"How do self-touch and hand gestures of patients with major depression change over the course of a successful cognitive behavioral psychotherapy?"

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Abstract

The aim of this study was to examine the nonverbal behavior of patients with major depression over the course of successful cognitive behavioral psychotherapy (CBT) in an outpatient setting. A therapy was classified as successful if the patient scored ≤13 on the Beck Depression Inventory at post-measurement. Video recordings from 22 depressive patients were analyzed regarding their self-touch and hand gesture behavior at the beginning and at the end of therapy. It was hypothesized that self-touch movements would decrease and hand gestures would increase over the course of a successful therapy. The movement data was coded using the NEUROGES-ELAN analysis system for nonverbal behavior and gestures.

Results revealed a significant decrease in self-touch behavior, particularly irregular self-touch movements, towards the end of therapy. However, no significant changes were observed in hand gestures in the gestural space over the course of therapy. These findings suggest that nonverbal cues, such as self-touch behavior, provide valuable information about patients' depressive symptoms. More research is needed to explore how different forms of self-touch and hand gestures change over therapy and how they are linked to a patient's mental state.

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1 Introduction

Nonverbal communication, also called nonverbal behavior, encompasses a wide variety of cue modalities, such as gestures, gait, posture, facial expressions, appearance or self-touch (Hall et al., 2018). The terms nonverbal communication and nonverbal behavior are used interchangeably in this master's thesis, reflecting the current state of research (Hall et al., 2018). Nonverbal behavior plays a major role in almost every social interaction and its importance is reflected in the interdisciplinarity with which it is studied. Research ranges from psychology and communication research, anthropology and linguistics to medicine and even criminal justice - nonverbal behavior is of interest in many areas (Hall et al., 2018).

Despite the fact that nonverbal behavior is researched across various disciplines and its origins can even be traced back to the time of Pythagoras (580-500 BC), no independent field of research has developed (Lausberg, 2022). This is particularly notable in psychology, which is defined as the scientific study of human behavior and mental processes (American Psychological Association, 2025). Similarly, in psychotherapy research, body movements are often not a primary focus. Although there is consensus that nonverbal behavior plays a crucial role in psychotherapy, it is rarely emphasized in overviews of the field (Ramseyer, 2023).

This thesis focuses on self-touch movements and hand gestures of depressive patients during a cognitive behavioral psychotherapy. First, self-touch movements and hand gestures, along with their assumed functions, are explained. Next, the relevance of studying these movements in psychotherapy is discussed, followed by a review of the current state of research. Finally, the hypotheses and research questions are presented and the coding system used in this study is introduced.

1.1 Definition and function

Self-touch refers to movements in which individuals touch their own body. Usually, the hand acts on a part of the body, leading to a dynamic physical contact (Lausberg, 2022). Self-touch includes scratching, rubbing, stroking, or squeezing parts of the body. As an example, also movements such as brushing hair out of the face or touching the neck are considered self-touch. These movements are typically performed unconsciously and do not have a communicative function (Kreyenbrink et al., 2017; Schacter, 1992). Gestures, on the other hand, usually have a communicative function, as they often accompany verbal expression and interactions (Kendon & Birdwhistell, 1972). While the term "gesture" is used variably in the literature (Lausberg, 2022), in this paper, gestures refer to movements of the hands that occur in the gestural space.

Studies demonstrate that both touch and gestures serve vital functions. The absence of touch, particularly in infants, can lead to developmental impairments (Spitz, 1945), while massages for premature babies have been shown to promote faster weight gain and reduce blood cortisol levels (Field et al., 1986; Guzzetta et al., 2009). Further research with infants shows that when their skin is stroked at a certain frequency, C-tactile nerves are stimulated, producing positive effects on the infant's well-being (Croy et al., 2016). This evidence supports the assumption that touch has a powerful calming effect. Consequently, self-touch can be understood as a form of self-soothing and, therefore, a mechanism of self-regulation in response to stress or negative emotions (Harrigan, 1985). Observations with healthy participants revealed that individuals exhibit more self-touch movements during moments of discomfort, stress or after experiencing something shocking or unpleasant (Knapp et al., 1978; Morris, 1978; Navarro & Karlins, 2011). Recently, the neural correlates of self-touch have also been explored. Von Au et al., (2024) found that self-touch activates various areas of the prefrontal cortex and triggers internally focused processes, enabling individuals to emotionally distance themselves from external stimuli and, in a sense, "escape" the moment.

While self-touch appears critical for emotion regulation, gestures also fulfill essential functions. Although the extent of gesturing varies across cultures and situations, gestures are performed universally (Feyereisen, 1991). Even children born blind gesture, supporting the assumption that gesturing is innate to humans (Goldin-Meadow & Mylander, 1998; Iverson & Goldin-Meadow, 1998). Nonverbal communication is believed to have preceded spoken language and was crucial for survival. Consequently, nonverbal communication is often regarded as the primary mode of information exchange, with verbal communication viewed as an extension of this nonverbal form (Darwin, 2013). This aligns with studies indicