming” group, had to read a short story about the relationship of caring of a fictional character and his mother, written with the aim of implicitly activate secure attachments representations, while those in the “neutral priming” group read an alternative story, analogous in length and sentence complexity, about a beautiful vacation on a Greek island, without any relational content. The sessions were audio and video recorded and simultaneous skin conductance was measured for both dyad’s participants.

Attachment style and traits were measured for each participant one week before the experimental procedure, in order to avoid unconscious priming by the questionnaires’ items, whereas after the session participants were asked to rate their interlocutors’ empathy, level of working alliance, perceived attractiveness and competence.

Permutation analysis of fake dyads composed by the SC signals of people that never met allowed to calculate a confidence interval for random synchronization, at the different lags.

Only the dyads in the “secure priming” group showed an average synchronization outside these boundaries, and specifically a higher synchrony for inverse lags (i.e. a predominance of situations in which the pseudo-patients were activating in response to a previous therapists’ activation) and a lower-than-random synchronization at direct lags (i.e. between 3 and 5 seconds after a patient peak, the therapist were predominantly in a phase opposition state).

Correlation analyses between synchrony and the questionnaires, mostly confirmed the hypotheses, showing significant associations between the SYNC1 index at 3-5 seconds lags, and the pseudo-patients’ perceived empathy and working alliance in regard to the therapist. Furthermore, therapists’ attachment anxiety, as measured by the ECR, showed an inverse association with synchrony.

To sum up and properly assess the influence of all these results, a linear mixed regression model analysis was performed on the data. The results showed a significant interaction between groups and lag, whereas the simpler additive model without the interaction term was not found significant. This means that while the two groups average synchronization across lags was not different, they were different in regard on how this synchronization was expressed across lags. This could lead to the interpretation that secure priming does not directly promotes an higher overall synchronization, but instead change how the synchronizing behaviours are expressed in the dyad. Furthermore a moderating effect of therapist’s attachment anxiety, as measured by ECR-A score, was found on the synchronization data, with anxiety interacting both with the type of priming induction and lag. Specifically, higher attachment anxiety predicted lower synchrony in the neutral priming condition, an effect that was absent in the secure priming condition. This was an expected

result, and supported the importance of therapists' self-development and training, as their baseline attachment characteristic do influence their ability to attune to patients.

Previous investigations on this specific and advanced modelling of synchronization are almost absent in psychological literature, leaving only the room for tentative interpretations of these observations. For instance the fact that perceived empathy correlates with higher direct lags, and the secure priming promotes higher synchronization at higher inverse lags, could point to the conclusion that while the secure priming had an effect on the relational modalities of the therapists, such effect was not optimal, enhancing maybe an artificial attitude that was perceived as unnatural by the interlocutor. This might be supported by the moderation effects of therapists' attachment anxiety, with higher anxiety predicting higher synchrony at indirect lags and vice versa, although the statistic power is definitely too low to consider these results more than suggestions for further investigations. An alternative interpretation may as well be that perceived empathy, as assessed by self-report measures, could be biased toward more general sympathy traits, which may not be predictors of an efficacious treatment. Yet, many studies have found perceived empathy and alliance, measured by these means, to be good predictors of a therapy outcome, somewhat undermining this latter interpretation. It may also be possible that the setting difference between our experimental simulation and a real clinical context may drastically change the weight of these relationships and directions of effects. Further studies in real therapeutic dyads could eventually lead to a refining of these interpretations.

5. The Clinician Effect

STUDY 2

The promising results of study 1 mostly confirmed the research hypothesis, but had some limitations that restricted the interpretation possibility. For instance, the relatively small sample size precluded the use of more sophisticated analysis of the many covariance factors that can be theoretically postulated to contribute to the overall synchronization level. Furthermore having all dyads composed by different peoples could lead to an overall masking effect given by individual characteristics of each dyad. To assess these issues, a replication of study 1 was performed with two following crucial changes in design. The first modification was that therapists were substituted with psychologists. This choice had multiple reasons: on the pragmatic hand, since most psychotherapy students are not resident in the school's city they were difficult to recruit and had restricted time availability; on the theoretical hand, it was interesting to compare the effect of training on the synchronization levels. While this question was already partially answered in my Master thesis and subsequent research (Kleinbub, 2011; Kleinbub et al., 2012; Messina et al., 2013), that work was done with a primitive instrumentation and results were not conclusive.

The second crucial design change was that this time each psychologist (PSY) had two different interviews with two different pseudo-patients (PAT), in order to control for individual characteristics.

Thus, the hypotheses of this second study were defined in two groups, first as a replication study it was expected:

1. To observe a significant amount of synchronization between the two dyad's members SC signals;
2. That a secure priming (Mikulincer & Shaver, 2007), enhancing the internal attachment working model, would have an effect on that synchronization level;

3. To observe a correlation between synchronization in SC and perceived empathy from the PAT participants;
4. To observe a moderation effect of the dyad attachment styles;
5. To explore how much of the synchrony depends on the psychologists traits and how much to the specific dyadic configuration.
6. To evaluate if the secure priming effect lasts also for the second interaction or is to be considered as a short duration effect.

Furthermore, by comparing the collected data with that of study 1 it was expected to:

1. Highlight differences in the synchronization patterns between dyads composed by psychotherapists and psychologists.
2. Highlight differences in the way in which the security priming acts on the two different clinicians groups. Specifically therapists should show a reduced effect of security priming in comparison to psychologists, as their training should already position them in a condition that favours the expression of prosocial responses and being more likely to perceive themselves as able in providing effective help.

5.1 Participants and procedure

21 psychologists (PSY) and 42 volunteering students (PAT) were recruited to participate in the study. PSY participants (15 females, 6 male; mean age = 27.2, SD = 2.79) were selected among young clinicians that passed the Professional Practice Exam required by Italian legislation to work as psychologists, since no more than two years and who did not undergo further professional trainings. This was chosen in order to avoid overlap with the THER group of study 1, which consisted as well of young therapists, and not full-fledged professionals.

PAT group participants (21 females, 21 males; mean age = 21.56, SD = 1.38), just like study 1, were volunteering undergraduate university students.

As in study 1, one week before the experimental session, both PSY and PAT participants were interviewed separately, they were informed on the scope of the research, and after they expressed their participation consent, verbally and in written form, an appointment was taken for the experimental session. In this context, they underwent the same assessment of study 1 (chapter 6, table 1)

At the experimental session date, the psychologist and the first pseudo-patient (PAT-A), were asked to wash their hands with water and soap. While soap may potentially interfere with skin conductance measurement, that was the only way to even out each participant's skin condition.

Afterward the two first dyad's members had to read their instructions, which were dependent on their role. Specifically the PSY group instructions stated to listen carefully to their interlocutor, and to freely interact, trying to get into his/her shoes and to understand he/she, and to put effort into building a good relationship.

Furthermore, the psychologists were asked to not reveal their professional status, in order to avoid biases and expectations in the PAT group members.

Half of the PSY participants were randomly assigned to a "secure priming" group whereas the other half to a "neutral priming" group. According to the assigned group, 10 minutes before the session, psychologists had to read a different text, identical to that of study 1.

The pseudo-patients instructions, instead, asked to share an episode or a situation, either actual or from a near past, connoted by emotional relevance, and which was or still is source of distress or discomfort. As also stated in the informed consent, all the information collected this way would have maintained confidential.

After this introduction, the two participants of each dyad were allowed to meet, and to have a brief presentation, the experimenter proceeded then to set up the audio, video and physiologic measures. With all the setting ready, the experimenter left the room.

After 20 minutes the experimenter knocked on the door before entering again to stop the recordings. In case that the interview still was in a crucial phase, some more minutes were allowed to the dyad to conclude the interaction.

After the conclusion of the first interview, PAT-A was debriefed and left the laboratory, while the next pseudo-patient (PAT-B) was prepared to begin the second interview with the same psychologist by washing his/hers hands, and by setting up the electrodes for SC recording. Then the very same procedure of PAT-A was repeated with the new dyad composed by the psychologist and PAT-B pseudo-patient.

5.2 Measures

The employed measures are the same reported for the first study. The full description and references for these measures can be found in chapter 4.

5.2.1 Skin conductance level (SC). SC was continuously and simultaneously collected from both participants of each dyad through the BIOPAC MP-150 System, by using BIOPAC BioNomadix wireless amplifier and disposable electrodes attached to the distal phalange of the index and medium finger of the nondominant hand. XC data was collected with a sampling rate of 1 KHz, filtered with a 5 Hz low-pass filter to remove electric noise and motion artefacts. The SC signals were individually monitored for remaining artefacts, and too deteriorated parts of the recording were either corrected (were possible) or flatted out. This was needed to preserve the time locking between different participants' tracks, and different measures, such as audio and video. Finally the data were downsampled to 100 Hz to proceed to further analysis.

5.2.2 Questionnaires. The same questionnaires of study 1 were employed:

- The Relationships Questionnaire (RQ). The RQ is a measure of attachment style focusing on four categories: secure, fearful-avoidant, preoccupied and dismissing-avoidant attachment patterns. Two indexes of model of self and model of other can be calculated from the items.
- Experiences in Close Relationships (ECR). The ECR is another measure of attachment on two dimensions, Avoidance (or Discomfort with Closeness and Discomfort Depending on Others) and Anxiety (or Fear of Rejection and Abandonment).
- The Interpersonal Reactivity Index (IRI). The IRI, one of the most broadly used measures of empathy, consists of four subscales, assessing separate facets of empathy: perspective taking, empathic concern, personal distress, and fantasy.
- Barrett-Lennard Relationship Inventory - Empathic Understanding subscale (EUS) Previously used in synchronization research the EUS is a monofactorial scale to assess a clinician's empathy as perceived by the client/patient.

- The Inclusion of Other in the Self scale (IOS). The IOS is a graphical measure of self-other inclusion and relationship closeness.
- Mental Representation of Caregiving Scale (MRC). The MRC assesses individual differences in caregiving representations through five subscales: perceived ability to recognize others' needs, appraisal of others as worthy of help, perceived ability to provide effective help, egoistic motives for helping, and altruistic motives for helping
- Counselor Rating Form – Short version (CRF-S). The CRF-S, is a 12 items scale used to assess expertness, trustworthiness, and attractiveness of a counselor or therapists, as perceived by the client or patient.
- The Revised Helping Alliance Questionnaire (HAq-II). The HAq-II is a widely used 19-item questionnaire that measures the strength of the patient-therapist therapeutic alliance on two factors: “positive therapeutic alliance” and “negative therapeutic alliance”.
- The State-Trait Anxiety Inventory (STAI). STAI is a commonly used measure of trait and state anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Form Y, its most popular version, has 20 items for assessing trait anxiety and 20 for state anxiety. In this research only the trait anxiety. Trait anxiety items include: “I worry too much over something that really doesn't matter” and “I am content; I am a steady person.” All items are rated on a 4-point scale (e.g., from “Almost Never” to “Almost Always”). Higher scores indicate greater anxiety.

5.3 Statistical analysis

5.3.1 Marci et al., synchronization index (SYNC1). In accordance with a procedure validated by Marci and colleagues (Marci & Orr, 2006; Marci et al., 2007), SC data was furthermore filtered with a 1.5 seconds window, moving average filter. Physiological concordance was estimated using the average slope of the EDA levels within 5-second mobile windows with 1-second increments. I.e. the average slope for the first 5 seconds was determined, then the window was moved forward 1 second and the average slope for the subsequent 5 seconds was calculated. To

measure the concordance, Pearson's correlations of the average slopes of the two components of each dyad were performed using 15-second windows. A total score of the entire session was obtained through the calculation of the ratio between the sum of the positive correlations across the session and the sum of the absolute value of negative correlations across the session. Due to the skewness of the ratios, a natural logarithmic transformation was applied to the result, obtaining a whole session index ranging from +1 to -1. An index value of zero corresponded to an equal weight of positive and negative correlations in the session, a value greater than zero reflected the predominance of positive correlations, and thus the presence of a physiological concordance, and a value lower than zero corresponded to the predominance of negative correlations. This procedure was repeated for several temporal lag values, ranging from 0 to 5 seconds both shifting the PAT signal forward (direct lags, 1-5) or the PSY signals forward (inverse lags: 1i-5i)

5.3.2 Permutation Analysis. As in study 1, to discriminate “true” synchrony against the amount of synchrony that could be randomly be achieved by applying the SYNC1 index on data which not shares a relational co-causality, permutation analysis was performed to create fake dyads by randomly selecting 1000 among the possible permutations without repetition of the tracks of different subjects. For instance by matching the SC signal of the PAT-A participant of the first dyad with that of the PAT-B participant of the third dyad, and so on.

5.3.3 Kendall Rank Correlation Coefficient. To initially explore the association between questionnaires and measured synchrony, correlation analysis were performed through the Kendall tau, an association measure not relying on any assumption on the data distribution. Kendall tau has been described by different authors as having some advantages over the more often used Spearman's Rho (Kendall & Gibbons, 1990; Gilpin, 1993)

5.3.4 Linear mixed models regression. To assess causal relationships in the variables and estimate the weight of each moderating variables, linear mixed model regression analysis was performed. Mixed models are a family of statistical analysis that allows to distinguish between fixed and random factors. The first are those effectively manipulated by the experimenter, or which are expected to have an effect on the dependent variable(s), whereas the latter are factors that are expected to vary in a random fashion, for instance as a baseline difference of each subject, independent from the experimental conditions.

5.4 Results

Visual inspection of the raw SC data revealed that 9 of the 42 collected dyads had poor signal quality and/or excessive amounts of artifacts, and were removed from further analysis.

The 33 remaining dyads were evenly distributed among conditions: the SECURE-PAT-A, SECURE-PAT-B and NEUTRAL-PAT-A conditions were composed each by 8 dyads, whereas the NEUTRAL-PAT-B condition by 9.

5.4.1 Synchrony over chance. A first preliminary analysis is to assess if synchrony is present in the observed dyads, and if such synchrony is significantly different from chance. To answer this question the SYNC1 index for shuffled dyads was computed, i.e. by pairing the signal of one participant with that of another one, different from his/her real partner. To assess if SECURE and NEUTRAL primed dyads individual data, as well as PAT-A and PAT-B individual data, were coming from the same distribution, the permutations from the whole group of participants was compared with the permutations of the four conditions (figure 1).

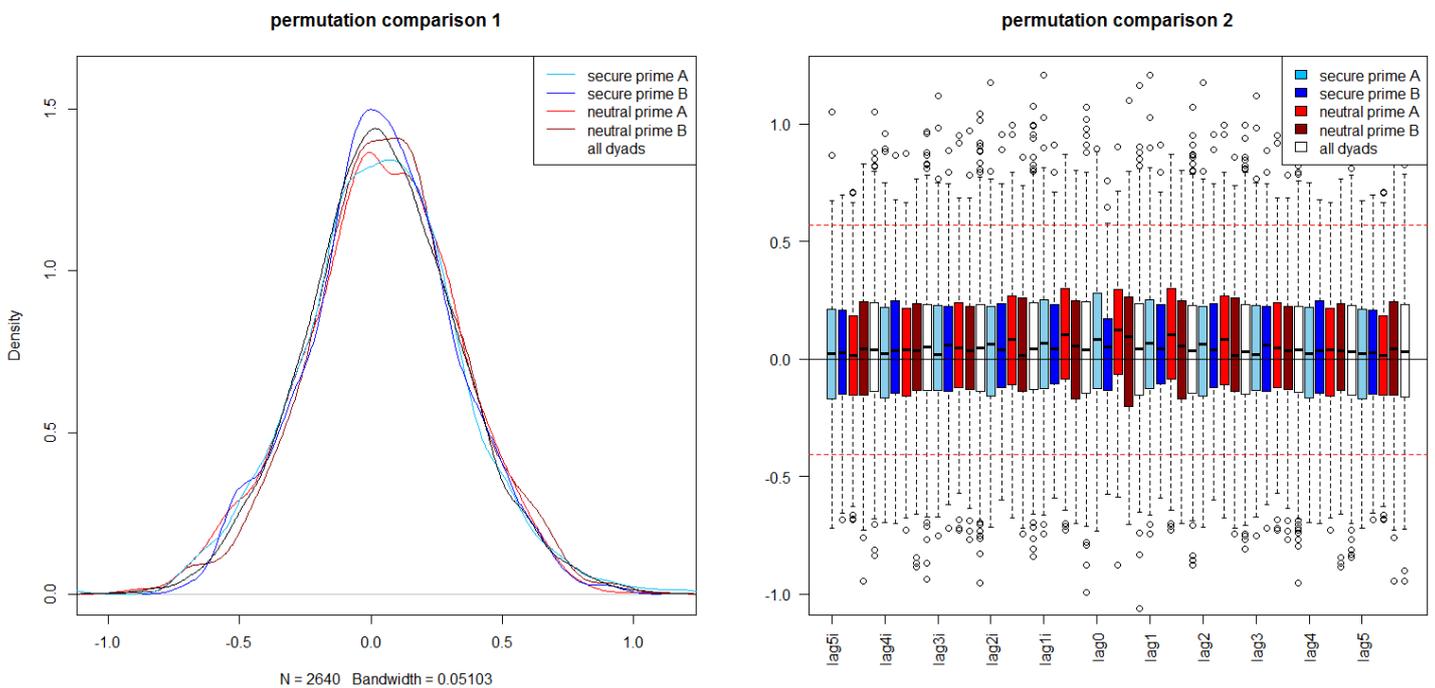


Figure 1. Permutation analysis obtained by reshuffling dyads either within the SECURE and NEUTRAL priming groups, or by considering both group as a single population showed no difference in the synchronization levels.

Visual inspection of the data led to the conclusion that there is no baseline difference in the individual SC signals that may account for different levels of synchrony. Thus, 1000 among the possible permutations without repetition were randomly selected to assess the distribution of random synchrony. The obtained random distribution is approximately normal, with mean = 0.052 and SD = 0.27. On this distribution, 5% confidence intervals were calculated as an interval of “chance synchrony”.

5.4.2 Lag analysis. Next, SYNC1 for the 33 real dyads among the four conditions were computed. Results are showed in plot 2.

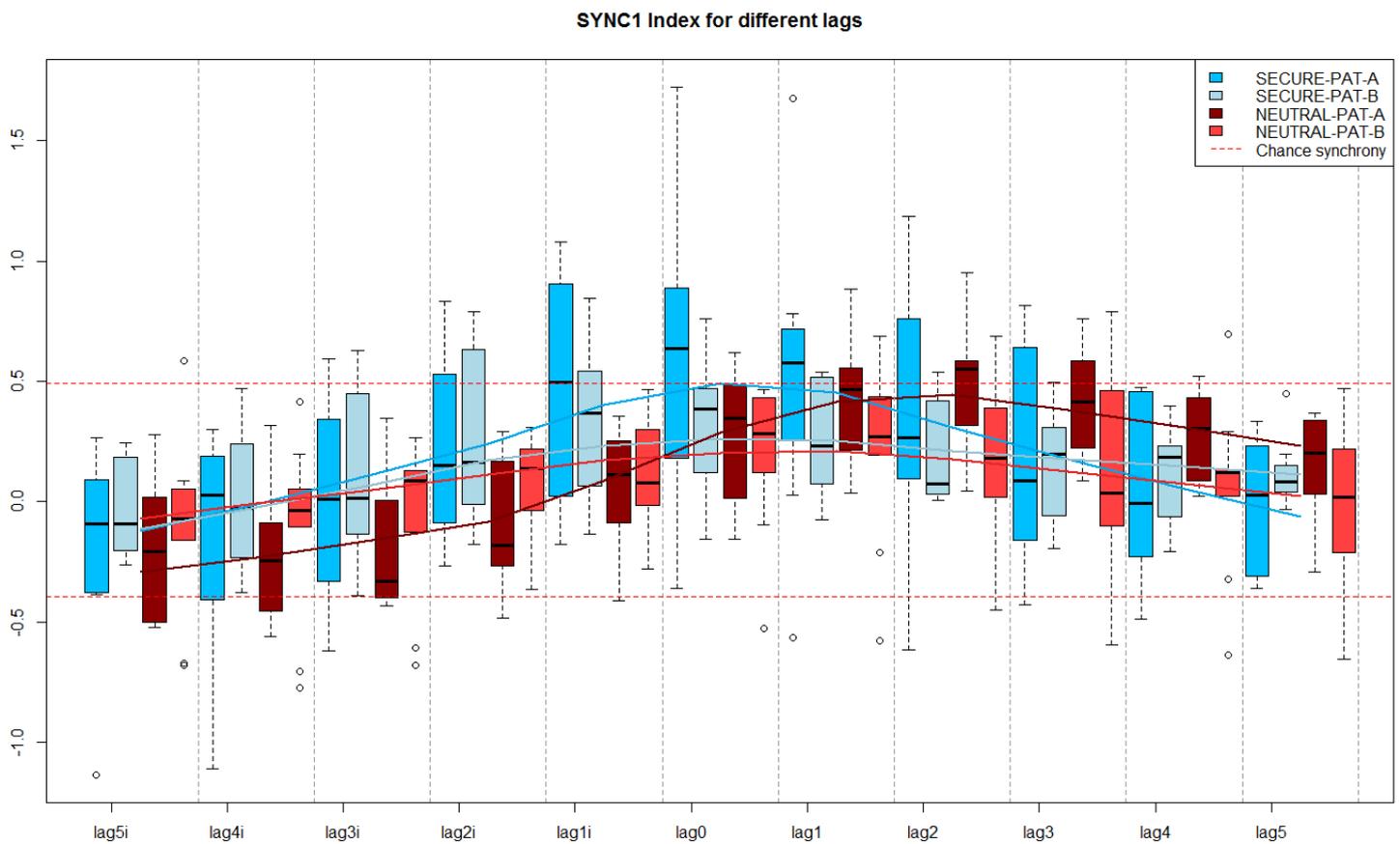


Figure 2. The boxplots represents the SYNC1 index at different lags for both conditions, the synchrony of dyads in the SECURE group are in blue, and that of the NETURAL group dyads in red, PAT-A dyads are of darker colours than PAT-B dyads. Lags labelled from 1 to 5 indicate the synchrony for the patient track anticipated from 1 to 5 seconds. High synchrony in this range means that the patient was leading and the therapist was synchronizing after him. The opposite is true for lags labelled from 1i to 5i. The horizontal red dotted lines indicate the “chance synchrony” confidence interval.

As emerged also in previous analyses (Kleinbub, 2011), visual inspection of the data confirmed the hypothesis that lag information is crucial in interpreting synchrony modulations. Indeed whereas the results in the middle range of Plot 1 panels does not present a relevant difference between the two groups, the more extreme lag values, and the overall shape of the data is relevantly different. Furthermore the group levels of synchrony appeared significantly different from chance only for the SECURE condition in the lag2i – lag0 frame.

To test this latter observation a permutation test was performed for each condition and each lag point. P-value for this tests (reported in table 1), are obtained as the ratio of the random values equal or more extreme than the average observed value for each condition, and the total number of observations.

	SECURE		NEUTRAL	
	PAT-A	PAT-B	PAT-A	PAT-B
lag5i	0.176	0.405	0.176	0.291
lag4i	0.244	0.46	0.156	0.289
lag3i	0.436	0.412	0.189	0.319
lag2i	0.271	0.214	0.291	0.491
lag1i	0.076	0.164	0.489	0.41
lag0	0.035*	0.177	0.22	0.313
lag1	0.054	0.226	0.097	0.298
lag2	0.143	0.301	0.063	0.33
lag3	0.293	0.342	0.097	0.393
lag4	0.493	0.41	0.19	0.494
lag5	0.409	0.387	0.344	0.386

Table 1. Permutation tests for real vs chance synchrony in the four conditions. The only significant comparison for a 0.05 alpha, is the lag0 synchrony for the first dyads in the security priming group.

Similarly to study 1, the results shows that only in the SECURE group synchrony was higher than chance ($p < 0.05$) at lag0, but only for the first interaction of each psychologist. Instead the second interaction was characterized by nonsignificant levels of synchrony just as in the neutral condition.

5.4.3 Questionnaires. A preliminary correlation analysis on this sample showed no association between SC synchrony at any lag and patients’ evaluation of therapists’ empathy and working alliance through the EUS and HAQ scores. Instead a mild association between the affective empathy score of IRI was found to be negatively associated with direct lag synchrony (lag3, $r = -0.37$; lag4, $r = -0.43$) and positively associated with indirect lag (lag2i, $r = 0.36$).

Furthermore the RQ “model of others” score, correlated negatively with direct lags (lag3, $r = -0.40$; lag4, $r = -0.45$; lag5, $r = -0.36$).

None of the collected pseudo-patients personality measures correlated with synchrony.

5.4.4 Linear Mixed Models. To test whether security priming had an effect on the overall synchronization level, and if this effect was dependent over the order of interaction with the primed clinician, just as in study 1, linear mixed regression models were employed. By defining the dyads id as a random factor, the model properly accounts for the dependency between different lag measurements. As visual inspection of plot 2 showed a non-linear trend for all the four conditions, quadratic lag parameter were included as well.

All the different mixed models were fitted on the data through the “lme4” R package (Bates, Maechler, Bolker & Walker, 2014). As the chosen models are nested, model comparison was performed through the likelihood ratio test (LRT), as well as Akaike Information Criteria (AIC).

Additionally the moderation effects of therapists attachment anxiety were considered in the model. The results of the model comparison is shown in table 2. The “full” model was chosen as the best model. The estimated parameters and fit indexes for the chosen models are reported in table 3.

				Likelihood ratio test against the simpler model			
Model	formula	AIC	R ²	χ^2	Df	p-value	sig
Full	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} * \text{ORDER} * \text{ECR_ANX} + (1 \text{ID})$	282.94	0.38	47.46	15	<0.001	***
Attachment	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} * \text{ORDER} + \text{ECR_ANX} + (1 \text{ID})$	300.40	0.30	4.74	1	0.030	*
Order2	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} * \text{ORDER} + (1 \text{ID})$	303.14	0.30	18.61	7	0.009	**
Order1	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} + \text{ORDER} + (1 \text{ID})$	307.75	0.26	1.18	1	0.277	
Priming2	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} + (1 \text{ID})$	306.93	0.26	12.96	3	0.005	**
Priming1	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) + \text{PRIME} + (1 \text{ID})$	313.90	0.23	3.04	1	0.081	.
Quadratic2	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) + (1 \text{ID})$	314.94	0.24	2.75	1	0.097	.
Quadratic1	$y \sim \text{LAG} + \text{I}(\text{LAG}^2) + (1 \text{ID})$	315.69	0.23	62.46	1	<0.001	***
Intercept	$y \sim \text{LAG} + (1 \text{ID})$	376.15	0.06	21.54	1	<0.001	***
Null	$y \sim (1 \text{ID})$	395.69	0.00				

Table 2. ANOVA on the nested models. The combined evaluation of the likelihood test ratios and the AIC criteria, shows evidence in favour of the “Full” model.

Parameter	Estimate	Std. Error	t value
(Intercept)	0.34850	0.17780	1.96
LAG	0.09916	0.09582	1.035
LAG ²	-0.02238	0.01331	-1.681
SECURE priming	1.35500	0.30280	4.474
PAT-B	-0.14550	0.22960	-0.634
ECR_ANX	-0.00186	0.00297	-0.627
LAG:LAG ²	-0.00337	0.00496	-0.678
LAG:SECURE	-0.29750	0.16310	-1.824
LAG ² :SECURE	-0.09212	0.02266	-4.065
LAG:PAT-B	0.03951	0.12370	0.32
LAG ² :PAT-B	0.01199	0.01718	0.698
SECURE:PAT-B	-1.07400	0.40790	-2.633
LAG:ECR_ANX	0.00086	0.00160	0.536
LAG ² :ECR_ANX	0.00012	0.00022	0.531
SECURE:ECR_ANX	-0.01508	0.00441	-3.419
PAT-B:ECR_ANX	0.00110	0.00367	0.298
LAG:LAG ² :SECURE	0.00989	0.00845	1.171
LAG:LAG ² :PAT-B	0.00381	0.00640	0.595
LAG:SECURE:PAT-B	0.02828	0.21980	0.129
LAG ² :SECURE:PAT-B	0.08831	0.03053	2.892
LAG:LAG ² :ECR_ANX	-0.00002	0.00008	-0.295
LAG:SECURE:ECR_ANX	0.00244	0.00238	1.026
LAG ² :SECURE:ECR_ANX	0.00101	0.00033	3.073
LAG:PAT-B:ECR_ANX	-0.00237	0.00198	-1.2
LAG ² :PAT-B:ECR_ANX	-0.00014	0.00027	-0.526
SECURE:PAT-B:ECR_ANX	0.01253	0.00587	2.136
LAG:LAG ² :SECURE:PAT-B	-0.00164	0.01138	-0.144
LAG:LAG ² :SECURE:ECR_ANX	-0.00008	0.00012	-0.64
LAG:LAG ² :PAT-B:ECR_ANX	0.00001	0.00010	0.055
LAG:SECURE:PAT-B:ECR_ANX	0.00077	0.00316	0.243
LAG ² :SECURE:PAT-B:ECR_ANX	-0.00098	0.00044	-2.237
LAG:LAG ² :SECURE:PAT-B:ECR_ANX	-0.00001	0.00016	-0.062

Table 3. “Full” model fixed factors estimated parameters.

Summing up the selected “full” model accounted for the 38% of variance and was chosen as the best model. The model showed an overall effect of secure priming on synchrony with an average increase of 1.36 ± 0.3 on SYNC1 index. Synchrony was generally 0.14 ± 0.2 higher for PAT-A as compared to PAT-B, and this was particularly evident in SECURE priming dyads, in which PAT-B had a lowered index of -1.07 ± 0.4 in respect to the first interaction.

Finally therapists attachment anxiety predicted lower synchrony for a factor of -0.002 , which considering the mean ECR score of 72.3 is a mean change of -0.14 .

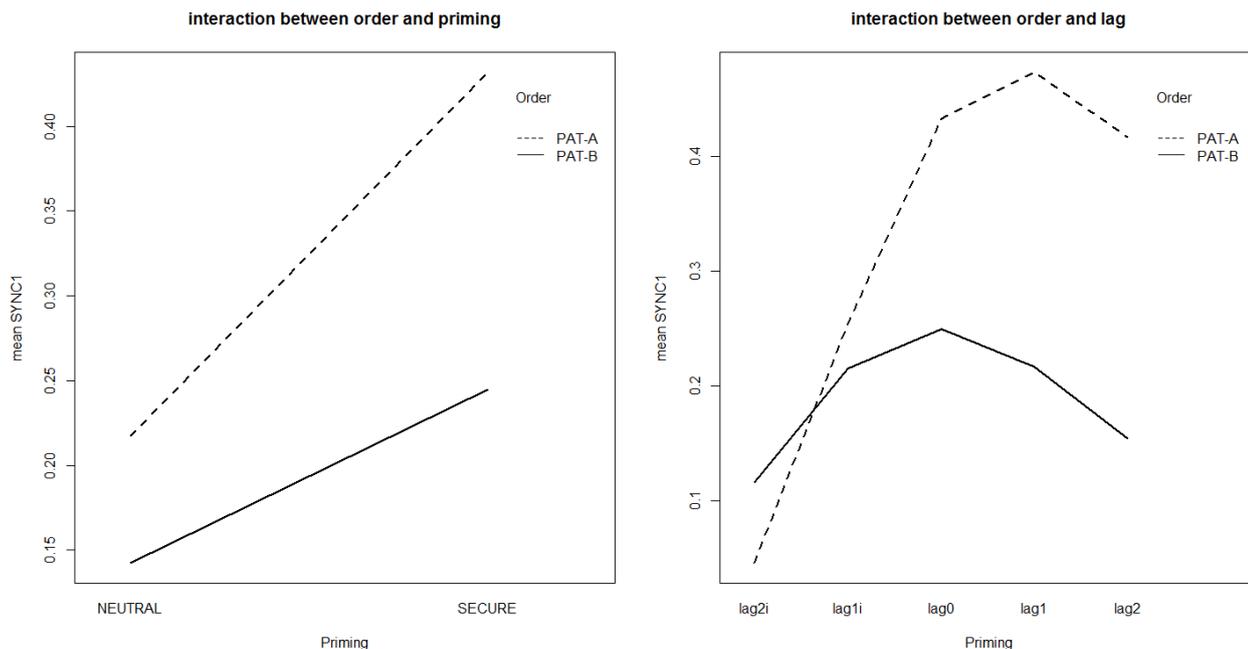


Figure 3. Interaction plots helps to understand the relative interaction effects of order and priming (left panel), and order and lag (right panel).

5.5 Comparison to study 1

In order to compare these results with that of the first study, to assess the difference between psychologist and psychotherapy in SC synchronization, only the PAT-A interactions were considered.

The SYNC1 index at varying lag for the two samples, split by priming type, are presented in figure 4.

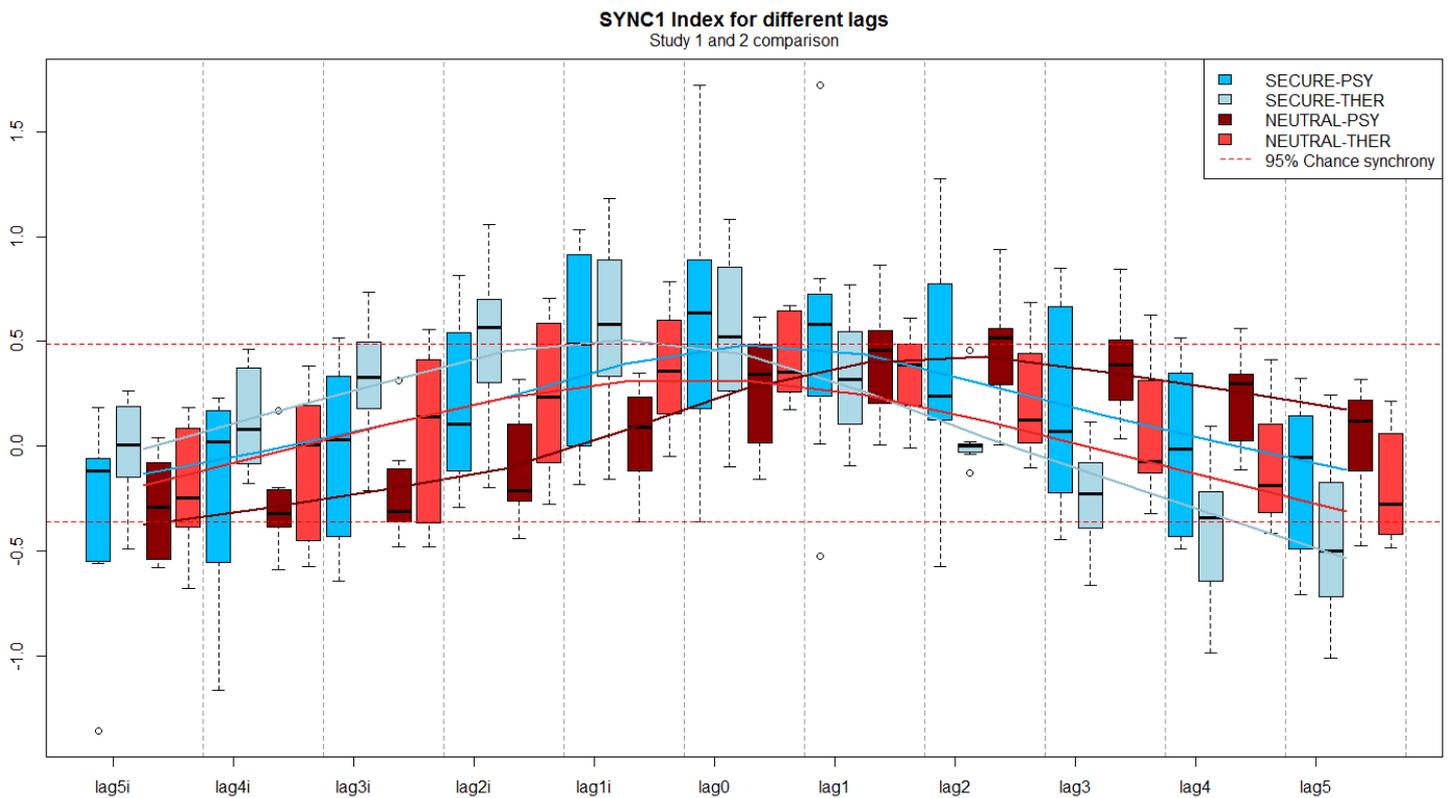


Figure 4. The boxplots represents the SYNC1 index at different lags for both studies.

Psychotherapists' data of study 1 are labelled THER and have lighter colours than psychologists' data of the present study, labelled PSY. As in the previous plots the SECURE conditions are in blue shades, and that the NETURAL ones in red shades. Lags labelled from 1 to 5 indicate the synchrony for the patient track anticipated from 1 to 5 seconds. High synchrony in this range means that the patient was leading and the therapist was synchronizing after him. The opposite is true for lags labelled from 1i to 5i. The horizontal red dotted lines indicate the "chance synchrony" 95% confidence interval.

Graphical investigation of plot 3, confirms the pattern emerged from the individual study results. SECURE primed dyads appears to have an overall higher attunement level at lag 0 in comparison to NEUTRAL ones, and the lag-conditions interactions seems to describe a continuum with SECURE therapists showing higher synchrony at inverse lags, NEUTRAL psychologists, oppositely, showing higher index values at higher direct lags, and NEUTRAL therapists staying somewhat in the middle together with SECURE psychologists.

5.5.1 Linear Mixed Regression Models. From such preliminary observation, a 3-way interaction model between lag, priming and group, seems probable. Just like in the individual study analysis discussed before, linear mixed regression model are the most straightforward way to analyse this kind of data. Table 4 presents the AIC and the Likelihood ratio tests for the full interaction model, and its nested simpler models. Both criteria led to select the “Full” model as the best fitting.

Model	formula	AIC	R ²	Likelihood ratio test against the simpler model			
				χ^2	Df	p-value	sig
Full	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} * \text{GROUP} * \text{ECR_ANX} + (1 \text{ID})$	250.45	0.51	56.42	15	<0.001	***
Attachment	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} * \text{GROUP} + \text{ECR_ANX} + (1 \text{ID})$	276.87	0.42	9.38	1	0.002	**
Group2	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} * \text{GROUP} + (1 \text{ID})$	284.25	0.43	53.30	7	<0.001	***
Group1	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} + \text{GROUP} + (1 \text{ID})$	323.55	0.32	0.01	1	0.908	
Priming2	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) * \text{PRIME} + (1 \text{ID})$	321.56	0.32	26.03	3	<0.001	***
Priming1	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) + \text{PRIME} + (1 \text{ID})$	341.59	0.26	0.81	1	0.368	
Quadratic2	$y \sim \text{LAG} * \text{I}(\text{LAG}^2) + (1 \text{ID})$	340.40	0.26	0.46	1	0.497	
Quadratic1	$y \sim \text{LAG} + \text{I}(\text{LAG}^2) + (1 \text{ID})$	338.86	0.26	100.64	1	<0.001	***
Intercept	$y \sim \text{LAG} + (1 \text{ID})$	437.50	0.00	0.56	1	0.454	
Null	$y \sim (1 \text{ID})$	436.06	0.00				

Table 4. ANOVA on the nested models. The combined evaluation of the likelihood test ratios and the AIC criteria, shows evidence in favour of the “Full” model. P-values of pairwise comparisons between models correspond to the p-value of the predictor removed in the simpler model.

Table 5 reports the selected model's fixed effect parameters

	Estimate	Std. Error	t value
(Intercept)	0.2294	0.2156	1.064
LAG	0.3777	0.1124	3.361
LAG^2	-0.0170	0.0156	-1.091
SECURE priming	0.8992	0.3243	2.773
GROUP	0.1192	0.2792	0.427
ECR_ANX	0.0012	0.0028	0.407
LAG : LAG^2	-0.0125	0.0058	-2.144
LAG : SECURE	-0.4691	0.1690	-2.775
LAG^2 : SECURE	-0.0610	0.0235	-2.598
LAG : GROUP	-0.2786	0.1456	-1.914
LAG^2 : GROUP	-0.0053	0.0202	-0.264
SECURE : GROUP	0.4554	0.4433	1.027
LAG : ECR_ANX	-0.0049	0.0015	-3.332
LAG^2 : ECR_ANX	-0.0001	0.0002	-0.420
SECURE : ECR_ANX	-0.0114	0.0044	-2.575
GROUP : ECR_ANX	-0.0030	0.0041	-0.735
LAG : LAG^2 : SECURE	0.0173	0.0088	1.981
LAG : LAG^2 : GROUP	0.0091	0.0075	1.209
LAG : SECURE : GROUP	0.1716	0.2310	0.743
LAG^2 : SECURE : GROUP	-0.0311	0.0321	-0.969
LAG : LAG^2 : ECR_ANX	0.0002	0.0001	2.160
LAG : SECURE : ECR_ANX	0.0045	0.0023	1.940
LAG^2 : SECURE : ECR_ANX	0.0008	0.0003	2.439
LAG : GROUP : ECR_ANX	0.0058	0.0021	2.707
LAG^2 : GROUP : ECR_ANX	0.0002	0.0003	0.688
SECURE : GROUP : ECR_ANX	-0.0037	0.0062	-0.591
LAG : LAG^2 : SECURE : GROUP	-0.0075	0.0120	-0.623
LAG : LAG^2 : SECURE : ECR_ANX	-0.0002	0.0001	-1.577
LAG : LAG^2 : GROUP : ECR_ANX	-0.0002	0.0001	-1.716
LAG : SECURE : GROUP : ECR_ANX	-0.0020	0.0033	-0.626
LAG^2 : SECURE : GROUP : ECR_ANX	0.0002	0.0005	0.516
LAG : LAG^2 : SECURE : GROUP : ECR_ANX	0.0001	0.0002	0.650

Table 5. “Full” model fixed effects

Summing up, the full interaction model was selected as the best model, while the group, and the priming by themselves were not significant predictors, the interaction between them, lag values and clinician attachment were found significant. The effect of secure priming was strong for both groups, increasing synchrony by 0.90 ± 0.32 . Notably, security priming had a stronger effect on psychologist than on therapists, increasing SYNC1 by 0.45 ± 0.43 , and on clinicians. The pairwise interactions can be seen in figure 5.

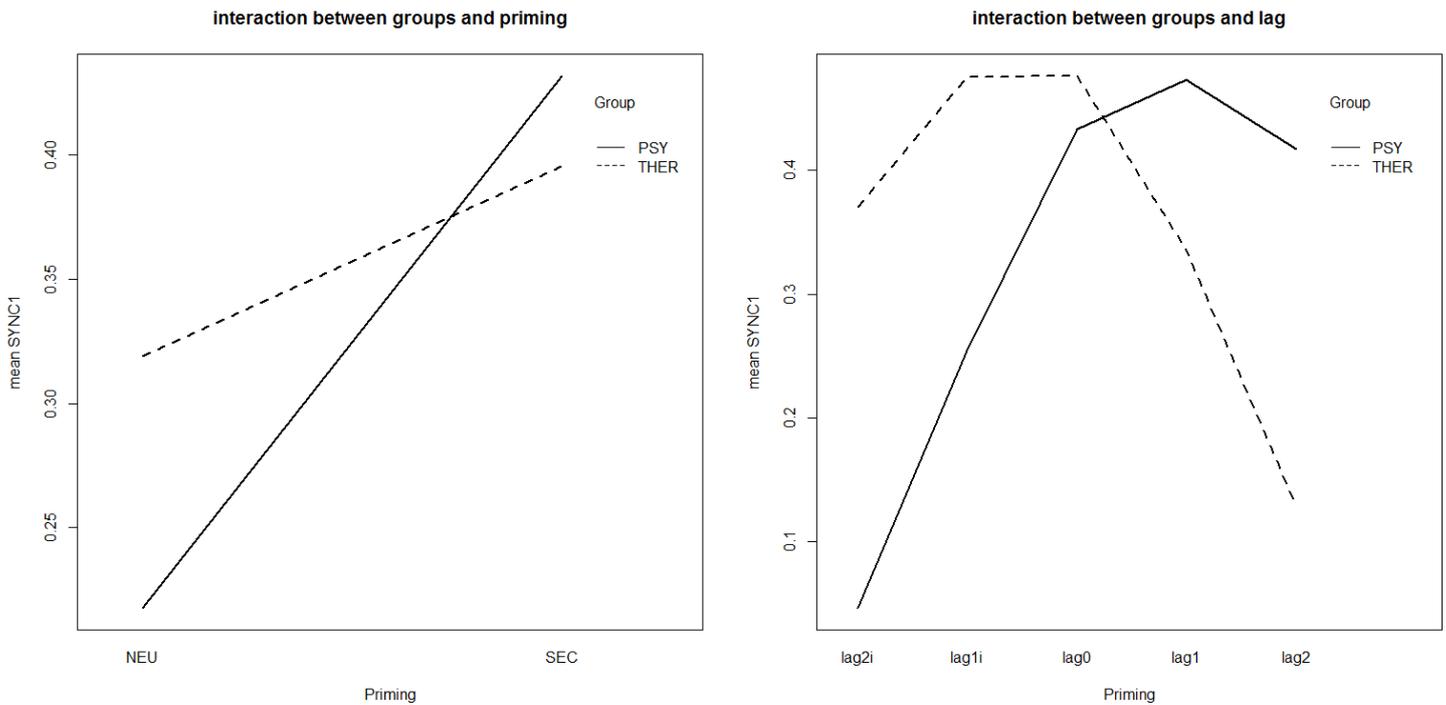


Figure 5. Interaction effects for the comparison between psychologists and psychotherapists

5.6 Discussion

The aim of the present study was to replicate the results of study one on a bigger and different sample. For this reasons the methodology used in the previous study was replicated with two significant differences. Firstly instead of psychotherapists, the clinician role was played by freshly graduated psychologists. This choice was done in order to highlight the specificity (or lack of) of the observed phenomena as an effect of psychotherapy training. The second relevant design change was that in this study each psychologist interacted not only with one pseudo-patient but instead with two. This manipulation had the goal to assess the duration of the priming effect. Twenty-one psychologists and 42 volunteering students, acting as pseudo-patients were enrolled in the study. Due to technical issues in the physiological data recording, only the SC signals of 33 dyads could be analysed.

The results were generally comparable to those of study one. Synchrony levels were found to be significantly higher than chance only for the first interaction of psychologists that received the secure priming. Yet no correlation between synchronous SC and perceived empathy was found in this sample. Linear mixed effects model regressions, performed to assess the impact of the independent variables on synchrony, showed significant interactions between priming and order, with SECURE priming increasing significantly more the first interaction. This means that the

employed methodology of inducing a security priming only had a short-term effect, which partially degraded in the second interaction. Furthermore, SECURE priming predicted higher synchronization at indirect lags, i.e. the clinician leading and the patient following.

Comparison of study 1 and study 2 showed that whilst the secure induction was efficacious for both groups, the effect was much stronger on psychologists. This was an expected result, as therapists' extended training should already position them in a condition that favours the expression of prosocial responses and being more likely to perceive themselves as able in providing effective help, limiting therefore the potential effect span of priming. Lag analysis showed a significant interaction as well, with a distinct difference in synchronization direction. The therapists had peak synchrony at inverse lag, meaning that most often their SC activation was followed by an analogous activation in the pseudo-patient, whereas the opposite was true for the psychologist' dyads. Notably the same effect direction was true for the effect of priming: secure priming shifted the leading role toward the clinician. These results are unexpected, as in previous research (Kleinbub et al., 2011; Messina et al., 2013), peak synchronization between therapists and pseudo-patients was observed at lag3, with clinician following the patients' activations. Still it is important to notice that the instrumentation used to acquire SC signals in that study was quite rudimental in comparison to the one employed in the present research: for instance, the maximum allowed sampling rate was of 1Hz, which may not be sufficient to do precise lag-analysis.

Summing up the observation of both studies, skin conductance synchronization (SCS) confirms its hypothesized role of biomarker of some intersubjective dimensions, capable of being manipulated, and dependent on individual factors such as the level of care training, and attachment.

While the explicit dimensions assessed by SCS could not be identified in the present research, our hypothesis was that it reflects a form of empathy, specifically a more affective facet of the construct, more in the direction of affective sharing, emotional contagion than explicit theory of mind processes. Such hypothesis received only partial correlational support. Specifically in study 1, an association between inversely lagged SCS and patients' perceived empathy was observed. In other words, when the therapists were leading, i.e. ANS activation of patients mirrored that of therapists with an average of 1 second delay, the patients felt to be more understood. This association was not found in study 2, on psychologists, which tended instead to follow patients ANS activations. This counterintuitive result may have many possible explanations. For instance it could be that perceived empathy questionnaires are biased by other relational factors, such as assertiveness, authority, age difference, etc., and thus, speculatively, the more self-confident attitudes were perceived as empathic. Alternatively, it may just be that the observed association is

just spurious and the EUS score and SCS are independent measures, in support of this possibility is the fact that the two groups were not different in terms of overall average perceived empathy.

It is noteworthy to observe that the observed effect of priming (summarized in figure 6) shows a pattern similar to that of the group effect, with security priming predicting indirectly lagged SCS as compared to neutral priming, associated to direct lags (i.e. clinician following patients activations).

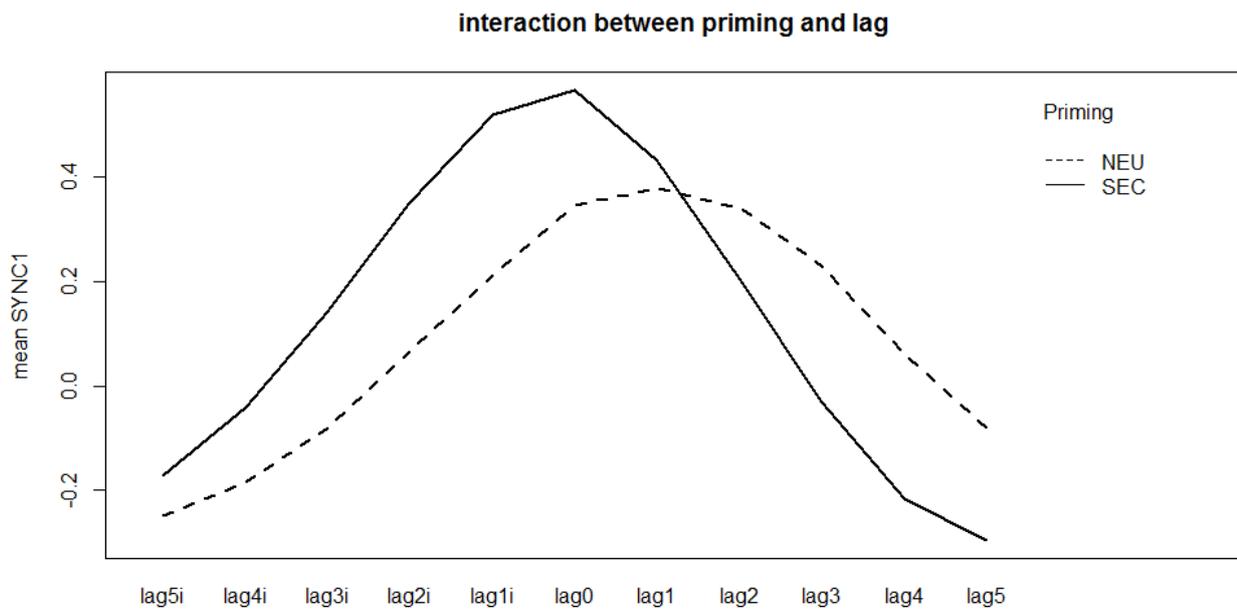


Figure 6. The interaction between priming and lag. Secure priming predicted higher SCS at lag 0 and at indirect lags.

This phenomenon puts all the effects on a common axis, with secure primed therapists at a vertex and the neutral primed psychologist at the other. Unfortunately, it is not entirely possible to assign a qualitative value to such positions, as no clear association emerged from the questionnaires, yet on an hypothetical level, both psychotherapy training and secure induction were expected to predict a higher quality of interaction. These results may therefore offer a coherent description of different degree of relational “quality” expressed as an increased tendency of the clinician to anticipate the patients ANS activations.

Further studies should try to understand the relational meaning behind this phenomenon, in order to understand how and why this anticipation occurs, where the opposite would make more sense (i.e. clinicians follows the patients’ activation as a consequence of active listening and receptivity).

6. Synchronization and Process

STUDY 3

Summing up the theoretical premises and the preliminary data presented in the previous chapters allows to draft a preliminary framework. There appears to be an ontological dependency between subjectivity (i.e. the Self, or the reflexive process of an intelligent system that lies at the hearth of identity, personality, psychopathology, and most other key human psychological characteristics), and the interaction of the individual with others, allowing us to better reframe the subject's problem in an intersubjectivity context. While the idea that a single mind is an oxymoron is starting to become widely accepted even in western thought, research on developmental age has demonstrated that a becoming human does not only needs interactions, but also *good* interactions. Good, in the sense of interaction that assist the development of higher cognitive functions, of healthier psyches, and efficacious coping mechanisms, are interactions characterized by a caring attitude which in turn is constituted by two strictly intertwined processes: early communication and scaffolding.

As shown by the many studies presented in the previous chapters, in order for the infant to develop agency on the external world, it needs to construct representations (initially pre-symbolic, and later with the emergence of secondary thought, symbolic) in the form of repeating patterns that allows to grow expectations on the environmental reactions to one own actions, igniting this way the separation process. Scaffolding also means that while these learned patterns must be broken in order to allow evolution of the first simple physiological schemes into more complex one up to the most sophisticated abstract processes of an adult, these ruptures must be gradual and happen in a safe context, as if the amount of novelty and/or distress is higher than the threshold of the system stability, it may result in a traumatic experience.

Crucially for the present study is a key finding from the Infant Research movement is that not only these early processes and relationship are fundamental for the adult configuration, as already postulated by dynamic psychology, but also that those processes are very well active in the adult and are working just in the same way as in the child, with the major difference of the addition of secondary processes and abstract thinking, which are layered upon the infant's same pre-verbal and pre-symbolic knowledge and organizational systems.

Yet, while these change-permitting processes are present in the adult, the peculiarity of the relationship needed to activate them is seldom in adult life. Although strong affective experiences both positive, such as new love stories or friendships, and negative, such as terminal illnesses diagnosis, traumatic accidents recovery, near-death experiences, etc., have all been reported to sometimes trigger life-changing processes, in the great majority of cases, the relationship that comes nearest (at least in intentions) to the mother-infant's one, in terms of potential change, is psychotherapy.

While explicated only by some theoretical models, such as the psychodynamic or psychoanalytical ones, the relational process happening during therapy is the key of clinical transformation. The explicit verbal and cognitive exchanges in the clinical dyad plays obviously an important role in the therapeutic process, as unlike in small children, the new affective dimensions need to be integrated in a pre-existing Self structure, often robust and/or rigid. Yet, the verbal exchanges alone, in their exquisitely symbolic meaning, cannot alone create the scaffolding needed for the change process to establish. In other words it could be said that the change has to be experienced in the relationship with the therapist in order to become an upgrade of the patient's schemes. The "simple" symbolic processing and comprehension is not sufficient. Furthermore, in order for this experiencing to happen, the bonding between the two members of the clinical dyad has to become much deeper than a formal explicit knowledge. There must be comprehension, contagion, empathy. In a way, a therapy will not be successful, until the same mirroring mechanisms that so seamlessly connect the gestures of a mother to that of her child will be present in the therapist, and for this to happen, to allow the transformation from two interacting individuals to a dyad, intended as the more-than-the-sum-of-its-parts emergent system, the relationship must become visceral.

Luckily this is not something unusual in the adult human relationship. We are able to attune to other in many other contexts, for instance during seduction, during mass events, and in many other everyday activities, we activate mimicry and contagion processes that spans from vocal and body behavior, up to the physiologic activations. It is evident, in conclusion that while not sufficient in itself, the clinical procedure relies on the affective sharing initiated by primitive processes such as mirroring and cross-modal matching.

Previous research on this topic, as reported previously, has just focused on the average amount of attunement, or synchronization, without considering the dynamics underlying them. For instance Ramseyer and Tschacher (2011) reported a correlation between the overall average amount of motion synchronization and therapy outcome, Marci and colleagues (2007) reported a correlation between empathy and the average synchronization of skin conductance in just one session of psychotherapy of different clinicians. Jaffe and colleagues (2001) reported more sophisticated time-series analysis to support their finding that early vocal behavior attunement could predict later attachment style development, but still did not associated the attunement dynamics to the relational ones. While these and other authors seemed to agree that synchronization is a promising index for some aspects of intersubjectivity, and may be able to predict therapeutic outcome, no previous study has investigated what exactly this synchronizing phenomena are, what triggers them, and how these can be connected to the vast knowledge, both theoretical and empirical on the clinical process.

The goal of the present work is to start to fill this gap in literature, by beginning to draw a bridge across three different information sources on the clinical process: the raw interaction data, offered by audio-video recording of therapy sessions, the theoretical interpretation offered by an evaluation of the clinical material by a trained therapist, and finally, the concordance between the autonomic nervous system activation of the patient and the therapist.

6.1 Participants and procedure

A male psychotherapist (EB, age: 41) and a female patient (AA, age: 25) were recruited to participate in the study. The psychotherapist was selected through personal knowledge, for his willingness to collaborate to the research and for his psychodynamic orientation. The patient was selected among the psychotherapist's new patients with the following criteria:

- Neurotic, or high-functioning borderline level of personality organization
- Absence of frank or previous psychiatric symptomatology
- Absence of any pharmacological treatment, in order to avoid interference in the psychophysiological measures.
- Willingness to participate to the experiment

These selection information were collected by the therapist in the context of his usual anamnestic routine for new patients. The duration of sixteen 45-minutes sessions was defined before the beginning of the actual therapy as a part of the therapeutic agreement.

The first, last and middle two sessions of AA's brief psychodynamic psychotherapy (sessions 1, 2, 7, 8, 15, 16) were recorded through audio and video. Skin conductance (SC) activity of both the patient and the therapist were continuously and simultaneously recorded for the whole duration of each session.

6.1.1 Continuous Synchronization Index. In order to isolate the moments characterized by high or low attunement in patient's and therapist's SC, a Continuous Synchronization Index (CSI) was computed by calculating the Pearson correlation index between progressive 15-seconds windows of the patient's and the therapist's SC signals. As each session had a duration of 45 minutes (2700 seconds) the basic CSI for each session was constituted by 180 progressive correlations. Additionally, in order to have information on the direction of the attunement process, the same CSI was calculated 10 additional times by introducing progressive amounts of lags, at 1 second increments, between the two series. Specifically the CSI was calculated delaying by 1, 2, 3, 4, and 5 seconds the therapist signal in comparison to the patient's one, which is called "direct lag" and the same amounts by delaying instead the patient's signal in comparison to the therapist's one, which is called "inverse lag" (defined by a 'i' letter after the number, e.g. lag 3i). High synchrony at direct lag could be associated with situations in which the patient is leading the interaction, and therapist reacts with an analogous, but delayed SC activation. The opposite is true for high correlations observed at inverse lag, where instead the therapist can be seen as leading the interaction and the patient pacing. Finally high simultaneous synchrony, i.e. at lag 0, can be associated to an intersubjective process connected to interpersonal patterns. In fact SC is a too slow signal to allow stimuli-reaction within one second.

Summing up, for each session, 180 cross-correlations of 15-seconds windows were computed for 11 different lags value, obtaining this way a 11x180 CSI Matrix (CSIM).

6.1.2 Permutation Analysis. In order to understand how much of the synchrony observed in the actual data could be attributed to the intersubjective processes, and how much to spurious correlations, the CSIM was calculated for the 132 possible pair permutations of the original patient's and therapist's signals. As expected, the permutation data did not show any relevant trend, or difference across lags, the values cover the entire range of possible values (-1 to 1; Figure 1). Surprisingly, the mean value was skewed up by about 0.042, a value that seems quite large to be casual, yet small enough to be negligible for the sake of further analysis.

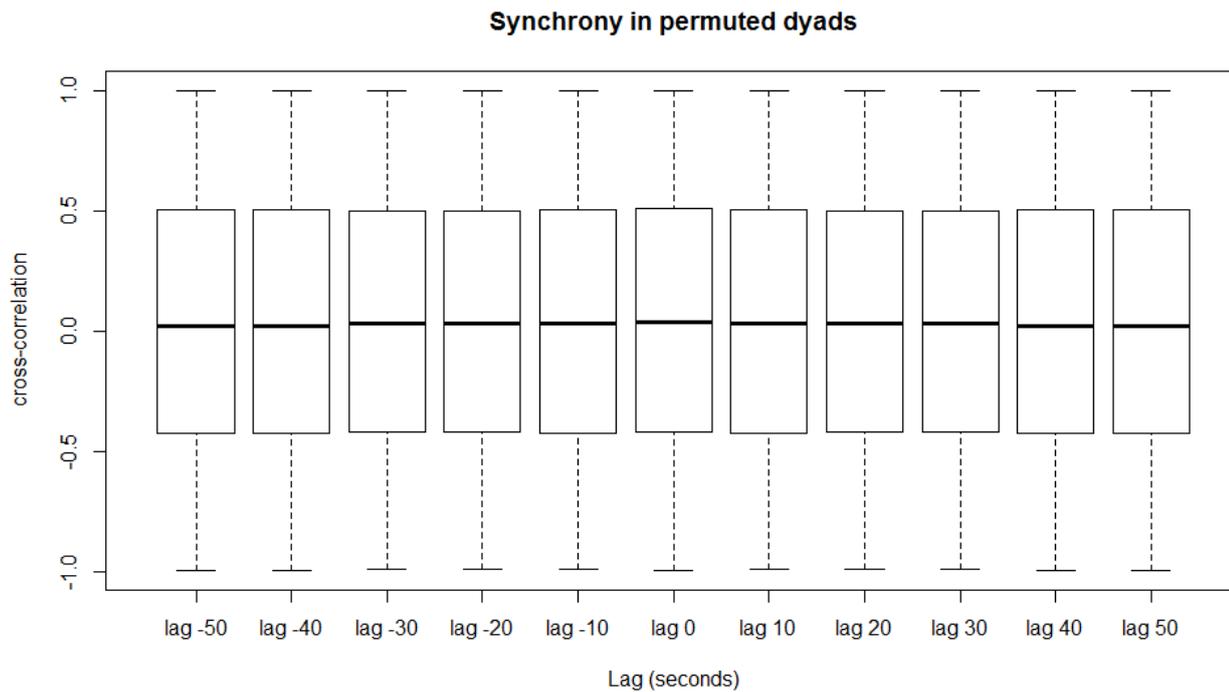


Figure 1. The boxes represent the values, for each lag, of the synchronization values of each windows of the permuted dyads.

6.1.3 Extrapolation of Salient Sequences. In order to extract from the whole 7.5 hours of recordings the moments characterized by intense physiological linkage and opposition, for each session, the CSIM was scanned for instances constituted by two or more consecutive windows with a cross-correlation higher than 0.6 or lower than -0.6. The ± 0.6 threshold was chosen in order to retain about the 20% highest and the 20% lowest values, while the two-consecutive windows criteria was chosen to furthermore exclude spurious occurrences of very high or very low synchronizations. Following these criteria the extrapolated sequences contained at least 30 seconds of intense synchronization or desynchronization at either lag. In order to ease interpretation, data for the 11 different lags were collapsed to three categories, semantically centered on the therapist: “leading” for the sequences in which the criteria were matching at inverse lags (from lag 5i to lag 2i), “pacing” for the sequences in which instead the extreme correlations were found at direct lags (from lag 2 to lag 5) and “sync” when the occurrences were characterized by high values in the central range of lags (lag 1i, 0 and 1). In the case of ties (e.g. windows in which both central range and direct lags were found matching the selection criteria), all the pertinent categories were assigned.

Due to the geometric properties of oscillating signals such as SC’s, the same patient-therapist sequence may present simultaneously very high and very low correlation values, at opposing lags (direct or inverse). For the same reasons, a mildly synchronized pattern, may appear

as highly desynchronized when applying lag. While these artifacts occurred in a very small proportion of occurrences, visual inspection of the SC signal was done for every selected sequence and the sequences in which graphical evidence was contradicting the algorithm were either removed or relabeled accordingly to the strength of the graphical evidence.

Figure 3 shows a paradigmatic example of such ambiguous sequences from the first AA's session. The extrapolation algorithm identified two overlapping windows, a high-sync one (green) from 06:26 to 06:56 and a de-sync one (red) from 06:41 to 07:11. As it is difficult to imagine that an intersubjective pattern is simultaneously synchronized and desynchronized, the explanation of the data is probably that both situations are equally likely given the data. One possible approach could be to intersect these data with the turn taking, in order to enrich the decisional process with information on who is talking, this would work under the assumption that, in an adult-adult interaction, the synchronization of emotional patterns follows the same direction as the speech, e.g. when the therapist talks, the patient has delayed physiological activations mirroring those of the clinician, an hypothesis that although reasonable, is not founded on any specific evidence.

Visual inspection of the data, while arguably a more subjective process, proves to be a more reliable process. In the Figure 3 example, the green window is labeled "pacing" pointing that the algorithm found a sustained high correlation by applying an amount of direct lag (i.e. shifting forward the blue line of the patient), yet by watching the signals it is evident that such correlation does not depend from explicit peaks correspondence, while instead the overlapped red de-synchronization window clearly presents phase opposition in peaks.

Finally overlapping or continuous windows of the same type (i.e. red or green) were merged into a single window.

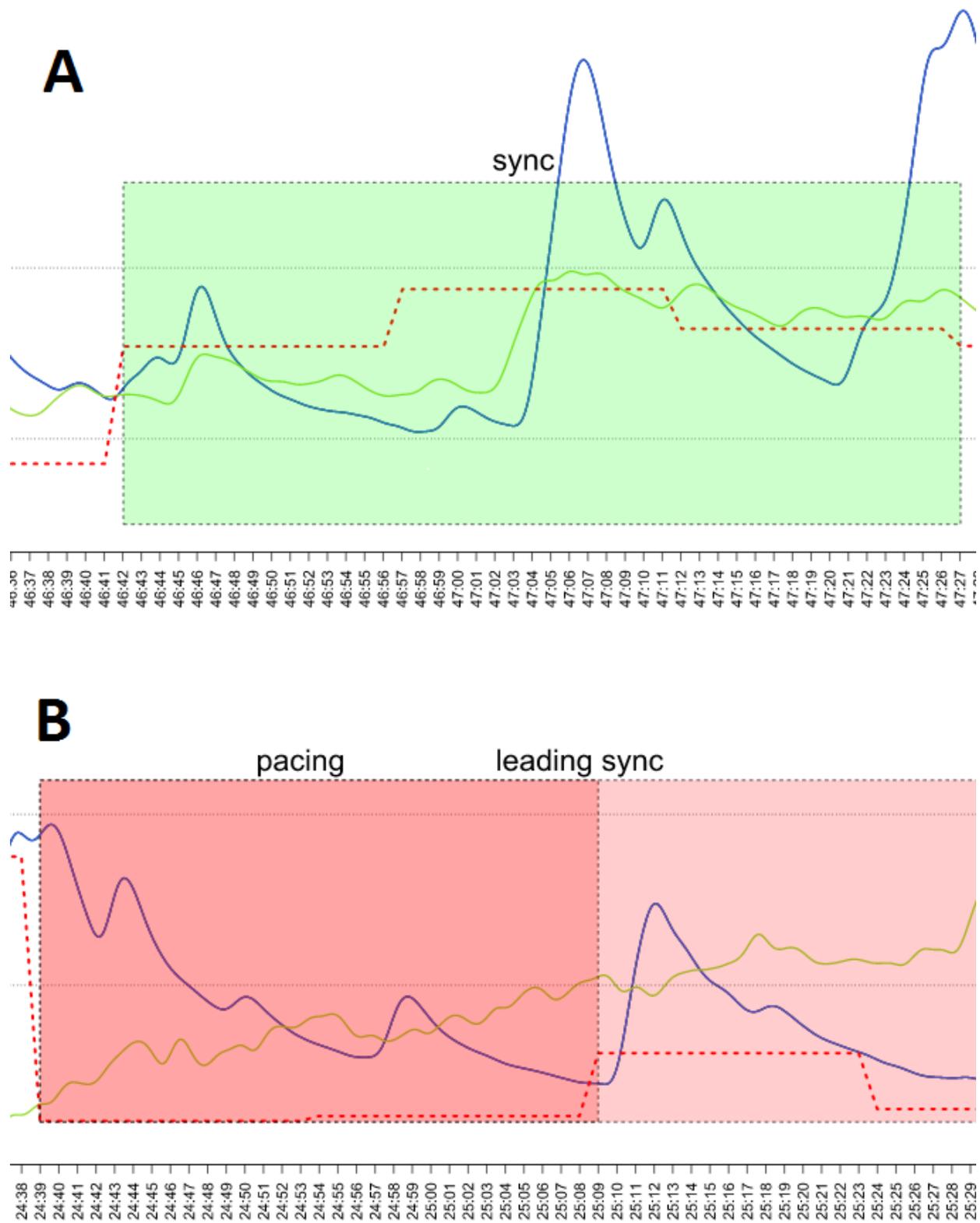


Figure 2. Graphical representation of the extrapolation of salient sequences. Both panels show the normalized simultaneous skin conductance activity of AA (patient, blue lines) and EB (therapist, green lines); the red dashed lines represents the lag 0 CSI. Panel A shows a sequence of 45 seconds characterized by almost simultaneous co-activations between patient and therapist.

Panel B, instead, presents a sequence characterized by strong oppositions between the two partners' activations.

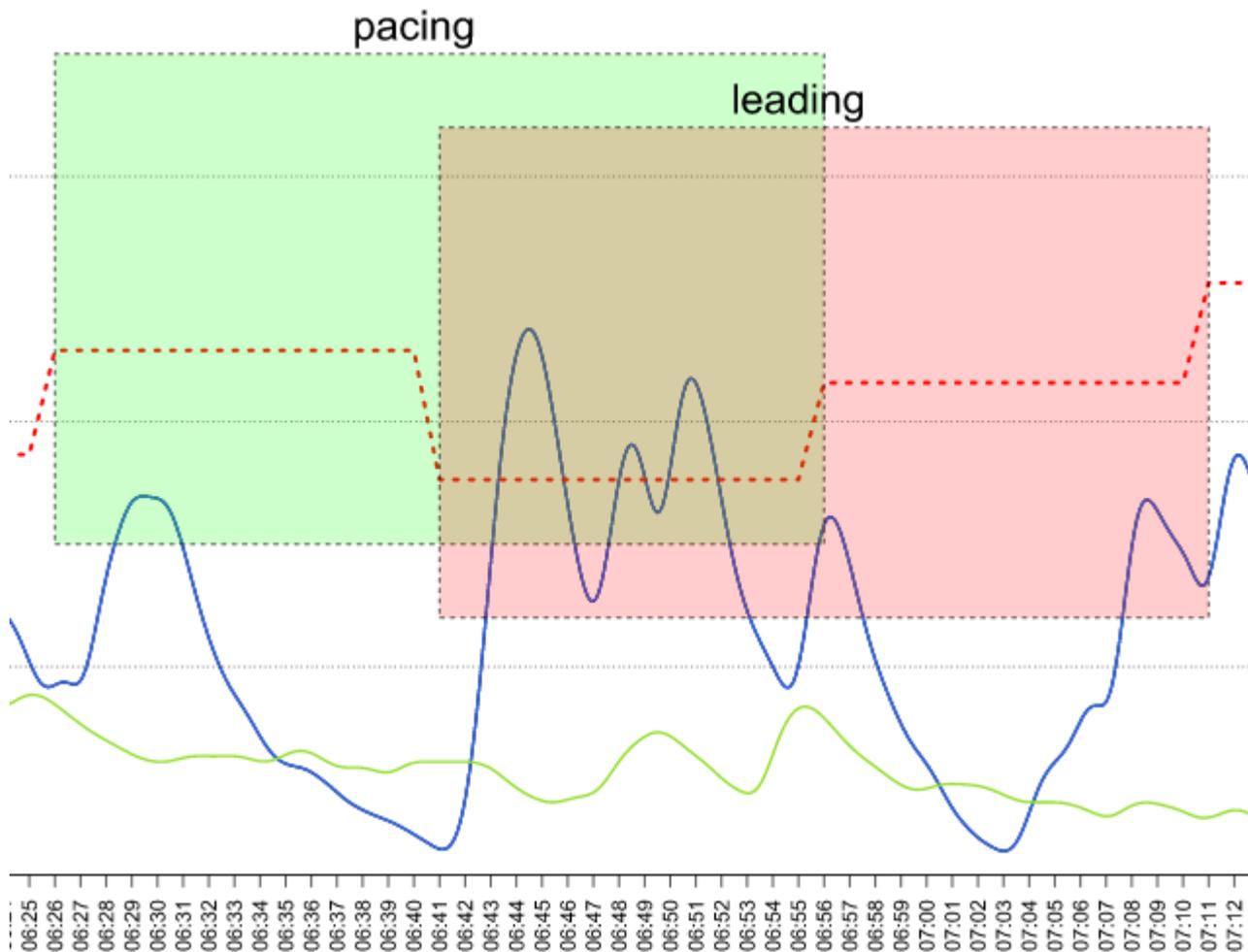


Figure 3. Overlapping windows may occur by looking at the signals through different perspectives. Under the hypothesis that in this sequence the therapist is pacing in the interaction (i.e. he, blue line, reacts with a delay to the patient’s activations marked by the green line; the red dashed lines represents the lag 0 CSI, which in this context is rather uninteresting) a positive correlation window is found from 06:26 to 06:56, under the opposite hypothesis, instead, a negative correlation window is found from 06:41 to 07:11. In such cases, it is still not possible to automatically solve the conflict. Human visual inspection is required to choose the most fitting window: in this example the leading one would be chosen.

6.1.4 Content Analysis. Following the neurophenomenology agenda, stating that “phenomenological accounts of the structure of experience and their counterparts in cognitive science relate to each other through reciprocal constraints” (Varela, 1996), the analysis of the data

are aimed to explore the bridges between physiological measurements, the clinical content and its theoretical interpretation.

In order to fulfill this goal, and since this is the first study in literature exploring this links, thus lacking previous sound theoretical and methodological guidance, a purely phenomenological approach was used to evaluate the sequences' content. Specifically Interpersonal Phenomenological Analysis (IPA; Smith 1996; Brocki and Wearden, 2006; Smith and Osborn, 2007) was initially selected to analyze this material. This methodology is applicable in a broad spectrum of topics, and is often used in health psychology (Brocki and Wearden, 2006; Biggerstaff and Thompson, 2008). IPA has a theoretical commitment to the person as a cognitive, linguistic, affective and physical being and assumes a chain of connection between people's talk and their thinking and emotional state (Smith and Osborn, 2007). Through IPA's bottom-up analysis the need of a pre-existing coding system based on a theoretical framework is substituted by the researcher's phenomenological praxis, in order to construct such a framework through abductive reasoning (Salvatore & Valsiner, 2010).

Yet, while traditional application of IPA is focused on its double hermeneutic property, i.e. the experimenter's process of trying to understand the subject's understanding process, the application in the present study had to assess an entirely different focus. Indeed, the subject of analysis in the present study is not the patient, but the dyad, intended as a system as discussed in the second chapter. At the best of my knowledge, there is no report in literature of an application of IPA on psychotherapy transcripts, and for this reason the most common IPA procedures (Smith & Osborn, 2007; Biggerstaff & Thompson, 2008) had to be heavily customized. Accordingly to these necessities, an IPA-inspired free content analysis, was performed accordingly to the following steps.

Initially the videos corresponding to the extrapolated sequences was transcribed verbatim, and both these visual and textual contents were repeatedly studied. From now on the totality of video and textual content corresponding to the salient sequences will be referred to as *corpus*. At this step the goal of the analysis was to familiarize with the dyad's members and to recognize all verbal and non-verbal material in the corpus that could be useful in understanding features of experience, sensations, and particular ideas on the dyad's intersubjective dynamics.

A second step consisted in writing a synthesis of the contents of each sequence. This was done by filling a table with a row for each sequence, and a column for each interpretative perspective used to read the clinical content. In order to allow the comparison between the results of this phenomenological process and the dyadic system theory, along the verbal and non-verbal content perspectives, three other perspectives were selected to represent the dyad system constituents: patient's processes, therapist's processes, and the dyad as a higher complexity whole.

Start	End	Type	Direction	Non verbal	Content	Patient	Therapist	Dyad
04:10	04:55	sync	pacing	Strong body synchrony, shared smiles.	T&P: Introducing the therapy	Expresses pleasantness to the experimental and clinical setting. Maybe appeasing	Warm and empathic	Interaction focused on interactive regulation
06:40	07:10	de-sync	leading	patient's auto-regulatory hand movements, long pauses, looks away, chuckles	Fear of other drivers, need of control	Oscillates in and out from interaction. Gets in touch with a conflicting area of self, yet chuckling	Active listening	The sequence matches the verbal turn change, she gets into herself, the therapist is left alone
07:55	08:25	de-sync	pacing	patient does not keep eye contact	need of having everything under control when somebody drives	Oscillates in and out from interaction. Gets in touch with a conflicting area of self, yet chuckling	Active listening	Therapist intervention catches back patient's attention only at the end causing the end of the desynchronization
10:10	10:40	sync	leading	Body movement and breath synchronized	distressing fantasies on car accidents	attentive listening, connected to the therapist words	Validates patient's suffering	dyad is involved in mutual attunement through repetition and mimicry
11:55	12:42	sync	leading	Body movement synchrony, well-paced turn exchange	Fear of travel	Expressive, reacts with freezing and deglutition to the therapist's interpretation	Active listening, reformulates and interpret	While the therapist sometimes interrupts the patient, both dyad's member are high attentive to each other
12:40	13:25	de-sync	sync	reduced movement	Criticizes her boyfriend	Oscillates back and forth toward the realization that her boyfriend does not respect her	Active listening, interrupts the patient with a suggestion that is only briefly followed	Difficult interaction, therapist suggestion is not accepted by patient

Table 1. This excerpt of the content analysis' second step shows the first six windows of the first session. Each window's content was summarized without a-priori categories, following different perspectives of verbal and non-verbal interaction, thematic content and processes. The whole table of the first session is reported in Appendix A.

An excerpt of the resulting table from the first AA's session is reported in table 1, its integral version can be found in Appendix A.

In a third step, the content description highlighted in the previous phase were clustered into encompassing categories through the identification of recurrent themes and modalities in the dyad's members, or repeating patterns, both verbal and non-verbal, and both individual and intersubjective, including therapeutic dynamics. The choice of using very broad categories for this step was decided in order to cut through the very high amount and complexity of the present data. An alternative approach could have been to use high-level categories originating from progressive levels of abstraction, on the basis of cluster analysis, in order to reach extremely data-driven models; while such methodology may have offered more predictive power, the amount of time and resources required by such an approach would have been overwhelming. The selected approach of using only very micro (step 2) and very macro (step 3) categories proved to be relatively economical, and offered a sufficient dialogue between phenomenological complexity and modelling needs.

In conclusion, of the third step, five macro-categories were identified, two broadly describing the state of the patient: egosyntonic (ES) and egodystonic (ED); and three broadly describing the interventions of the therapist: interventions with supportive functions (IS), interventions of expressive nature (IE), and interventions containing both supportive and expressive elements (ISE).

Egosyntonic and egodystonic are two terms stemming from the psychoanalytical tradition, yet were used here in a very unspecific acceptation. Specifically, ED was coded wherever either considered perspective was suggesting turbulence in the relational flow; in most of the instances that was declined in the patient expressing a conflictual content, usually with conflicting modalities. Contrarily, ES was coded whenever patient and therapist appeared to be one with themselves, i.e. in contact with their emotions and the other. For instance a smile or laugh of the patient, would have been scored ED, if it occurred while describing a traumatic experience, or if used as a nervous tension reliever, and instead ES, if it matched a joyful process.

Finally, the last step of content analysis consisted in the observation of the relationships between the micro descriptions, macro-categories, lag directions, and vocalization turns of the high and low synchrony sequences. This step was mostly performed through frequencies comparison, and allowed to start drawing connection points among data and theory, with the ultimate aim of proposing a tentative data-driven model of interaction in the clinical context.

6.2 Results

6.2.1 Skin conductance. Non-random physiological linkage was observed in the clinical dyad (figure 4). As in the preliminary studies presented in the two previous chapters, the cross-correlation function of the real SC signals shows a parabolic pattern, showing that the highest synchronization levels were most simultaneous or slightly lagged in both directions.

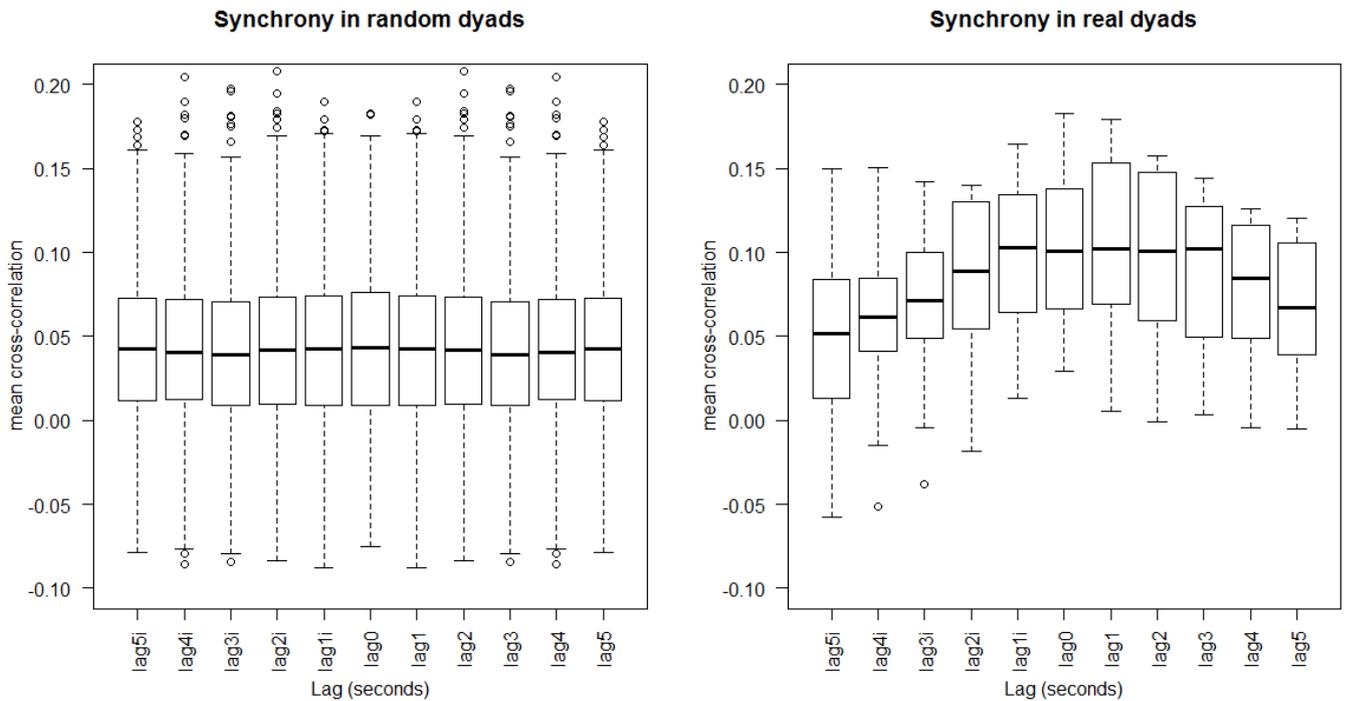


Figure 4. The boxplot represents the mean cross-correlations of the permuted sessions (left panel) and of the real sessions (right panel)

6.2.2 Sequences Extrapolation. The automatic process of extrapolation of relevant sequences, characterized by very high positive or negative cross correlation returned a total of 298 sequences across the considered sessions. Table 2 reports a summary of distribution, type and duration of the sequences across the sessions. The mean duration of each sequence was between 33 and 43 seconds and while in the first three considered sessions red and green sequences were equivalent, in the later three considered sessions the amount of green sequences increased up to a factor of 50% in session 15.

After the removal of artefactual sequences and the merging of consecutive or overlapped sequences of the same type, 251 windows were considered for subsequent analysis.

session	n sequences	n green	n red	mean duration green	mean duration red
1	42	24	18	00:00:33	00:00:37
2	43	21	22	00:00:35	00:00:36
7	45	22	23	00:00:34	00:00:33
8	46	28	18	00:00:41	00:00:33
15	63	42	21	00:00:36	00:00:43
16	59	37	22	00:00:38	00:00:34

Table 2. Summary of the relevant sequences automatically extracted from the SC data.

Table 3 shows the lag direction of the extracted sequences separated by type of correlation (direct, green, or inverse red) and session numbers. The sequences identified as “mixed” or in which it was impossible to define a lag predominance were excluded from this table, but not from the content analysis. In the last two sessions there was an overall increase of “pacing” type of windows, and “sync” windows tend to be slightly more probable to be green. Aside from these observations, no clear pattern emerges from this frequencies.

Session	leading green	leading red	pacing green	pacing red	sync green	sync red
1	9	6	8	6	4	2
2	6	6	6	6	6	8
7	11	10	7	6	3	2
8	11	6	8	7	3	3
15	9	7	16	11	8	3
16	9	5	14	9	6	4
TOTAL	55	40	59	45	30	22

Table 3. Summary of the lag direction of the extracted sequences after artifact removal

6.2.3 Themes analysis. After the careful multi-perspective description of the sequences, macro-categories were selected for content and process. In regard to verbal content, the following 9 macro categories were mostly represented in the selected sequences: the patient’s boyfriend, herself, her father, the rest of her family, traveling and her fear of it, her boyfriend’s family in general and specifically his mother, the therapeutic process and her car accident; Figure 5 reports all the thematic categories and their relative frequency; minor infrequent themes were condensed into a “others” category. In order to give a sense of the material, the three most frequent categories are here presented in detail with some verbatim examples.

Therapy themes

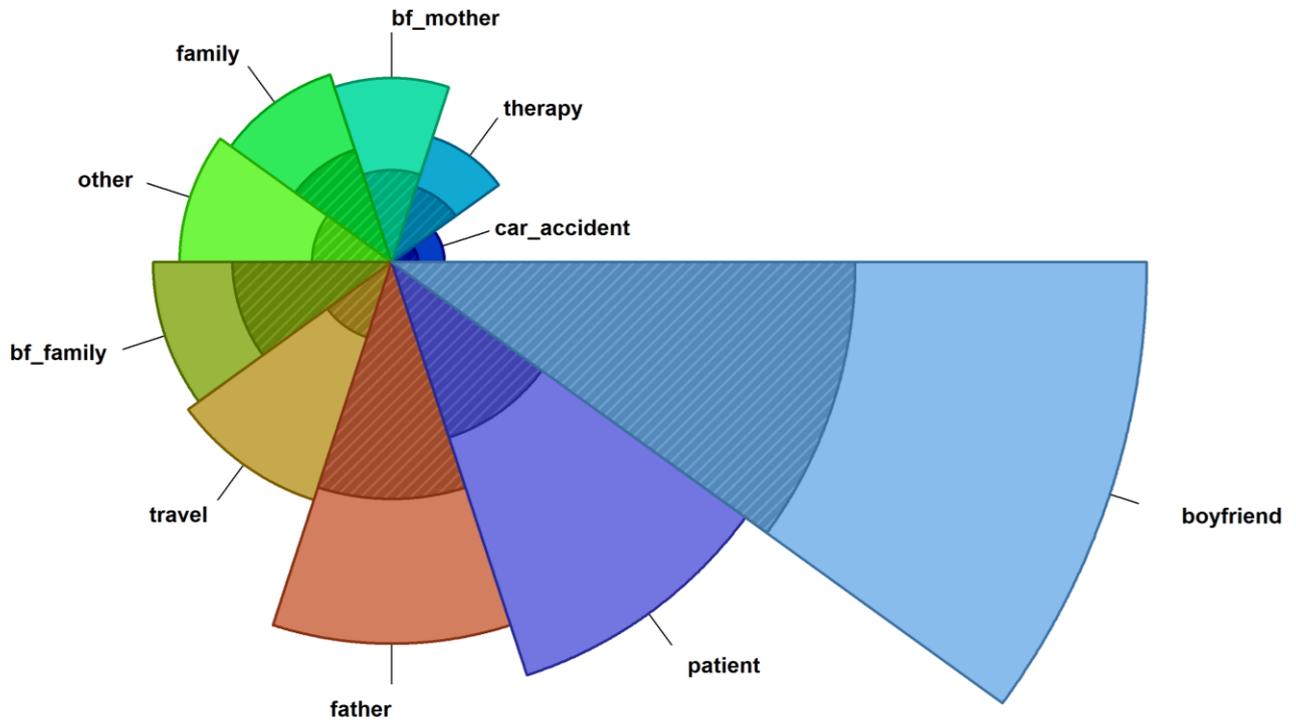


Figure 5. Coxcomb diagram of the therapy topics. The radius of each slice is proportional to that topic frequency in the selected sequences. Inside each slice, the darker, shaded area represents the proportion of occurrences of the topic in a high synchronization sequence, in contrast to the lighter area representing high desynchronization sequences. For instance, the “boyfriend”, “father” and “family” themes appeared slightly more often in high synchronization sequences, whereas other themes, such as “patient” or “travel”, showed up predominantly in “red” desynchronized phases.

Boyfriend. This was the most representative category, and one of the crucial topics of AA’s therapy. This category encompasses all the sequences in which the topic was AA’s boyfriend, the relationship with him, any free association linkable with him, with the only exception of his mother and family, that since were very frequent topics, formed two independent categories.

Two verbatim examples of the content of a “boyfriend” sequence follows. The first one in a high synchronization sequence:

Session 16, from 23'57'' to 24'27'' – Synchrony

P: ...mmh maybe I'm realizing what I had to deal with, that maybe before I tended to see [him] as the only source of truth, I mean the things he said were... were law, and now instead, I have maybe realized, more... I am realizing that I had to deal with a very fragile person. Very insecure...

T: How does that make you feel?

P: its... That I was insecure, and... eh, with this awareness, I would live our relat... all what our relation has been in a different way. Because as many times...

T: Why "would"? Why do you use the conditional mood? What keeps you from saying "with this awareness I live our relationship in a different way"?

And the second one from a high desynchronization sequence:

Session 1, from 12'40'' to 13'25'' – De-synchrony

P: Exactly. I mean, I don't believe that from his side there is an intentional evil, yet...

T: Neither do I

P: But when I'm there, I really feel the desire of telling him whatever really... It's clear that if we are with other people...

T: Telling him 'whatever' what? What would you tell him?

P: I would tell him that he does not understand me... I think that he sometimes has very rigid ways of thinking; meaning that he has mental categories that hardly...

Patient. The second most representative theme was the one comprising all the discussion regarding the patient herself, her representation of herself, the way she and the therapist see her and her behavior. Two excerpts follows:

Session 16, from 43'13'' to 44'42'' – Synchrony

T: (...) When... when you do things in the wrong way, it's because you did not trust your intuition, that you shouldn't be there doing that in that way.

P: Mmmh, indeed, in this vein, I'm evaluating also other things that, that I did, and if eventually the result in the end was, not necessarily negative, but um, I didn't do them with the firmness they deserved... um or didn't deserve. But... However, when he [her father] started to yell these things I managed to tell him that he had better calm down, that there was no need to scream, for starters...

Session 2, from 8'30'' to 9'00'' – De-synchrony

T: [talking about a previous session, missed without notice] (...) Furthermore there is this feeling of being in fault. As if it were not legitimate to make mistakes.

P: This is true but unfortunately... I mean... with the awareness that it requires time for the equipment [the SC measure device], for you, the experimenter that comes, I'm always, hence, on time... and me being the only... the missing part... it's a thing that, a bit, frustra... no, not frustrated... not... I was feeling, yes, faulty.

T: Objectively yes, there was fault, there was the relative inconvenience, it is not that...

P: Yes, whatever... but...

Father. The second most relevant character in AA's therapy, her father and hers relationship with him made the third category.

Session 15, from 20'20'' to 21'50'' – Synchrony

T: (...) [For her father] it is not a pleasure to tune on your needs of home, study, University, he tunes on his own need, gym, car, travel in America, giving you things that certainly are pleasing, but not the essential things, it is how if he was saying: "I give you the things that I like and I take you away the things you need.

P: Yes that's exactly how it is. Also because... I don't know... I think that he really has a pathological relationship with... with money, and furthermore he has this passion for these cars um, and he has a garage full of cars...

T: And you don't have one

P: Exactly. I mean, other times in which him... he has this constancy that he always pleads poor, and thus, when I was younger, and maybe more naïve, many times I did not expressed him my necessities and expenses, and I cared for them with the money that I saved, from small jobs and all the things I was doing...

Session 7, from 42'32'' to 43'32'' – De-synchrony

P: (...) and now it occurs to me... I had another flash... when I was a child and I had to stay alone with my father, maybe doing a walk, whatever... I didn't want to stand for it, and when I had to, I remember that I prepared myself, before going out, some topic or questions, something to talk about, so that there were no... "downtimes"... and he could not scold me... I mean, I don't know... I feared to be scolded... thus for not... I prepared beforehand things to talk about so that he could not... It just came to my mind... just now.

T: Well yes. If we were wondering from where it [the inability to express her own needs] came from... now we see that we're getting closer

P: Yes

T: Why can't you say "Bolognese sauce", and you say instead "Pesto sauce" [Referring to a previous episode in which the patient felt compelled to choose a sauce she didn't like and to turn down her favorite one to please other diners] ? Because since you were a child you prepared "pesto-argumentations".

P: [laughs] It's true

T: To fill a space that otherwise would have been full of scolding...

6.2.5 Process analysis. As described in the methodological section, the manifold perspectives outlined in the first steps of the content analysis were condensed into four broad macro categories, two defining the ego-states of the patient (ES, ED) and three defining the type of intervention (IE, IS, ISE). For both contexts “none” was coded whenever these broad categories were not applicable, for instance in those sequences in which only one member of the dyad had an active role for the whole duration, and nonverbal information were not sufficient to infer the state of the interlocutor. Figure 6 reports the relative frequencies of those occurrences split by high sync (dark areas) and de-sync (light areas).

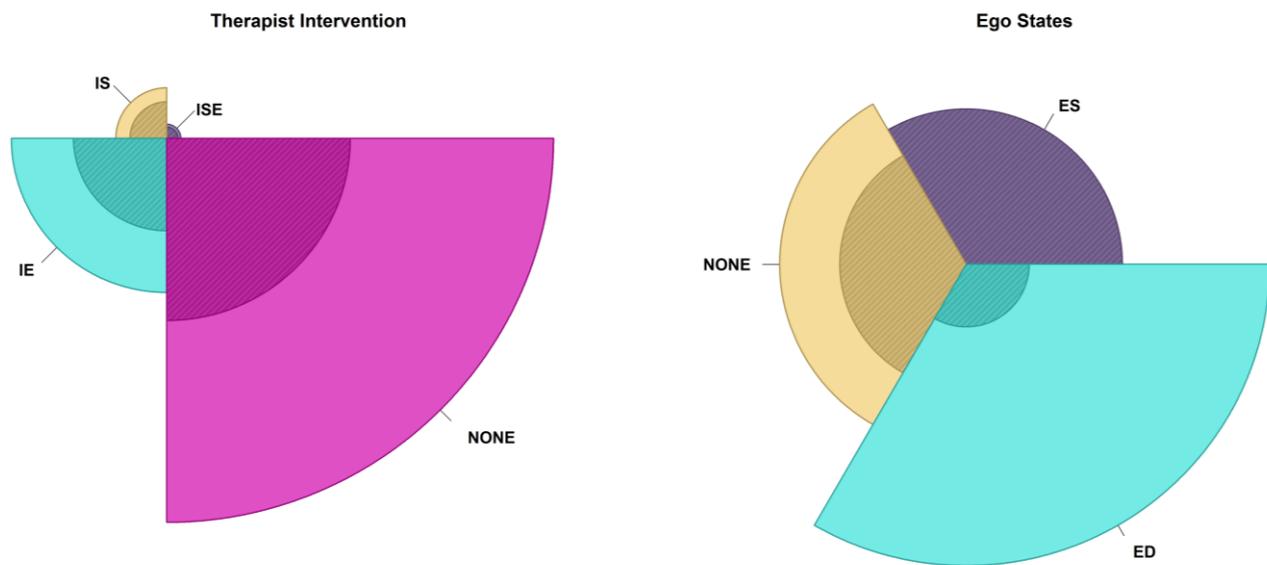


Figure 6. Coxcomb diagrams reporting the relative frequencies of therapists’ interventions (left panel) and patient’s ego-states (right panel). The difference in proportions is expressed by the radius of the slices. Each slice additionally reports the ratio between occurrences of the slice’s category during synchronization sequences (darker and shaded area) and those during desynchronization sequences (lighter flat areas). Intervention with supportive nature (IS, ISE) happened mostly during green, high synchronization sequences, whereas expressive interventions were not so explicitly connoted. Ego states were also highly polarized, with all the ES occurrences found during high synchronization sequences and a great majority of ED occurrences found during high desynchronization sequences.

The following example is an excerpt of an interaction coded as ES. During this sequence, the patient is able to express sadness toward the father’s behaviour, and, later to autonomously describe one of her main defense mechanisms. Nonverbal behaviour is coherent with her words, and able to convey a strong emotional content, which is received by the therapist that interacts with

short empathic sentences (not sufficiently structured to be coded as IS), and a body posture and movements that communicate an attitude of empathic listening. The sequence, as every other ES sequences, is characterized by high synchronization.

Session 1 from 30'11'' to 30'41'' – Synchrony

P: [talking about her father] But, also with him, I see that there are seldom times in which, if I pass a given limit, it kicks off... it kicks off the fact that he raises his voice.

T: Also to you?

P: Yes, actually it may happen one or two times a year, but when it happens, it clearly hurts

T: Yes, darn!

P: And when... I mean... My defense, that prevented me to be overwhelmed, to collapse, was, in my head, to not admit him to be right. Everything he says is a stupid thing, he's not right, everything he says, he says because he's nervous for his own reasons, and thus this purs on me. And thus this thing makes me always stay a step behind instead than a step forward, with him.

The next excerpt instead is of a high synchrony sequence coded as ED. The patient talks about her boyfriend, with whom she broke up during the course of the therapy. Her anger is not able to fully express, neither verbally nor bodily, especially at the end of the episode, at the emotional peak of the narration, when she says the word “annoying”, she immediately changes tone, and devaluates that feeling by saying “whatever” to herself, after which she is not able to finish a sentence up until the end of the sequence (which coincide with a therapist intervention). Concerning nonverbal behaviour, her left foot is hold up in tension and her hands when not involved in gesticulation are employed for self-regulatory movements, such as fixing her glasses' position, or touching her hairs and ears. While the therapist does not intervene verbally, he nods and hums empathically at rhythm with the patient's prosody, and in two occurrences, during patient's pauses, they both simultaneously breathe deeply.

Session 8 from 24'20'' to 25' 20'' – Synchrony

P: Now that you tell me that, by the way... it is not directly related but... er... both the journalist with which I met and other two people that are, let's say, our friends, with whom we sometimes used to stay, they made me notice that, that my boyfriend said that he had broken up with me instead that we both agreed to and decided together, but that he did it, and she said that he was stressing this a lot, and a third person also showed a text message in which he wrote "I left [patient's name]" ... that also... whatever, it was annoying, but this, I don't know if maybe... It could be linked to... Maybe has to do with...

Another example of an ED sequence follows, this time during a de-synchronized phase. The patient describes a conflict toward the mother of her boyfriend, a woman with strong personality, which is followed by many people that share her boyfriend's family daily life. The patient is crying during the sequence, whenever she and the therapist make eye contact she looks down, with distress. The speech is disorganized and her voice is broken, her left foot is held up in tension, as often happens to AA when facing distressful topics. The therapist sits silent and almost motionless for the most part of the sequence, toward the end he nods rhythmically but in a phase in which the patient is not looking at him.

Session 2 from 34'15'' to 34'45'' – De-synchrony

P: It's that unfortunately... I feel the desire to stay with... with this person, with my boyfriend, and everything but..

T: Sure...

P: I am not willing to become like the others [the followers] also because... I came to know, with time, that clearly, when also the families of these people became aware that something happened... to... to their children, they also had.. I mean, they went to the court against her...

T: Sure.

Additionally to these coding, data on the vocal turns (small utterances from the other interlocutor that did not interrupt major sentences were not coded as “Both”) and on the synchrony lag direction were collected and placed by side to the other codes. Frequencies of these data are presented in figure 7. Vocal turns led by the patient, or characterized by equal exchanges where not associated to synchrony or de-synchrony, while most sequences led by the therapist were associated to high SC synchronization.

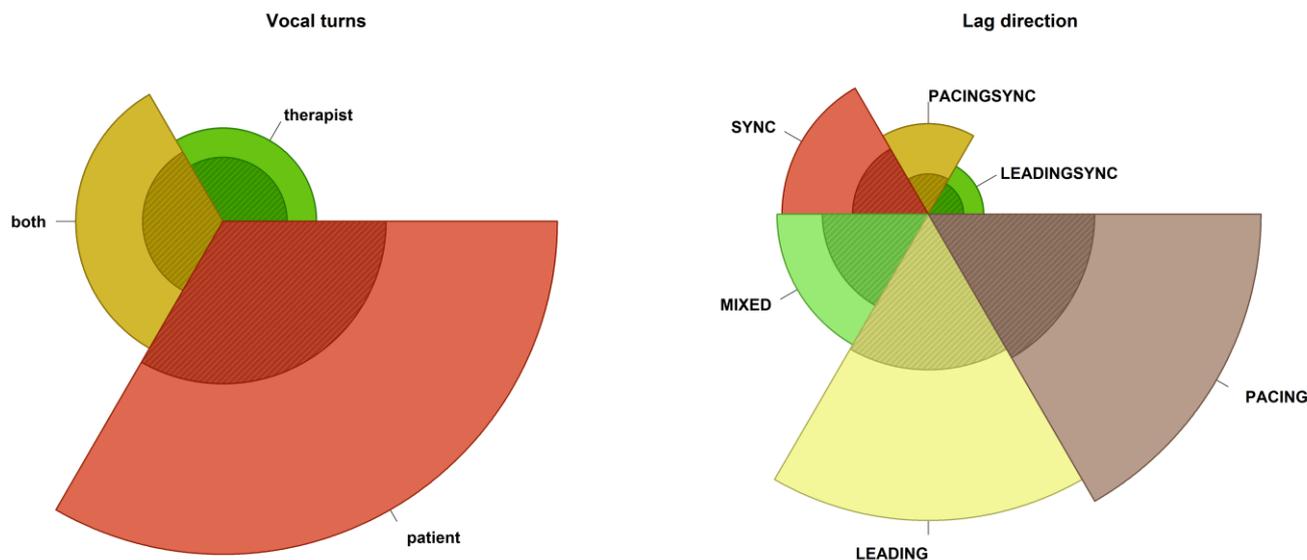


Figure 7. Coxcomb diagrams representing the relative frequencies of the leading speaker in the sequences duration (left panel) and those of observed lag direction (right panel). Just as in previous plots, the darker shaded area corresponds to the ratio of high synchronization sequences for each category, opposed to the high desynchronization in lighter flat colours.

6.2.6 Longitudinal analysis. Whereas the data from only 6 sessions does not allow a great power for longitudinal consideration, the relationship between the collected codes and the session progression was investigated in an exploratory fashion. Figure 8 shows the same data presented in the previous coxcomb diagrams but split among the sessions. The most straightforward observations are the progressive reduction of therapist-only vocal turns in favour to a more paced rhythm of exchanges (panel B) and a reduction of supportive interventions in the second half of the therapy in favour to expressive or supportive-expressive ones. Similarly, the amount of “mixed” lag synchrony, slightly increased during the course of therapy (with exception of session 8), and the “leading” kind of synchronization (i.e. when the SC of the patient was found to be similar to that of the therapist when lagged by a few seconds) peaked in the central sessions, and remained low in the extreme ones.

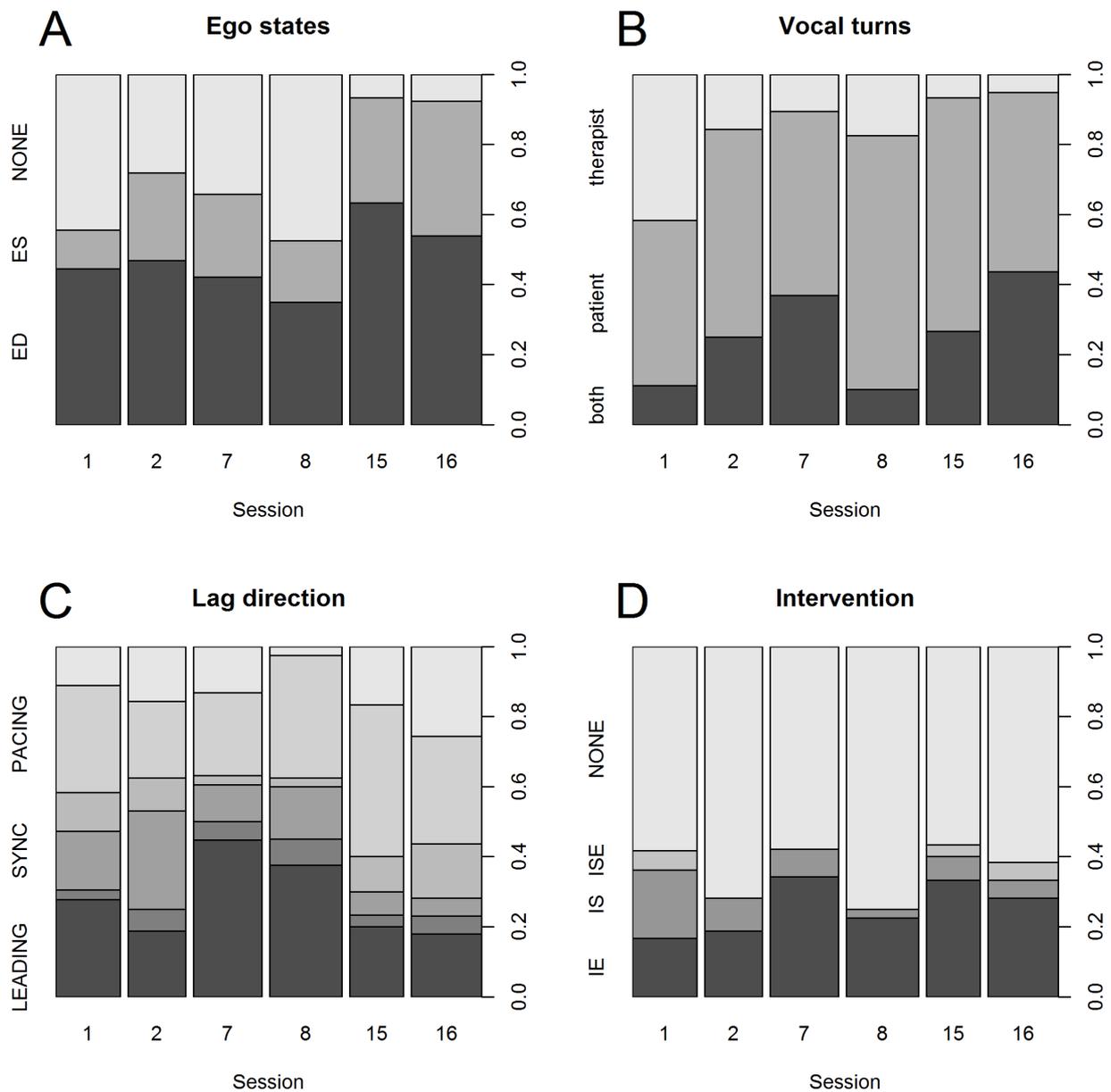


Figure 8. Spine plots representing the coded Ego states (Panel A), vocal turns (Panel B), synchrony lag direction (Panel C) and kind of intervention (Panel D) relative frequencies across the six sessions.

6.2.7 Crossed levels analysis. The last step of this exploratory content analysis consisted in crossing the various levels of collected information in order to try to build a bridge among the various different phenomena observed both physiologically and behaviourally.

The first analysis consisted in the observation of the three-way interaction between coded ego states, therapist interventions, and physiological linkage. Figure 9 presents this information split by typology of interventions. It is evident from the plot how in the case of interventions with expressive contents (IE and ISE), the ego-dystonic phases of the patient were mostly associated to a physiological desynchronization of the dyad, whereas in the case of supportive interventions, there

were much less ED occurrences and, most notably, they were all associated to high SC synchrony in the dyad. On the contrary, those sequences in which no clear ego-state was detectable were slightly more often characterized by high synchrony in concomitance to interventions with expressive nature.

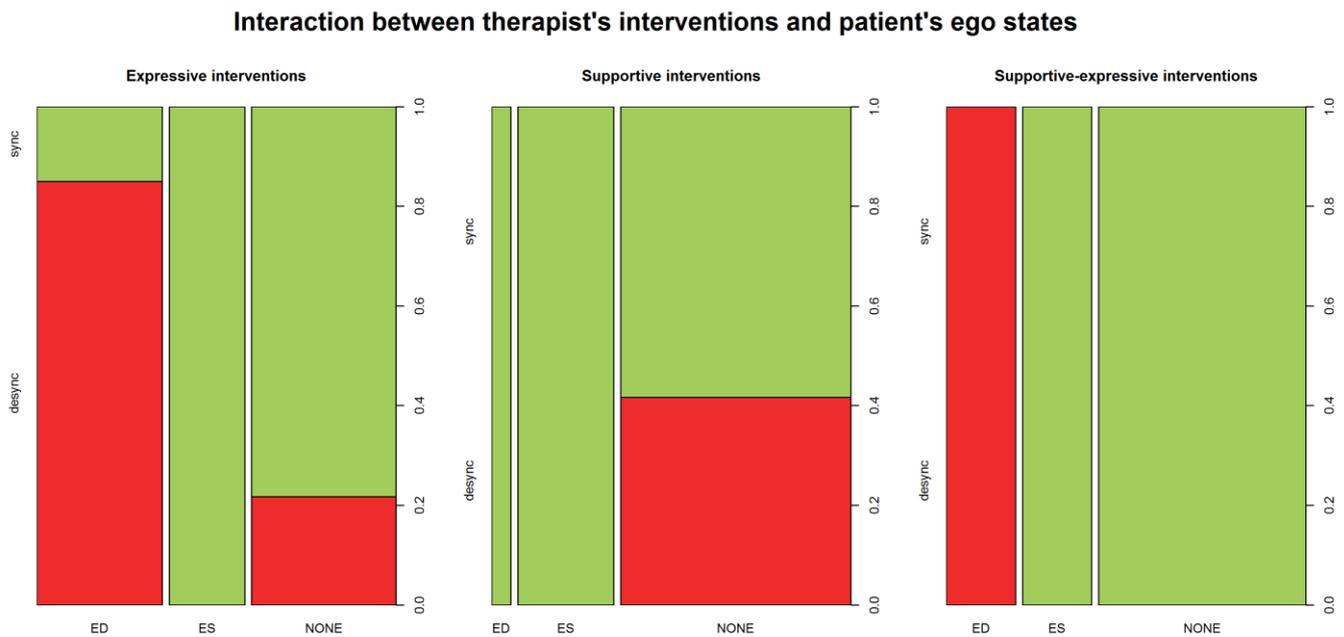


Figure 9. The three spline plots present the relative occurrence frequency of high vs low synchrony and syntonic or dystonic ego-states, accordingly to the three different categories of coded therapeutic intervention: expressive interventions (left panel), supportive interventions (middle panel) and interventions with both supportive and expressive contents (right panel). The slim and green ED bar in the middle panel, means that there were overall few occurrences of ED during ISs and when it did happen, it was accompanied by dyadic physiological synchrony, in contrast to the EDs observed in concomitance to interventions with expressive nature.

While the high synchronizations in the ED-IS condition were an expected phenomenon, compatible with and providing support to the theoretical framework, the (relatively few) high synchronizations in the ED-IE condition were more puzzling. Thus, the micro-level analysis (e.g. Table 1) for those sequences was re-analysed to find constancies that could explain the physiological linkage in those moments. The information extrapolated from this process was then compared to the micro-level codes of the de-synchronized ED sequences, in order to verify that the found constancies were specific to the sync-ED condition, in absence of supportive content.

This additional layer of analysis highlighted two interaction pattern that seemed univocally associated to those unexpected high-synchrony occurrences:

- 1) Expressive interventions happening during fast paced turn exchanges between patient and therapist, and generally in a phase of intense interaction, as opposed to other phases characterized by long sentences by both dyad's members. Often, in these occasions, the expressive content of the intervention was "already in the field" and was being accepted or elaborated promptly by the patient. These kind of interactions were more frequent toward the last sessions, and were characterized by high verbal and non-verbal synchronization and reciprocity, that allowed for fast and smooth co-regulation.
- 2) Sequences in which, although no explicit supportive process was acted by the therapist, his empathic listening was very focused. This was usually observed in a very high nonverbal synchronization, such as of simultaneous breathing, self-regulatory movements, or posture changes, or with rhythmic head or body movements that matched those of the patient (for instance a rhythmic nodding, in phase with the patient's gesticulation), together with high levels of eye contacts during the sequence. These sequences were most often characterized by patient's speaking and therapist listening, and by a "pacing" synchrony (i.e. the therapist's SC peaks following the patient's ones).

Conversely, the ED happening during physiological de-synchronization were characterized by three prototypical types of interaction:

- 1) Intense expressive interventions of the therapist, such as deep interpretations, that were unsettling for the patient. Generally speaking, in these kind of episodes the words of the therapist left the patient worried and silent, often with subtle nonverbal manifestations of distress and tension, such as by muscular contraction of a hand or foot, or by acting "freezing-like" behaviours, as reduced breathing rate and body movement and gaze fixation with reduced blinking. Alternatively, these interventions led her to a more active manifestation of distress such as promptly changing the subject, or covertly denying or criticizing the therapist.
- 2) Episodes in which, although the therapist was present in the interaction, with active listening and emphatic attitude, the content brought by the patient was too emotionally intense to allow her to stay in relationship with him. These sequences were characterized by a dominant amount of self-regulatory process of the patient, who looked away from him, lowered the pitch of the voice, talked in a less organized fashion, cried, touched herself (e.g. touching her hairs, rubbing a hand on a leg, etc.) and orientated her body posture in directions different from that of the clinician.
- 3) Finally, interactions in which the distressful contents brought by the patient were not matched by a reaction from the therapist. In these occasions, either the therapist stood

still and silent, listening passively, without giving signals of any kind, or the manifestations of his active presence were not attuned with the processes of the patient. Examples of this latter expression were: giving attentional signals (such as nodding) when the patient wasn't looking, humming or producing short empathic utterances that overlapped the patient's voice, or even interrupting her flow without starting a new interactional pattern, and, generally, with behaviours not rhythmically aligned with the patient. Interactions in this category gave a perception of roughness and misalignment.

6.3 Discussion

Empathy, reciprocal understanding, intersubjectivity, ultimately, relationships, are different tightly intersected sets of phenomena that are only artificially split by the scientific reasoning. Indeed, among their (more or less) vague definitions they all share the common insight, repeatedly verified by empirical observation, that a fundamental part of “being with” the other is “being alike” the other. Furthermore, plentiful of studies across many field of psychology have verified another old knowledge, that “being alike” has the consequence of “being liked”. Eventually, following this simplistic way of reasoning, the conclusion may be drawn that upon these two simple mechanisms, just like the simple fractal generator rules, many of the extremely sophisticated social dynamics are built. Yet such reasoning only takes in consideration one side of the coin. An interaction based only on mimicry will be perceived as fake and deceiving, just as a social organization with extremely tight cultural identity will originate proportionally strong dissident factions, as well as a child whom opportunities to update its own learned schemes will delay its development and eventually never learn more mature coping strategies, as abundantly shown by attachment research.

The two complementary dimensions of equality and diversity, with their temporal manifestation of synchrony and desynchronization are thus crucial in the understanding of social interaction at any scale of observation. Previous research in this work and by other authors has shown ways to monitor and measure some manifestations of this temporal dynamic, and put it in relation with many crucial topics of contemporary psychological research: empathy, therapeutic efficacy, therapeutic alliance, to name a few.

The goal of the present research was an in-depth exploration of the clinical phenomena associated with physiological synchronization in the psychotherapeutic dyad. A detailed micro analysis of verbal, nonverbal and processual contents of very high and very low SC synchrony sequences was performed in order to understand which processes and which behaviour was accountable for SC synchronization. A perhaps less explicit aim, was, similarly, to understand the

connections between these processes and synchronization, in the perspective of verifying previous suggestions (Marci et al., 2007; Messina et al., 2012) proposing SC synchronization as a possible index of empathy.

These observations were performed on the first, middle, and last two sessions of a brief psychodynamic psychotherapy. Each of the six sessions was audio and video recorded, and simultaneous skin conductance measurements of both the patient and the therapist were acquired for the whole session duration. An algorithm was run on the SC data to extrapolate the sequences of at least 30 seconds, with highest and lowest windowed cross-correlation. The algorithm included a lag analysis in order to find sequences which correlation was above the selected threshold when shifting forward or backward the signal of the therapist in respect to that of the patient. Visual inspection of the plotted SC signal in the extrapolated sequences was performed to check for artefacts and to solve overlapping windows; of the 298 sequences originally identified by the algorithm, 251 were retained after this procedure, their mean duration was 36.1 seconds.

The videos and transcript corresponding to those high-correlation time frames were then subject of a detailed content analysis, inspired by idiographic methodologies such as the Interpretative Phenomenological Analysis. During this process, the clinical interaction content of each sequence was synthesized under the following five perspectives, two focused on content, verbal and non-verbal and three, reflecting the three components of a dyad system, focused on the processes of the patient, the therapist, and the dyad as a whole. Additionally to these perspectives, in this phase, information on leading vocal turns, lag direction and type of synchronization were collected and coded for each sequence.

After a thorough observation of this micro-analysis, five macro-categories were identified to broadly describe the contents of the sequences' interactions; two categories to represent the experience of the patient: ED (47.0%) and ES (24.2%), pointing respectively to situations in which there was an evident conflict between different communication modalities in the patient, or conversely to phases in which emotional, cognitive and bodily expressions were coherent. Other three macro-categories were chosen to represent the type of therapist intervention: IE (25.6%), IS (8.4%), ISE (2.3%), interventions with respectively, expressive, supportive, or supportive-expressive focuses. The reported percentages are referred to the share of all 251 sequences that were coded that way. It is noteworthy that the labels chosen for these categories are not used in a specific theoretical acceptance, they were chosen as their lexical meaning was the one best fitting the observed categories. Finally, all the coded information, at every level was put in mutual relationship in the last step of analysis, which is summarized in table 4.

The first relevant result was the observation that ES and ED codes were strongly polarized in regard to the kind of synchronization. Specifically every ES occurrence was found during a

“green” high-correlation sequence, whereas most (79.8%) ED occurrences were found during a “red” high desynchronization sequence. The fewer sequences coded as ED, but presenting high synchrony, were found to be characterized by an efficacious supportive behaviour by the therapist, either with verbal interventions (coded IS) or powerful non-verbal communications characterized as well by high movement and breathing synchronization. A minority of high-synchronization-ED were found instead to present fast-paced turn exchanges between therapist and patient, usually with expressive focus concerning the therapist’s contents.

	Synchrony	De-synchrony
Phenomena	Smooth interactions and tight bonding manifested by: <ul style="list-style-type: none"> • Ego syntonic processes • Conflictual content hold by therapist’s supportive and emphatic interventions 	Withdrawal from interaction caused by: <ul style="list-style-type: none"> • (Too?) intense expressive interventions • Excess of self-regulation • Silence and lack of motion
Description	SC synchronization is observed during interactions characterized by a good communication flow, and often high synchronization in other communicative modalities, such as body movements.	SC desynchronization is observed when the communicative flow interrupts, there is contrast or incomprehension in the dyad, or withdrawal from one of the members.
Interpretation	Both in presence or absence of conflictual content, SC synchronization is associated with “staying with the other”, in processes otherwise described as patterns-building or alliance building. Might be a marker of empathy, emotional contagion, and relational reparations.	Usually observed in concomitance to distressful interactions, desynchronized sequences encompass relational disengagements from both the therapist and the patient. May be associated to relational disruptions, as well as to phases of dominant self-regulatory processes.

Table 4. The content analysis main findings are synthetized in the table

These contingencies may be interpreted in the sense of “staying in relationship”, i.e. high synchronization is observed either when the patient is showing high integration of the self and mature interaction, or when the therapist puts an explicit and efficacious effort in empathic and caring behaviours. Conversely, high desynchronization sequences were characterized by disconnection of the communicative bonding; such interruption was mainly observed in two typical

situations, firstly when the emotional distress of the patient was overwhelming, either as an effect of patient's own narration, or of a therapist's intense expressive intervention, or, secondly, when one of the two interlocutor withdraw from the interaction, both with verbal and non-verbal modalities.

According to the dyad system theoretical model, the result of the analysis can be read in terms of processes of mutual regulation. Specifically high synchrony exchanges had in common a marked focus on reciprocal adaptation, either as an effect of therapist's emphatic attitude (i.e. adapting his own rhythms and prosody to stay in touch with the patient) or as an effect of fast and organized interactions. These can be seen as phases in which the relationship consolidates, in which the patient's self can experience a safe haven and feel both her genuine emotional manifestations and her conflictual ones to be accepted. Furthermore through the "being alike" property of synchronization it could be speculated that the patient may watch herself in a mirror, enforcing thus a reflexive function, crucial to the development of self, that may have been hindered as an effect of traumatic experiences (Schimmenti & Caretti, 2016). In the same vein, sequences characterized by strong desynchronization, may be described as characterized by a preponderance of self-regulatory processes. Strong interpretations, as well as the (consequent or independent) emergence of overwhelming emotional contents, break the rhythmic cycles that keeps the dyad in balance. The amount of new information, of turbulence, exceed the system's threshold, and determines a shift to a different state. It is conceivable that what emerges from the unaligned SC signals, corresponds to what is called a disruption, i.e. a failure of a relational pattern. Yet disruptions are both traumatic and necessary; traumatic, as they imply that the actual state of the dyad system is insufficient to manage the relational contents, but necessary as the breakage of old schemes is the condition to develop new and more functional ones, given the condition of a sufficiently strong bonding.

The results of the present research, in conclusion, converge with the dyadic-system theoretical model, and confirms the potentiality of the use of psychophysiological measures to explore psychotherapy processes. Specifically SC concordance between patient and therapist may be interpreted as a potential biomarker of empathy, in its more affective acceptations, such as emotional contagion or affective sharing. Additionally the dynamics between phases of high and low synchronization may reflect more in-depth dyadic clinical processes, such as disruptions and reparations.

While the collected data showed very promising results, the qualitative and exploratory nature of the design left many unanswered questions. Further applications of this methodology is necessary to assess some crucial knowledge. First of all, a replication of the coding procedure performed by independent judges and using in a top-down fashion the categories developed bottom-

up in this study, will be important to assess the pertinence of the chosen categories. High inter-rater reliability would account for efficacious categories, whereas a low agreement would point to the need of a revision. Once the categorization process will be established, cluster analysis and time-series analysis could be performed on the sessions' data in order to extrapolate hidden patterns and structure of the synchronization-desynchronization dynamic.

Finally, and most crucially, since many publications have pointed out the relevance of the therapeutic relationship in the first session to predict the therapy's outcome, replications of the present design on a higher number of therapies may open a window on the research on outcome, offering an economical and reliable marker, that could be used to assess relational quality in new therapies and used as a powerful aid to the training of new psychotherapists.

These statements are coherent with the idea that psychotherapy “needs to be described in terms of patterns of functioning rather than of linear trends of single parameters concerning specific aspects occurring within the process.” (Salvatore, Gelo, Gennaro, Manzo, & Al Radaideh, 2010; p. 223).

7. Entropy and Order in Psychotherapies' Verbal Content

STUDY 4

Under the theoretical framework of a system model, such as those presented in the theoretical section of the present work, every aspect of the dyad's behaviour underlies the systemic properties, such as autopoiesis or temporal coordination. The researches presented in the previous chapters have focused on physiological activation as the referring dimension on which to observe coordination, but the same logic can be applied to verbal content.

The research presented in this chapter, stemming as an in-depth analysis on the data of a larger work by Omar Gelo and colleagues (2016), has indeed the focus of studying the systemic properties of verbal production in psychotherapy.

One of the advantages of a dynamic system model of psychotherapy (Sander, 1977; Beebe & Lachmann, 2002; Haken, 2010) is that different methodologies, developed to investigate systemic properties in other disciplines, can be effortlessly borrowed and applied on the clinical dyad. The approach used in the present study, for instance was to consider another perspective of the autopoietical pattern-formation property of a system; instead of considering it in its spatiotemporal dimensions, as was done in previous studies with skin conductance, an increase of self-organization can be described as a reduction of the system entropy. This approach is founded on Claude Elwood Shannon's classical mathematical work on information theory (Shannon, 1948).

A system manifesting high entropy is a system that shows a homogeneous probability of occurrence of its possible states, just as a fair die has the same probability for any of his faces. Such a system provide very low information, as randomness accounts for the most of it; in information theory, this randomness is called "noise" in contrast to "signal" which would constitute a meaningful information. In the case of the die, having a heavier side would cause one of the faces to

show up more often than chance, providing thus an information on the die, or, in other terms improving the die's order, as the possible outcomes are reduced. While having an unfair die might be undesirable, applications of the same model in real information contexts, clearly shows the advantages of high signal to noise ratios. For instance if two people were trying to communicate in a loud and crowded area, the amount of order of the message will determine the probability of being understood, for example just using one meaningful word may prove a better strategy than trying to express a very sophisticated concept through the use of polished dialectics. As another example, repeating the same concept in different ways, a concept called "redundancy" will as well increase the order, in contrast with the external noise.

A key point of this approach is that the concept of order versus entropy, or signal versus noise, can be properly applied to any phenomenon presenting systemic properties.

In the present research, the dynamics of order were analyzed over the verbal production of psychotherapeutic dyads, following Erhard Mergenthaler's categorization system (Mergenthaler, 1996). The system works by comparing whole verbatim transcripts of clinical sessions with standardized vocabularies, in order to find words denoting "emotional tone" or "abstraction". The expression "emotional tone" is used to distinguish the word's meaning with from the experienced, physiological, emotion. For instance the sentence "I'm really worried" may actually be used to express preoccupation, but could as well be used ironically and imply that a matter is irrelevant, or again be used defensively in occasions in which the real emotional content, such as an intense terror, may not be directly accessible (Bucci, 1993). Since these levels of understanding are precluded to automatic text-analysis, the "emotional tone" of a given text unit is intended as its density of emotion-related word.

The aims of the present research are mostly explorative and are based on the hypothesis that real therapeutic dyads transcript will show a relevant amount of order in their emotional tones, both considering each dyad's member as an individual system and considering the dyad as a whole, and that amount of order is significantly higher than chance. A second hypothesis is that such differences in order levels should be able to discriminate among good and bad outcome therapies.

7.1 Participants and Method

The six best and the six poorest outcome dyads were selected from the psychotherapy dyads in the York Depression I Project, a project that compared 17 client-centered (CC) and 17 process-experiential (PE) treatments. This project had the goal of assessing treatments of major depression (see Greenberg & Watson, 1998). The selected 12 dyads, identified according to their reported score on standard symptoms intensity inventories, were transcribed for further process analyses.

7.1.1 Automated content analysis. The transcripts were then analyzed through a computer-assisted text analysis (Mergenthaler, 1996), using the text analysis program TAS/C (Mergenthaler, 1993), using as text units chunks of a preset length of 150 words. The result of these analysis would then be the frequency of positive emotional tone, negative emotional tone, and abstract words in each 150-words unit.

Next the relative probability of codified content for each text unit was calculated by dividing each individual frequency f of the three categories c by the total sum of all the frequencies for that session as in equation 1:

$$p_i = \frac{f_{i,c}}{\sum_{i,c} f_{i,c}} \quad (1)$$

7.1.2 Definition of entropy and order. Following Shannon's definitions, information source is represented as a Markoff process in which $p_{(1,2,3 \dots n)}$, with n equal to the number of text units in a given session, is a vector of probabilities of finding a meaningful word of any of the three Mergenthaler's categories. With these premises entropy is defined as by equation 2:

$$H = - \sum_{i=1}^n p_i \log p_i \quad (2)$$

H in this form does represents the effective amount of entropy in a given information system, but in order to get to the amount of order, it is necessary to know how this measure of the specific system compares with the overall possible entropy of any other system of the same size. Potential entropy is defined in equation 3:

$$H' = \log n \quad (3)$$

Finally the amount of order in the given system can be defined as:

$$\Omega = 1 - \frac{H}{H'} \quad (4)$$

Equations 2 and 3 hold true while the considered frequencies are those of a single stream of information, i.e. one of the members of the psychotherapeutic dyad. That means that such equations can be used to investigate the inter-subjective amount of order in participants' vocal behaviour, but not the reciprocal intra-subjective level of coordination. In order to assess such a measure a cross-entropy equation is required. Shannon (1948, p.12) provides such an equation, but in his formulation cross-entropy is not symmetrical, i.e. $H(i,j)$ does not necessarily equal $H(j,i)$, as would instead be logical in the nature of the present research data.

Equation 5, provided by Professor Enrico Ciavolino in a personal communication, is specifically the equation for symmetric cross-entropy:

$$H = \sum_{i,j} (p_i - p_j) \log \frac{p_i}{p_j} \quad (5)$$

While equation 5 defines the amount of cross-entropy for the given system, in order to apply equation 4, the potential cross entropy is needed as well. Since its analytic definition was not found, a bootstrap estimation was used instead.

7.1.3 Bootstrap estimation of potential cross-entropy. In order to estimate analogous values for potential entropy in the multivariate case, random sessions were generated by sampling with replacement among the frequencies extrapolated from automatic content analysis, independently of outcome, role, session and units order. Since potential entropy is primarily dependent on n , i.e. the number of text units, a different estimation was performed for each value of n in the range from 16 to 86, that were the minimum and maximum number of text units per session observed in the selected dyads. For each value of n , one million of random dyads were generated and the maximum H (Equation 5) was considered the best estimate.

Linear and log-linear regression analyses were performed on the estimates in order to find the best fitting model which was subsequently used to predict H' for any value of n .

Figure 1 shows the estimated values as a function of n , and the fit lines of the models; exponential model was chosen as the best fit with an adjusted $R^2 = 0.94$

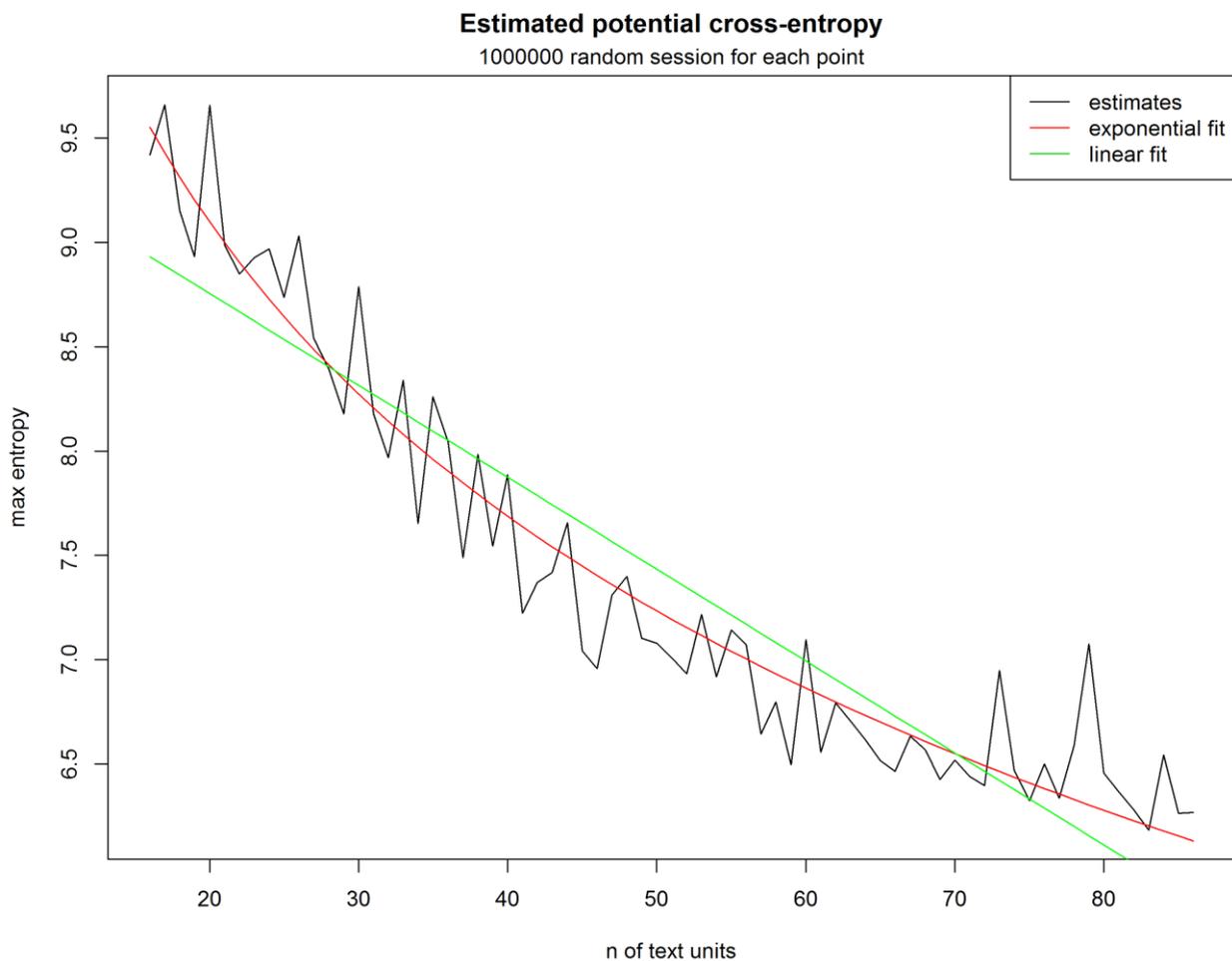


Figure 1. Bootstrap estimation of potential cross-entropy in the verbal data for varying amounts of text units. The red and green lines shows respectively the fit of the exponential and a linear regression models.

The predicted values from the best fitting model were used to compute Ω based on cross-entropy, following equation 4.

7.1.4 Intra-subject permutation analysis. In order to assess whether the amount of order calculated for each member of the real dyads was different from chance, permutation analyses were performed on the data, by shuffling all the text units at the frequency level, independently of the original dyad, session, or units' order (Table 1), but splitting between positive and negative outcome group dyads and role (patient or therapist). 10000 random sessions were created for each condition and a permutation test was performed by comparing the order values obtained through equations 2, 3 and 4 for the permutations and the real sessions.

7.1.5 Inter-subject permutation analysis. Similarly to the previous procedure, in order to assess the non-randomness of the order in the dyads considered as a whole, a set of random sessions was selected through permutations of the original dyads. This time data was only split for outcome and the match between patient and therapist as well as the text units' order were kept constrained (table 1). 10000 permuted sessions were generated for each condition and a permutation test was performed by comparing the order values obtained through equations 4 and 5 and the estimated potential entropy values for the permutations and the real sessions.

Constraints	Intra-subject permutations	Inter-subject permutations
Dyad id	Free	Free
Session order	Free	Free
Text unit order	Free	Locked
Role	Split	Locked
Outcome	Split	Split

Table 1. The table presents the logics behind the permutation sampling for intra and inter-subject analyses.

7.1.6 Permutation t-tests. In order to assess differences between the various conditions in real data, permutation t-tests, which are a more robust test when the data distributions are not normal, were performed through the R's flip package v.2.4.3 (Finos et al., 2014) set with 1000 permutations.

7.2 Results

Figure 2 shows the data of the permutation tests on the intra-subject data. The density distributions represents the order observed in the permutation dyads, whereas the vertical segments represent the mean value of the real dyads. P-values were obtained as the ratio of the observations equal or greater (or lesser according to direction) to the true mean and the overall number of observations. Therapists' intra-subject order was greater than chance ($p < 0.0001$) in both good and bad outcome conditions, whereas patients' intra-subject order was lesser than chance ($p < 0.0001$) in both good and bad outcome conditions.

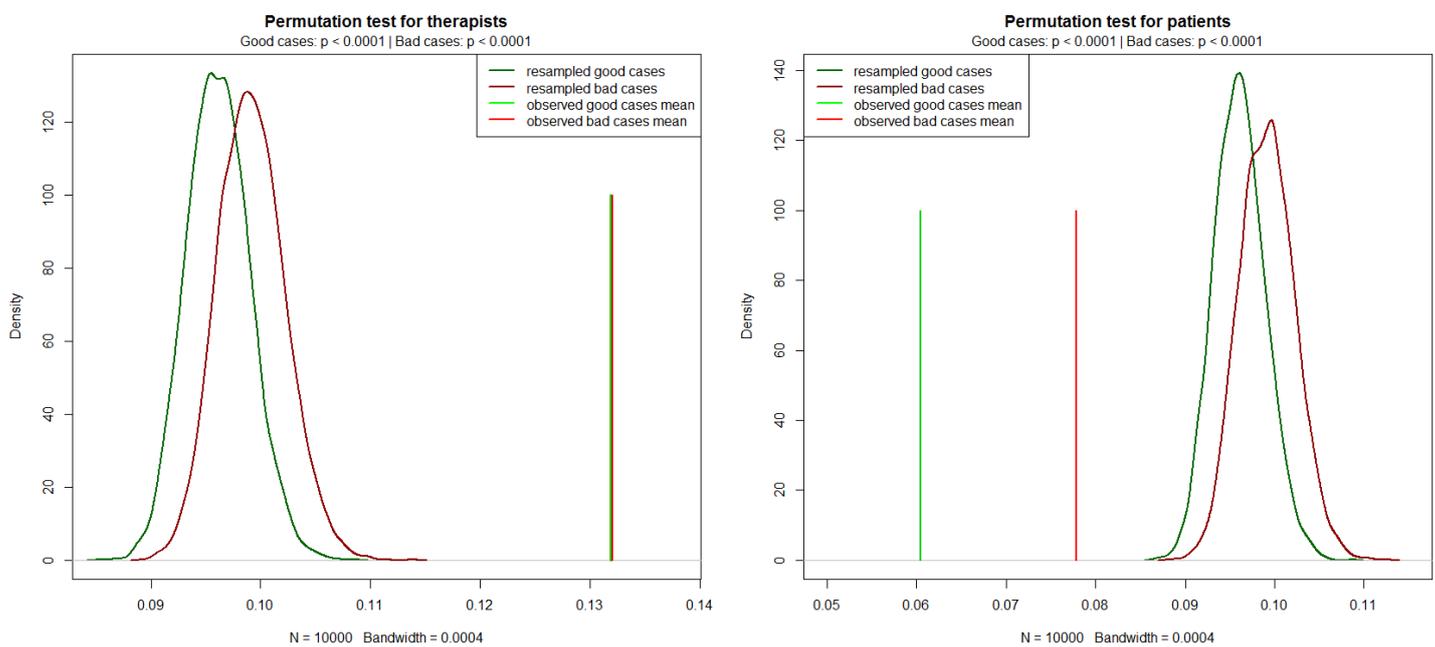


Figure 2. Graphical representation of permutation tests for the intra-subject data. The real observed levels of order were significantly different from the permutation dyads in all conditions (all p-values < 0.0001). Notably therapists showed a level of order greater than chance, whereas patients showed a lesser order.

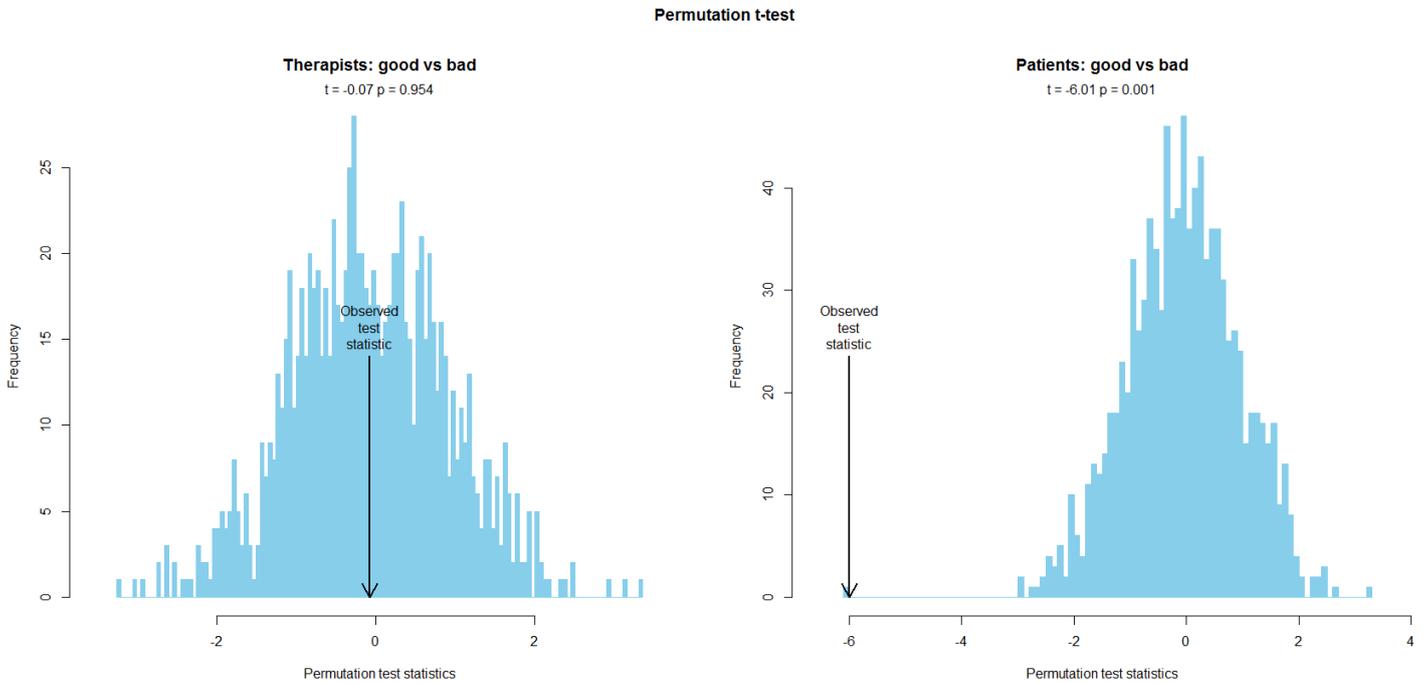


Figure 3. Permutation t-tests results between different outcomes in therapists (left panel) and patients (right panel). Good outcome patients showed a significantly smaller level of order ($p = 0.001$) in comparison to bad outcome patients.

Figure 3 shows the permutation t-tests between levels of order in good and bad outcomes in the intra-subject data. No difference was found in the therapists' order level in the two outcomes ($t = -0.07$, $p = 0.954$) while a statistically significant difference was found among patients order levels ($t = -6.01$, $p = 0.001$), with good-outcome patients showing a lesser amount of order.

Analogous analysis were performed on the inter-subject cross-order data. Figure 4 reports the results of the permutation analyses. No statistical difference was found between real dyads' amount of cross-order and permuted dyads' one in good outcome cases ($p = 0.466$) and in bad outcome cases ($p = 0.997$). Similarly, no significant difference was found between good and bad cases' cross-order levels in the real dyads ($t = 1.03$; $p = 0.325$).

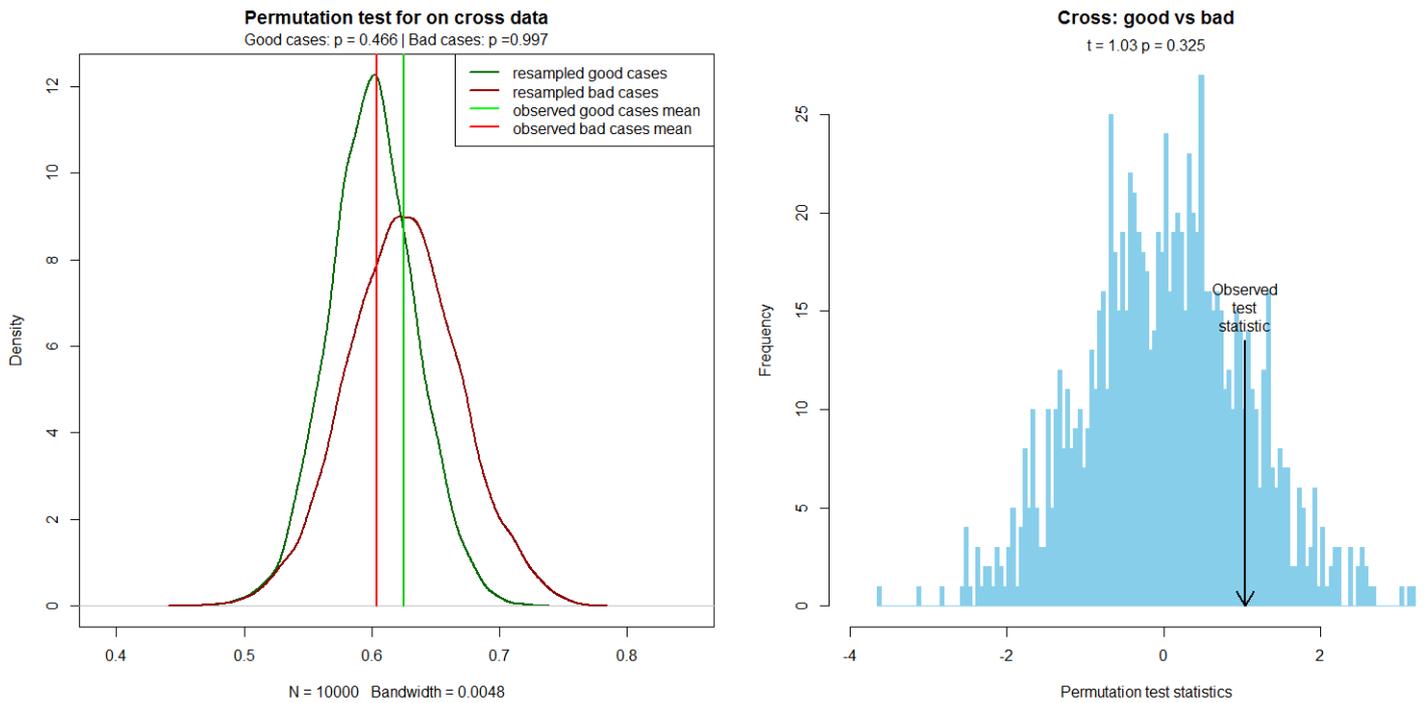


Figure 4. Permutation tests on the cross-order levels between random and real dyads (left panel) and t-test between real good and bad outcome dyads (right panel) none of the tests reported a significant difference, meaning that cross-order is not present at a verbal level and not influential on the therapies' outcome.

7.2.1 Exploration of longitudinal dimension. In order to further investigate the relationships between intra and inter-subjective order and outcomes, the order data for each condition and each session was plotted in Figure 5's violin plots. The uppermost panel shows the intra-subject level of order in patients, split by outcome: an unexpected sinusoidal pattern can be seen in the real data, more marked in the good outcome patients. The middle panel shows the intra-subject levels of order in therapists, while no insight is offered for the bad-outcome condition, it can be observed how in the first session the good-outcome levels of order is very low and comparable with the random dyads. Finally in the lowermost panel, data for the cross-order is presented. As highlighted in the analytical section of this chapter, no constant difference was found among random data and good or bad outcome real data, yet focusing again on the first session, a distinctly higher violin can be observed in the good-outcome dyads both in comparison to random and bad-outcome data.

7.3 Discussion

Mathematical theory of information defines “order” as an increase in coherence and coordination of the possible outcomes of a system. High levels of order increase the “volume” of signal, whereas high amounts of entropy means that every possible outcome is equally possible, or in other words, that there is no signal that overcomes the “noise”. In the present research these concepts were applied to the verbal contents of 12 psychotherapies, 6 with good and 6 with bad outcome. The transcripts of the sessions were processed through an automatic content analysis (Mergenthaler, 1996) to extrapolate the relative frequencies of emotional tone and abstraction for each 150-words text unit. The occurrence probability of Mergenthaler’s categories were then used to calculate the amount of order, both considering patients’ and therapists’ separately (intra-subjective analysis) and the dyad as a whole (inter-subjective analysis). The first hypothesis behind this methodology was the expectation to find an amount of order in the verbal production in therapeutic dyads that was higher than chance. Permutation tests were used to verify this point: by calculating the order levels in random dyads obtained by reshuffling the original data, it was possible to compare if the observed levels of order were ascribable to the specific verbal structure, or only to the spontaneous data variability (or lack of thereof).

The results partially confirmed this hypothesis: higher than random levels of order were found in therapists’ verbal production, while in patients’ one the order was unexpectedly lower than chance. Analysis of the cross-order levels, i.e. the amount of coordination and signal’s volume considering the production of both patients and therapists together, found no significant difference, probably meaning that either in the selected dyads there was no significant inter-subject coordination in semantic themes, or that the employed measures were inadequate.

Furthermore the comparison between outcomes, showed that patients which found the most benefit from the therapy, had a significantly lower level of order across the therapy in comparison to bad-outcome patients.

These results may be interpreted in the light of a dialectic between flexibility and specialization. Indeed an increase in the order of the content categories may imply the presence of strong patterns and meaning structures, but also reduced mobility across the different discourse categories with which the content was codified, whereas a high observed entropy may reveal as a predictor of good outcome as it implies a less polarized type of narration by the patient, open to more alternatives.

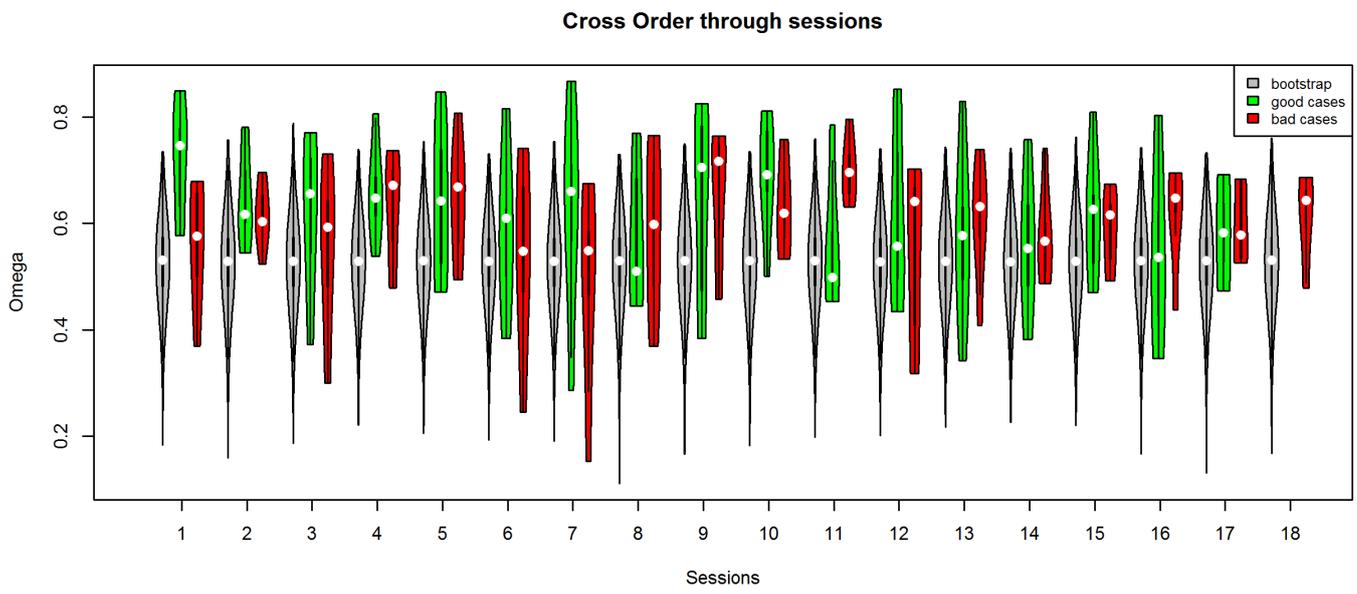
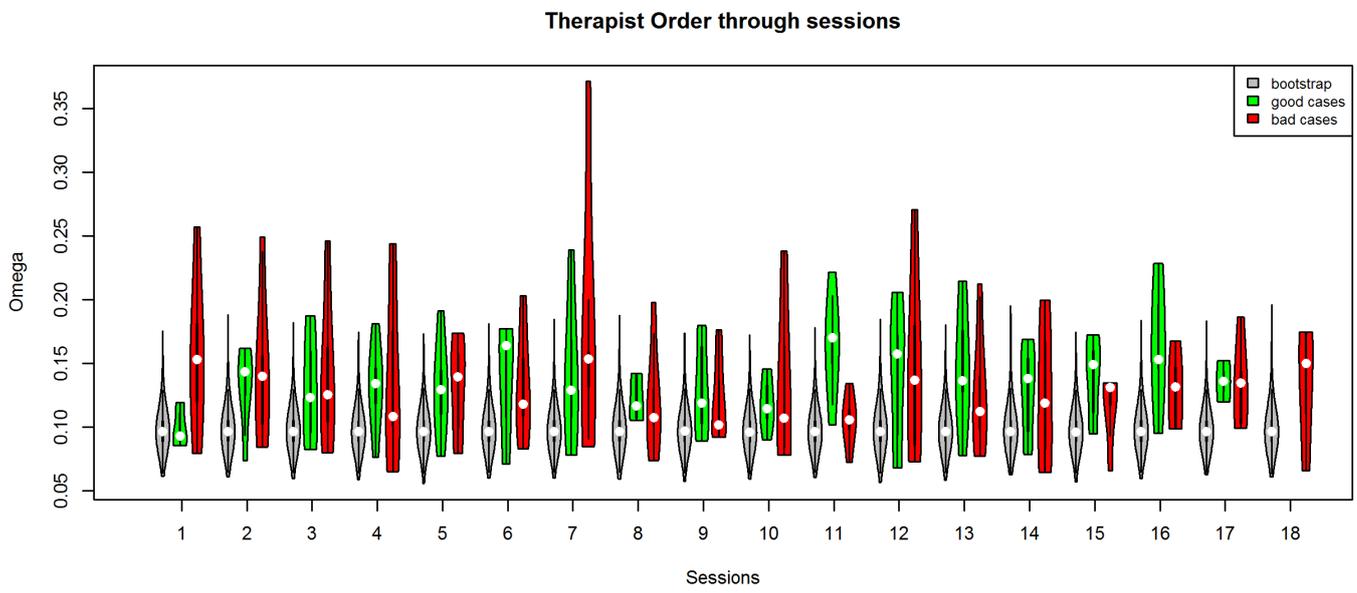
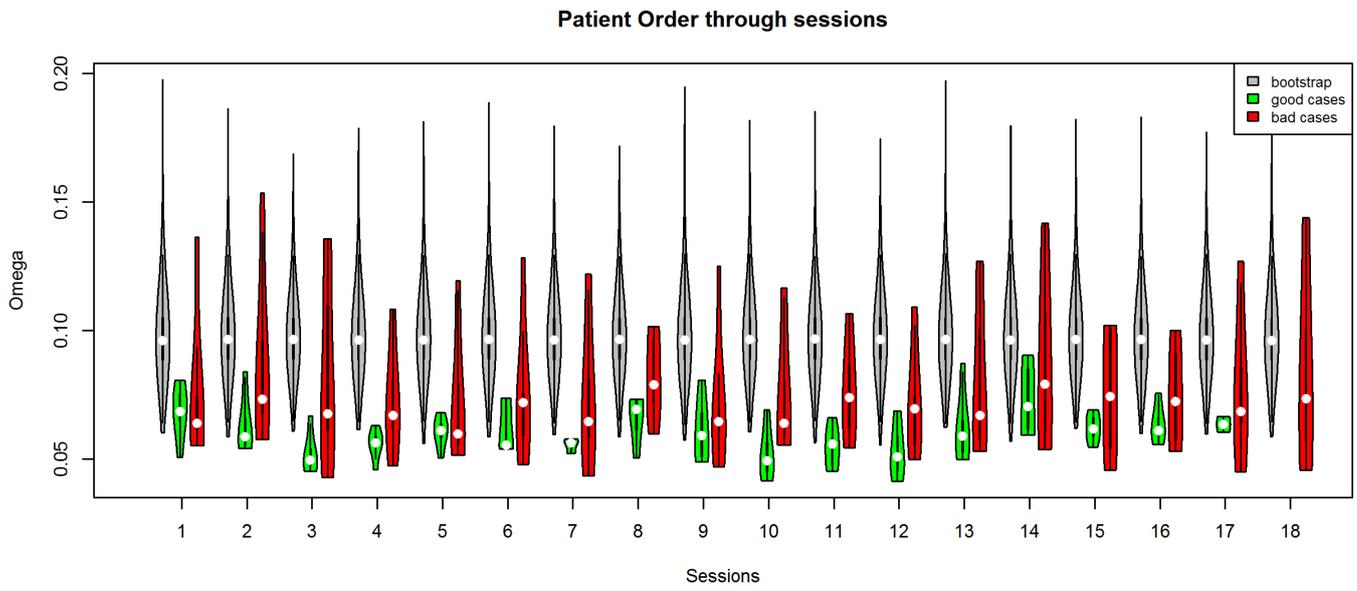


Figure 5. Order data presented across sessions.
123

Such an interpretation would also be compatible with the observation of the initially low order in good outcome therapists' vocabulary, as if in the first session they aim for openness and flexibility, instead of providing a strong highly structured message.

Good outcome, following the data, is predicted by a high amount of flexibility from both patient and therapists in the first session, and a progressive specialization in the therapist.

Interestingly, also in the cross order analysis the data of the first sessions shows a singularity: good outcomes therapies show a high inter-subjective coordination, which disappears in later sessions. While further data needs to be collected to confirm this finding, this would be coherent with the increasing literature describing the emphatic perception and therapeutic alliance built in the first session as crucial for the treatment's outcome (Sexton et al., 2005; Castonguay et al., 2006; Constantino et al., 2002; Horvath 2001).

Finally, the amount of order in the good-outcome patients is observed to fluctuate with a sinusoidal trend, a phenomenon for which no direct explanation could be thought of. Yet, more in-depth analysis, taking in consideration also the specific variations of each single content categories, instead of only their relative probabilities, may reveal a link between this observed pattern and Mergenthaler's (1996) prototypical cycle of emotion-abstraction patterns, which also follows a sinusoidal trend.

In conclusion the present study showed evidence for the presence of non-random structures of order and entropy in the verbal content of psychotherapeutic dyads, further increasing support for a systemic perspective of the clinical relationship, and offering precious insights into the increasingly relevant issue of outcome research. While not sharing the temporal domain of synchronization, order and cross-order are a promising measure of association and attunement of a system which are worth to be thoroughly explored in the perspective of providing strong quantitative dimensions of the clinical relationship that still keep awareness of the complexity behind the phenomenon, i.e. by avoiding the reductionism intrinsic in many direct causality models. In this vein, the simplicity of the presented methodologies, is to be interpreted as necessary to move the first steps into the exploration of the psychotherapy world with new approaches, and not as a finish line.

Further developments of the present research should assess both methodologic and clinical questions such as the determination of the ideal size of the word units, the specific role of each linguistic variable, the fluctuations in order levels inside each individual session and the potential link between this sophisticated measure and the clinical process. This latter point, especially, will be

a fundamental step, needed to link this potentially new family of measures to the existing lore psychotherapy practice.

8. Conclusion

Psychotherapy is a very peculiar expression of human relationship, sharing the means of everyday intersubjectivity and the goals of development-oriented interactions such as the mother-infant one. One of the most fundamental mechanisms that drives both these forms of interaction (together with countless other communication phenomena in nature), is the ability to perceive and mirror the behavioural and emotional rhythms of the other. The main idea on which the present work is founded is that such synchronization lies at the core of the multifaceted processes needed for a person to understand somebody else and, specifically, for a psychotherapist and a patient to co-construct an efficacious relationship with potential for change.

8.1 Context

While this idea is present in experimental literature since the Fifties (Di Mascio et al., 1955, 1957), and has lived major spikes of mainstream consideration, such as with the discovery of mirror neurons in monkeys (Di Pellegrino et al., 1992), the precise mechanisms underlying these phenomena in humans and, most crucially, the relational meaning of those mechanisms, have been only marginally investigated, with most research aiming instead to connect these observations to other known constructs, such as empathy, therapeutic alliance, romantic bonding, mother-child caring, etc. (see Palumbo, 2015), and providing a scattering of different theoretical interpretations.

The first goal of the present work was to provide a common theoretical ground on where to place the interpersonal synchronization phenomena, with a specific focus on physiological

synchronization. The principal desiderata for such a framework were first for it to be based on empirical observations, as much as possible, and rely on (possibly broad) theoretical constructs only where no explicit data was present. This was necessary in order to encompass the multiplicity of actual studies in a common dimension of meaning, and to avoid strict dependency on any specific conceptualization, such as, for instance, the psychoanalytic one. Second: to pragmatically rely on empiricism while controlling the risk of reductionisms. This was pursued by embracing complexity as a feature, and phenomenology as the leading conceptual methodology.

Given these needs, neurophenomenology (Varela, 1996; Varela, Thompson & Rosh, 1991), provided an ideal context in which to locate the foundations of interpersonal synchronization. The first core concept used to explain this phenomenon is that of embodied cognition; in Varela's theorization, embodiment is the answer to the old mind-body problem that, since Descartes, was traditionally dealt through a now unsustainable dualism. Embodiment, instead, proposes a model in which body and mind are two polarities, involved in a reciprocal construction dynamic, of a same natural entity. To use a sociological metaphor, where the mind is "the message", body is "the medium", and, as famously stated by the philosopher Marshall McLuhan (1994), the latter one is symbiotically necessary to define the shape of the first. This idea draws directly from Merleau-Ponty's phenomenological dissertations: the French philosopher brilliantly evidenced how perception is a necessary a-priori process to interface a person with the world, and although perception itself is not unmediated (it is indeed powerfully influenced by context, previous experiences, representations, and culture), it holds a fundamental primacy in the cognition hierarchy. In other words, the constitution of human biological substratum determines the way the world is experienced, or again, the body constitutes the proxy of experience. With such a premise, the observations of synchronization of the autonomic nervous system activity during dyadic interactions becomes suddenly reasonable.

This mutual co-construction between mind, body and world, opens to another theoretical cornerstone: the view of human beings as autopoietic systems. The switch to a complex systems perspective is by itself revolutionary: for instance, cells may be described as independent self-sufficient units when studied under a microscope, yet when the subject of description is a human being, it is not usually depicted as a pile of cells, because a person is itself an independent self-sufficient unit. The idea here is that the cutting point between different systems depends entirely on how narrow or broad is the lens through which a given reality is observed. From atoms to human societies, there is a same matter that is organized with progressively increasing levels of complexity. Each level's autopoietic units constitute the building blocks that allows the next one to emerge, and each additional level presents new emerging properties, which are though functional consequences of the organization of multiple simpler elements.

Among the infinite levels of complexity through which reality can be organized, it is the scientist role to choose the one most fitting to the phenomena that requires explanation: cells interaction would prove a way to complex source of information to a sociologist, just as would regular patterns in demographics of a nation be overwhelming data for a surgeon. There is thus a mandatory pragmatic process required in any scientific approach to reality, but acknowledging the interdependency between different complexity layers, allows for deeper comprehension and interesting insights on a given phenomenon.

Mirroring of facial expressions between mother and children, for instance, can be as fast as about one third of the mean reaction time to a generic stimulus (Cohn & Beebe, 1990). On a level of complexity focused on the individual only, this is a paradoxical result. Yet, considering the mother and the infant as a system on its own (i.e. considering a higher level of complexity), it can be observed that these speeds are possible since the interaction is codified in patterns that are well known to both dyad's members. In regard to face mirroring, mother and child are more similar to two jazz musicians, adding improvisations on top on a well-known tune, than to two independent systems relying on sophisticated input-output processing. In other words, this synchronization might be described as a phenomenon emerging from the dyadic level of organization.

This line of reasoning led different psychologists (mostly from the "infant research" movement) to draw from classical publications on system theory (e.g. von Bertalanffy, 1968; Ashby, 1952) to delineate a model of human development and interaction focused on the dyad instead that on the individual (see Beebe & Lachmann, 2002; Carli & Rodini, 2008).

Dyadic system models of human interaction, through their linking of interaction dynamics and self-development, finally provide a working model with which interpersonal synchronization in psychotherapy can be interpreted. One of the most interesting theoretical innovations of these models is the focus on regulatory processes. The dyad system is described as involved in a continuous and recursive feedback process, in which both member employ proprioceptive information as well as the partner behaviour to regulate (i.e. determine how to modify one own psychophysical state). Regulation has the twofold goal of maintaining homeostasis (e.g. by looking away, or performing repetitive gestures such as touching hairs or chin) and to support a frictionless interaction through the learning of previous patterns and the possibility of sticking to them. Sharing the same patterns, either consciously or not, is a process associated with positive affects, and is able to magnify the positivity of an experience or relationship, but is also the way through which, since the first moments in a human life, one can feel its own agency. Indeed in order for an homeostatic regulation process to work, it is both needed that the process is effective on the individual level, but also that such state modification is perceived and understood by the partner, who has to regulate and/or act accordingly. As conceptually developed by Tronick (1998), the psychophysiological state

of a dyad's member is always at least partly determined by that of the partner, and this dependency exists in such a founding way to lead the author to coin the expression "dyadic state of consciousness".

Apart from describing how necessary interaction is for the individual, dyad system models also include an explanation of how the systems evolve, which is a crucial step to apply this knowledge to psychotherapy, a social interaction context in which change and self-development are the primary goals. Drawing again from infants' observations, development of the self is described through the updating process of the established interpersonal patterns. In extreme synthesis, disruptions of previous dysfunctional schemes, can be updated with more advanced ones, given a safe enough relational context. Many authors (see Mitchell, 2000; Beebe & Lachmann, 2002; Fonagy, 2002; Stern, 2004; Carli & Rodini, 2008) have worked in the direction of integrating the powerful explanatory potential of these models into the dynamic psychology (mostly psychoanalytic) frameworks. This process, sometimes called "relational shift" (e.g. Seligman, 2012), has the advantage of updating the insightful richness of clinical traditions with a sophisticated interaction dynamic drawn from empirical observation and trans-disciplinary system logic. While the fact that these innovations were able to permeate even psychoanalysis, a branch of dynamic psychology historically reluctant to change, should alone speak about the virtues of such an approach, research efforts substantiating the dyad system in adult psychotherapy are still scarce.

Attempts of such explorations have taken principally two directions, on one side through the clinical vignettes of individual cases, reporting interpretations of clinical processes under the light of system models, on the other side instead, where also the present contribution can be situated, researchers developed more or less automatized procedures to infer the linkage (also called attunement, synchrony, mirroring, behavioural matching, etc.) between patients and therapists, in the least invasive possible means. One of the main limitations for this kind of research is, indeed, the difficulty of creating an experimental setting, or condition, in which interactive regulation and self-development can happen, but controlling most of the other variables as could be done for famous infants' paradigms (e.g. Tronick's still-face, or Ainsworth's strange situation).

This latter branch of research employed many different indexes to assess the existence, relevance and dynamics of interpersonal patterns, for instance Ramseyer and Tschacher (2006, 2011) developed an automatized analysis of video data, comparing the amounts of movement of patients and therapists, and other authors (see Bernieri & Rosenthal, 1991) reported analysis of synchronization in vocal features. Still, the most extensive area of research on these phenomena has focused on physiological measures. Skin conductance, central nervous system activity, cardiac activity, skin temperature, respiration, as well as cortisol and other hormones has all been employed to assess various "interpersonal physiology" dimensions (Palumbo, 2015) not necessarily under the

premises of system theory. Furthermore, only a small percentage of the overall studies on physiological coordination, directly assesses psychotherapeutic (or counselling) contexts, reducing even more the amount of evidence on the subject.

The general conclusion of these studies is an observation of a certain amount of synchrony in the chosen indexes, which is usually associated to some other specific psychological construct, such as empathy (Marci et al., 2007) but also conflict (Levenson & Gottman, 1983), and an explicit statement on the nature of the observed coordination processes, is mostly lacking.

In the researches on the infants, interactive regulation has been extensively observed, mostly in the form of facial expression mirroring dynamics (e.g. Cohn & Beebe, 1990), in video recorded paradigms, in which frame-to-frame analysis could be performed to extrapolate not only group-level macro-phenomena, but specific interactive patterns, eventually specific to each dyad. Such an high level of information was able to guide the theoretical process, ultimately explaining the methodological reasons for infant research movement's successes (among which Bowlby's attachment can be included). In their approach, data was not collected to confirm a theory, on the contrary, following an idiographic to nomothetic path, from the complexity of observed phenomena, the best theories were chosen or woven ad hoc, and put to test only in subsequent confirmatory studies.

On the contrary, most of the aforementioned literature studying shared physiology employed only a nomothetic approach, that is, the physiological linkage measures were used at group levels, either to discriminate between different conditions or to connect such synchronies to other psychological constructs, also most of these were performed in laboratory settings, and not in-vivo conditions, thus potentially ignoring significant context-dependent relational dynamics.

The researches presented in the previous chapters aimed to answer to some of the missing parts of this interesting mosaic. Specifically, as a continuation of previous research efforts (Marci et al., 2007; Kleinbub, 2011; Kleinbub et al., 2012, Messina et al., 2013), studies 1 and 2 were aimed to explore the group-level relationships between physiological synchronization, attachment and its manipulation. Study 3 was aimed to assess the need for an in-vivo idiographic analysis on physiological linkage in a psychotherapy context, in order to explore its connections with therapeutic process. Lastly, study 4 consisted in a first exploration on verbal psychotherapies' data, employing a mathematical methodology directly drawn from system information theory.

In the next paragraphs the main findings of the four studies will be discussed in the light of theoretical premises, and finally the implication of the presented results will be drawn both in the clinical and research perspectives.

8.2 Findings

The theoretical framework that was chosen to encompass the synchrony in adults' physiological rhythms, object of these researches, largely draws from the observations on the developing processes of infants. The main idea behind this connection is that the mechanisms that account for the evolution of the children's psychological structure are active and functional during the whole life-span (Beebe & Lachmann, 2012). This concept is strictly related to the attachment theory, which postulates that bonding strategies learned in early life phases with the primary caretaker, determines a large part of the bonding qualities employed in adult life, together with the ability to rely on more or less sophisticated coping strategies. Attachment style and interpersonal physiology have been explored in the mother-infant dyad with promising results (Field et al., 1989; Jaffe et al., 2001; Butler, 2011) but at the best of my knowledge, no study has reported any information of such dynamics in adults.

Study 1 and 2 were planned with the goal to begin bridging such gap, specifically drawing from several studies from Mikulincer and colleagues (Mikulincer et al., 2001; 2005; Mikulincer & Shaver, 2007) observing how through specific priming techniques it was possible to activate internal representations of the caregiving system, thus boosting empathic and prosocial behaviours.

Priming of secure attachment was introduced in a design based on replication on a previous study (Messina et al., 2013) Specifically, the studies hypotheses, were to replicate previous results in regards to the association between SC synchronization and empathy, and in regard to the difference in such physiological linkage according to the level of training of the clinician. Furthermore, it was expected to observe a different effect of secure priming in the two studies' samples, as theoretically the psychotherapy training should have the effect of eliciting internal caregiving schemes, and thus the priming effect was expected to be more expressed in the psychologists group.

In order to test these hypotheses, simulations of a first psychotherapy session of the duration of 20 minutes, were arranged. Each pseudo-clinical dyad was composed by a volunteering student, who had to discuss an emotional experience, and either a psychotherapist (study 1) or a psychologist (study 2) with less experience and training. In both studies, half of the clinician received a secure priming prior to the interview, whereas the other half received an analogous stimulus without any caregiving-related content (neutral prime). A further addition to study 2 was that each clinician was involved in two different interviews, in order to control for the effect of the individual clinicians' attunement ability, and to verify the duration of the priming effect. Simultaneous skin conductance level was continuously recorded for both dyad's member for the whole duration of each session, and following Marci and colleagues approach (2007) a global

session index was calculated to express the degree of synchronization in the physiological signal. Additionally, self-report measures were collected to investigate the clinicians' psychological characteristics and the pseudo-patients' evaluation of the session, in terms of perceived empathy, working alliance and closeness of the clinician.

Results of both studies presented an homogeneous pattern: while neither the different trainings nor the type of priming predicted an overall higher level of SC synchrony, the different conditions presented a significant interaction with the lag variable, which means that the synchronization was higher either when considering the clinician leading or pacing the interaction by an amount of few seconds. Psychotherapy training and secure priming indeed predicted a higher synchronization towards the "leading" polarity, whereas neutral priming and only psychologist' level training predicted a higher synchrony toward the "pacing" polarity. This finding, that was found consistently among the two studies, was unexpected. Since psychotherapy training and secure attachment priming were expected to enforce an empathic attitude, it was hypothesised that both these variable would have instead predicted a tendency toward the "pacing" polarity, with the clinicians' SC activations following slightly those of the patient. Furthermore, correlation analysis from study 1 and previous research (Messina et al., 2013), found an association between pseudo-patients' perceived empathy and high "pacing" synchronization, peaking at a lag of 3 seconds. It could be thus inferred that contrary to the hypotheses, both higher training and secure priming led to a less empathic approach, although no significant between-groups difference was observed in perceived empathy. Possible interpretations of these data are twofold, on one side it could be that effectively the two favourite conditions were counterproductive; for instance it could be that psychotherapist may have experienced the autonomic system measure to be somehow judging their professionalism, thus increasing anxiety and eventually leading to a worst predisposition toward the other person, and the security priming may have, instead of working as intended, elicited an artificial attitude that was not natural for the clinicians, those leading them to underperform.

On the second hand instead it might be that self-report measures employed to assess perceived empathy where actually measuring some more vague construct, which responded more to some sympathy-related behaviours that both the higher training and secure attachment prime inhibited. Additionally it is important to note that, while all the effort was made to create a setting as ecological as possible, the experimental setting was very different from a real therapy session, both in environmental and internal (e.g. motivation, goals, etc.) terms.

In conclusion the experiments highlighted the presence of a tangible non-random phenomenon of physiological synchronization in the interacting dyads. As predicted by the theoretical models, this linkage was associated with empathy and was different for different clinicians' training level and manipulated by secure attachment priming. Yet, no clear association

could be done among this observed phenomenon and the other variables, mainly due to a general lack of understanding on what interpersonal process exactly SC synchronization describes. The most straightforward hypotheses on its meaning were either disconfirmed or put in a more complex perspective (e.g. the observed difference between conditions was not in overall amount of synchronization but in its lagged-expression), highlighting the need for more in-depth exploration of the nature of this mechanism before attempting other tries in finding group-level differences or using the measure as a predictive index.

In order to assess these problematics, a third study was designed as a qualitative micro-analysis of actual psychotherapy content. The first, middle, and last two sessions of a 16-sessions psychodynamic psychotherapy were audio and video recorded, and simultaneous SC was acquired continuously for both the patient and the therapist for the whole duration of the six considered sessions. Physiological synchronization in the dyad was assessed employing a lagged moving window cross-correlation analysis (based on Boker et al., 2002) on each session's filtered SC data. Instead of employing a global session index, as in the previous two studies inspired by existent literature, this methodology allowed to inspect the variations in time of synchronization during each individual session. The observed synchronization levels were compared to random estimates obtained by applying the same algorithm on fake dyads obtained through permutations of the effective matchings (e.g. by assessing synchronization on the SC signal of patient's first session and therapist's last session, and so on for each of the 132 possible permutations). As expected, real sessions presented higher than random levels of synchronization, with a clear lag interaction comparable to that of the previous two studies.

Highest and lowest SC synchronization sequences were extrapolated from the sessions by employing a windows search algorithm that extracted the sequences lasting at least 30 seconds, for which the computed cross-correlation were constantly in the upper or lower 20% margin, that for this sample was estimated at ± 0.6 . This algorithm employed as well the lag-analysis data, in order to find both sequences that were synchronized with exact phase locking and sequences which showed synchronization when the therapist signal was shifted forward or backwards by a discrete amount of seconds. In order to simplify interpretation of the lagged data, the sequences' lags were aggregated to three categories: "pacing" when the therapist signal was found delayed in comparison to the patient's (by 2 to 5 seconds, called direct lag), "leading" when instead the therapist signal anticipated that of the patient's (by 2 to 5 seconds, called inverse lag), or "sync" when the highest synchronization was found at lag 0 or at lag 1 in both directions.

The timings of the selected SC sequences was then matched to the corresponding video-recordings in order to investigate the psychotherapeutic processes corresponding to them. While

dyad system models do provide some schemes and flows of interaction with which micro-analysis of process is possible, given the complete lack of previous investigation on the specific correlates of SC linkage and clinical process, it was decided to opt for a phenomenological approach, using the dyad system concepts only as perspectives lenses, thus trying to avoid as much as possible a-priori categorization that may mask unexpected findings or dynamics that are not encompassed in a given interaction model.

This content analysis was thus performed through many steps of increasing abstraction, starting with a thorough observation of the video material and the transcripts. Next a detailed description of the content of each sequence was performed under the following six dyad system inspired perspectives: verbal content, non-verbal content, patient's processes, therapist's processes, and dyad's dynamics. The following step consisted in the individuation of macro categories that were broadly encompassing most of the phenomena observed at the micro level. Five such categories were identified, two relating to the patient's state and three to the therapist's interventions. Patient's state was described to be either syntonic (ES), when all the manifestation observed through the different perspectives were coherent, and dystonic (ED) when instead there was conflict, for instance between the verbal content and the nonverbal behaviour. Therapist's intervention were categorized either as supportive (IS), expressive (IE), or supportive-expressive (ISE), accordingly to the general level of additional information provided by the intervention, for instance interpretations and clarifications were coded IE, instead simple reformulations, or sentences like "I can feel that", "I understand", empathic hums, etc., were coded as IS. ISE was coded for sequences that contained both IE and IS elements. Finally a process analysis was performed by linking, both through frequencies and direct observation of individual sequences, micro and macro categories, lag, and type of synchronization.

Indeed all these variables proved to be tightly interrelated. The most relevant finding of this whole analytic process was that high and low synchronization windows were effectively associated to different clinical processes. Specifically, ES episodes were only found in high-synchrony sequences, whereas ED episodes were found in low or high synchrony sequences according to the concomitant therapist intervention: when EDs were matched by supportive interventions the synchronization was high, and when instead the therapist proposed an expressive intervention (IE and ISE), most often the synchronization was very low.

According to the dyad system model, interactive regulation is a process that works through reciprocal knowledge (organized in relational patterns), and by devoting resources and attention toward the partner, in order to be receptive to his/hers internal states and modulation and allowing prompt alteration of one owns, to keep the interaction smooth and emotionally satisfying. In these terms, the reported findings seems to support the interpretation that SC synchrony may act as an

indicator of the amount of interactive regulation, indeed, high synchrony is observed either when the patient is in a state of integration, and the clinical interaction can be smooth and deep, or when the conflicting state of the patient is matched by an additional effort of the therapist to maintain relational “contact”, through the employment of supportive interventions or other forms of involvement, such as evident motion or respiration synchrony. Instead, low synchronization was mainly observed in sequences where communication was failing, either for the overwhelming intensity of the patient’s negative emotions, or when the therapist’s interventions were unsettling or inadequate (according to the manifest patient’s reaction), or finally when the therapist would not respond to the patient’s inputs. Also these observations are fundamentally compatible with the regulatory model, indeed, self-regulation and interactive regulation are theorised as bound by an energy law; that means that the more resources are invested on one side of the spectrum, the least can be devoted to the other. The reported low-synchrony conditions could also be described as sequences in which the patient’s or the therapist’s focus was on self-regulation, an interpretation supported by the high amount of classical self-regulatory bodily expressions, such as looking away, changing to a closed posture, touching one own face, hairs, legs, etc.

In regard to the clinical meaning of synchronization, the scenario appears more complex. No clear predominance of high versus low synchronization emerged, neither overall, nor longitudinally across the therapy. Instead both kind of sequences were present and followed each other in every session. This is also coherent with the dyad system theory, describing a good relation as characterized by a dynamic interplay between the two polarities of interactive and self-regulation. For instance, in one of the most thorough reports on interpersonal synchronization (Jaffe et al., 2001), focusing on vocal features in mother and 4-months infants dyads, the researchers reported how extreme levels of synchrony, either high or low, predicted the development of insecure attachment styles in the same infants, at 12 month; instead infants of dyads which exhibited intermediate synchrony, or in other terms, a balance between interactive and self-regulation, showed an higher chance of developing a safe attachment. The theoretical explanation proposed by these authors, and that is proposed to interpret the present data as well, is that proper development requires an updating of existing schemes, in a safe environment. Thus disruptions of expectations, or failure to accommodate the other internal state, phenomena that would necessarily correspond to desynchronized activations, are crucial in order to develop more sophisticate schemes, internal representations, and ultimately to internalize those aspects of relationship that are required to cope healthily with adult life. Still, these interruptions in the relational flow must happen in a “safe-enough” environment to avoid them to be traumatic instead of constructive. And such safe environment, in relational terms, means that reciprocal trust, bonding in the mother-infant dyad, and working alliance in the psychotherapeutic one. That safeness acts as a buffer toward the system

instability caused by the disruption, and allowing the higher level dyad system to keep the equilibrium even when the two members are dysregulated. This process may allow enough margin to activate reflexive processes, and increase flexibility of one own schemes, analogously to the relaxed exploration in children with safe attachment, or the process through which children are able to progressively tolerate increasing periods of their mothers absence. The key mechanism to maintain the quality of the relationship, is not that of never incurring in disruptions, but instead to develop the ability to repair them, by updating old schemes with new information.

Finally, the fourth study presented was intended as a methodological corollary focused on the mathematics underlying the information and system theories. One of the advantages of embracing a system model of interaction is that the many laws and mechanisms identified in other research fields, or even abstractly, as in the case of the historic work of Shannon (1948) from which this study stems, should be employable in other contexts that show system behaviours. To verify this theoretical assumption, the transcripts from the entire verbal content from 6 good-outcome and 6 bad-outcome psychotherapies with depressed patients (see Greenberg & Watson, 1998) were automatically analysed through a computer-assisted text analysis (Mergenthaler, 1996) that identified the occurrences of positive and negative toned, and abstract words. The relative frequencies of occurrence for each 150-words unit were used as the source data to evaluate entropy and order (defined as $\Omega = 1 - \text{entropy}$) dynamics in the dyads. The order levels, considered both in the intersubjective (regularities between patients and therapists) and intrasubjective (regularities inside each participant vocabulary) domains (Haken, 2006) were estimated through the classical Shannon's expressions. Permutation analyses were employed to estimate the amount of order that was specifically ascribable to the real participants dynamics and not to random chance. Finally permutation t-tests were employed to explore the differences between the expression of order in good and bad outcome dyads.

The study hypotheses were only partially confirmed, as significant amounts of order were found only in the intra-subjective domain, i.e. no significant content structure emerged through the paired content categories of patients and therapists, in comparison to random dyads. Instead the explorations of the differences between outcomes, yielded interesting results. Indeed patients in the good-outcome group showed a significantly lower degree of observed order in comparison to bad-outcome patients. Speculations on the possible clinical meaning of this observation are discussed in chapter 6, yet these very preliminary data do not allow for much insight into the psychotherapeutic processes dynamics, but still provide an extremely relevant result. The presence of non-random levels of order, does in fact supports the system model interpretation of psychotherapy, and furthermore, by clearly distinguishing between good and bad outcomes, enforces the idea that

system-level measures of different components and contents of the clinical process are a promising investigation area for the difficult field of psychotherapy research.

8.3 Implications

The findings discussed in the previous paragraphs focuses on different aspects of the same hypothesised phenomenon: that psychotherapy, as one of the change-focused relationship par excellence, relies on many mechanisms that are shared with the primary change-focused relationship, which is the one between the mother and the infant. Specifically, among these mechanisms, interactive and self-regulation prove to be those with the strongest relational influence, and are expressed cross-modally through various verbal and non-verbal dimensions, and revealed explicitly through many forms of mirroring and synchronization.

Studies one to three focused on physiological activations. All their results pointed to the presence of an effective non-random synchronization between interacting adults, providing a solid confirmation of previous literature findings on the existence and legitimacy of the phenomenon.

Furthermore, these findings are compatible and aligned with the dyad system model and its two-way regulations dynamic, which proved to satisfyingly explain most of the data.

Still some minor discrepancies were observed, especially in regard to the lag at which synchrony was manifested. Indeed, whereas Messina and colleagues reported their highest synchrony with the clinicians pacing by 3 seconds, a lag value that was also the one associated with psychotherapists and correlated to empathy, in studies 1 and 2 of the present work synchrony peaked at lag 3i, that is, also three seconds, but with the therapist leading. In study 3, finally, SC synchronization peaked at lag 0, and episodes of synchrony with the therapist both pacing and leading were observed. These differences are not immediately explained by existing theory and empirical evidence, as none of the previously published researches took actively in consideration results from lag analysis. The setting between study 3 and the previous ones was very different as in it measured a real psychotherapy context and not a simulation. It may be speculated that the optimal regulation processes, in a 20-minutes interview with a stranger, without an explicit clinical goal, is quite different from a full-fledged session in the therapist's own office. Furthermore, while studies 1 and 2 shared the same setting of Messina's and colleagues' study, this latter employed a 1 sample per second acquisition of SC due to technical limitation of the hardware, a very low temporal resolution that may have introduced unknown artefacts in the analysis.

Study 4, although focusing on verbal content, was as well able to identify system structures in the psychotherapy data. While non-random levels of order were only observed in the intra-individual domain, it is possible that the great simplification employed to transform the data, from

whole transcripts to relative frequencies of three categories, actually destroyed the inter-subject effect. Still, while the sample size does not allow to rule out chance, inter-subject data (i.e. cross-synchrony) of the first session only, showed a relevant difference between good and bad outcome dyads. A result that, if confirmed, may prove of extreme value for outcome research and clinical practice.

Overall the findings of the present work have contributed to existing literature, by crossing the domains of interpersonal physiology and psychotherapy research. All the researches supported the view of psychotherapy as a complex dyad system, in which regulatory processes play an important role. Furthermore, the substantial idea of infant research, that early mechanisms are still working in the adult was also supported, for instance by observing how attachment manipulation was able to impact on the regulatory processes. Yet, the scenario drawn by these studies also opened a new dimension of complexity for the literature assessing interpersonal synchronization phenomena. For instance, it appears evident that the direction in which synchronization is lagged, is neither a casual, nor an irrelevant phenomena, and further research should assess this dimension, with both theoretical and methodological means.

Study 3, at the best of my knowledge, was the first study in literature attempting to exactly identify the processual correlates of SC linkage. In this attempt, many steps toward the comprehension of the clinical meaning of synchronization were made, yet the extremely explorative methodology employed does not allow to generalize those findings. Further research should carry on the idiographic effort, by expanding the qualitative analysis on more dyads, and, eventually, switching from a free phenomenological approach to a multiple independent scorers system, once the categories have established. Indeed whereas studies 1 and 2 offered crucial insights in the potential flexibility of SC linkage to training and priming, the general inconclusiveness of the associations with the questionnaires outlined an important limitation of such kind of group-level designs. As the precise nature of the psychological process underlying SC synchrony (but any other form of interpersonal synchrony as well) is still unknown, the attempts to associate it to any kind of other construct, proves to be an unreliable procedure. Due to limitations of the traditional statistical practices in psychology, such as p-value reporting without effect sizes, and to those connected to publication biases, such as positive-result biases, in order to provide a conclusive evidence, such a study should employ very large sample sizes, in order to allow sufficient power to control for most of the many confounding variables. It is also because of these problems that in the last years, physiological linkage has been described as associated to negative contexts only by some authors (e.g., Levenson & Gottman, 1983), and only to positive values such as empathy or reactivity (e.g., Marci et al., 2007, Ham & Tronick, 2008); Similarly, some authors concluded that it is a

phenomenon limited to attachment relationships (Sbarra & Hazan, 2008), whereas others have observed it in strangers (Silver & Parante, 2004)⁶.

The main methodological implication of the present work, thus may be urging the scientific community to start questioning the real processual meaning of the phenomenon before trying to associate it to each authors' topic of interest. Synchronization appear to be such a founding property of interaction, that it is unsurprising that it can be associated to a vast amount of psychological constructs, yet simplistic causal associations should be avoided or considered cautiously until literature will provide substantial evidence.

With all the due caution, the findings of the present work, among all the one that preceded it, do evidence a fascinating phenomenon. Communication through synchronization is a feature that human beings share with the rest of the natural reign, and open a marvellous window on the understanding of our species. Carl Gustav Jung described skin conductance as the gate for the unconscious mind; it is my belief and hope that interpersonal skin conductance may prove to be the gate for the unconscious dynamics between patients and therapist.

⁶ For a discussion on the methodological issues on physiological linkage refer to Palumbo, 2015.

Aknowledgements

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Appendix A
Content Analysis

Start	End	Type	Direction	Non verbal	Content	Patient	Therapist	Dyad
04:10	04:55	sync	pacing	Strong body synchrony, shared smiles.	Introducing the therapy	Expresses pleasantness to the experimental and clinical setting. Maybe appeasing	Warm and empathic	Interaction focused on interactive regulation
06:40	07:10	de-sync	leading	patient's autoregulatory hand movements, long pauses, looks away, chuckles	Fear of other drivers, need of control	oscillates in and out from interaction. Gets in touch with a conflicting area of self, yet chuckling	Active listening	The sequence matches the verbal turn change, she gets into herself, the therapist is left alone
07:55	08:25	de-sync	pacing	patient does not keep eye contact	need of having everything under control when somebody drives	oscillates in and out from interaction. Gets in touch with a conflicting area of self, yet chuckling	Active listening	Therapist intervention catches back patient's attention only at the end causing the end of the desynchronization
10:10	10:40	sync	leading	Body movement and breath synchronized	distressing fantasies	attentive listening, connected to the therapist words	Validates patient's suffering	dyad is involved in mutual attunement through repetition and mimicry
11:55	12:42	sync	leading	Body synchrony, well paced turn exchange	Fear of travel	Expressive, reacts with freezing and deglutition to the therapist's interpretation	Active listening, reformulates and interpret	While the therapist sometimes interrupts the patient, both dyad's member are high attentive to each other
12:40	13:25	de-sync	sync	reduced movement, patient	Criticizes her boyfriend	Oscillates back and forth toward the realization that her boyfriend does not respect her	Active listening, interrupts the patient with a suggestion that is only briefly followed	Difficult interaction, therapist suggestion is not accepted by patient
14:40	15:10	de-sync	sync pacing	-	Therapist proposes that her need of reassurance is not met by the boyfriend	Listen and nods, in the middle of the sequence there is a strong emotion,	Reformulates and validates the patient's suffering	The strong emotional reaction by the patient is not caught by the therapist, who takes the

						she tries to talk but therapist takes turn		verbal turn, without letting here express.
17:55	18:25	de-sync	sync	patient initially nods, then motionless, small gesticulations by the therapist	having had a serious accident justifies the present fear	Listen and nods, swallows and stares the therapist in the eyes, appearingly frozen	proposes a restitution of the patient's fears	The whole interaction is strongly focused on the therapist
18:55	19:25	sync	pacing	Patients gesticulate and smiles, therapist still	Memories of family travels	Follows internal associations	Active listening	The patient follows an internal line of reasoning jumping to different topics with emotional content, the therapist listen empathically
20:10	20:40	sync	leading	many patient's regulatory movements, therapist sighs	Father ignores her request to slow down	Present a deeply emotional content	active listening. At the end of the sequence he interrupts the patient with improper timing	Therapist's verbal interruption breaks the synchronization sequence
22:25	22:55	de-sync	pacing	patient chuckles, touches ear and hairs	Is it me that is phobic or everybody else careless?	she blows off pressure	Is motionless, does not responds the verbal and nonverbal emotional activation of the patient	Therapist does not converge to patient's pattern. Possibly a positive rupture
22:40	23:10	sync	leading	Therapist gesticulate, patient rhythmically nods	Therapist highlights the severity of traumatizing accident	active listening	puts emotional weight on the past car accident	After a long pause following the word "accident" there is visible emotional bonding
24:25	25:10	sync	leading sync pacing	High tension expressed by both. Patient changes leg	memories of her father speeding on the motorway	Brings a strong emotional content of fear	empathize affectively	There is evident affective sharing in this sequence

				positions, her voice trambles. Therapist compresses breath				
25:25	25:55	de-sync	mixed	Reduced body movement, tension in her left foot	My father has always been like that, it's his nature	She justifies the father's behaviour	he cognitively validates the patient's defense thorough a reformulation	The emotional conflictual content of the patient is not followed by a therapist affective reaction
28:10	28:40	de-sync	pacing	she gesticulates, tension in her feet, he is motionless	memories of fighting parents, mother is a victim	she express emotional contents	active listening	The memory arouses intensely the patient, the therapist stays calm and empathic
28:55	29:25	sync	pacing	she gesticulates, strong tension in her feet, he is motionless	"bad" father and mother victim	Now calmer she oscillates between expressing bad and good things of her father	Active listening	Patient's memory is affectively charged, the therapist stays calm and empathic
30:10	31:10	sync	sync	She gesticulates and expresses emotionally	father sometimes shouts at her. She defines her defense to be negation	powerful introspection, talking about her father she expresses her main defense	Active listening and empathic interventions	Strong linkage and comprehension, frictionless interaction
32:55	33:40	sync	pacing	intense eye contact, and rhythmic nodding by both. Her foot relaxes from tension	She hides to her father the accident episode, therapist suggest is a mother's strategy	She accept the interpretation and listen intensely	Interpretation, calm and supportive	Nonverbal language suggests that the patient self-regulate in response to the interpretation, yet manages to stay in the interaction
33:40	34:10	de-sync	sync pacing	Strong tension in the left foot, she stares at him freezed. He gesticulates with expression	T: your father's devaluation of you and your needs	attentive listening, motionless	intense clarification	Therapist intervention is attentively listened by patient, who stays in high a tension posture.

34:40	35:10	sync	sync pacing	He gesticulates with expression she nods rhythmically, changes foot position toward therapist	T: father does much for her but ignoring her voice/needs/opinion	Active listening, seems to accept the words of the therapist	Intense interpretation	therapist softer intervention is accepted by patient, movement synchronizes, attunement
35:25	35:55	sync	sync	He gesticulates with expression she nods rhythmically, synchronized head movements, foot tension at the end of the sequence	Interpretation connects father's relation to fear of careless drivers	active listening	continues interpretation	therapist intervention is accepted by patient, movement synchronizes, attunement
37:25	37:55	sync	leading	Both gesticulates, she changes position, synchronized nodding	Her apparent adaptivity underlies oppositivity	contrariata da interruzione compiace	clarification	fast paced turn exchanges not always seamless but with good rhythm,
40:40	41:10	de-sync	pacing	High tension in left foot, few eye contacts, she gesticulates, he is motionless	The mother of my boyfriend does not like me	Oscillates toward and away the therapist, emotionally aroused	Initially listens actively then reduces movements and interactions	Patient withdraws from interaction, therapists disengages as well
41:25	42:43	sync	sync	her left foot is held in tension	memories of eating with her boyfriend family. His mother defines her insolent	Describes a very negative memory with tension, yet smiling	Active listening, interpretation	Therapist listen with presence and takes turn to interpret, seamless interaction good attunement
42:55	43:40	de-sync	pacing	she nods rhythmically, he gesticulates	Withdrawal was adaptive for her but condemned by boyfriend's mother	Active listening	Interpretation, calm and supportive	

43:55	45:25	sync	pacing	synchronized head movements and laughing	A 15 years old insolence has a developmental meaning	Participates actively in the interaction,listen carefully and actively	He justifies her and defends her from this memories	fast paced turn exchanges, synchronized body movements and prosody, strong linkage
46:25	47:10	sync	leading	synchronized head movements	fear of travel connected to fear of expressing. Lack of control comes from withdrawal	active listening	Interpretation, calm and supportive	strong nonverbal mimicry, reciprocal understanding, attunement

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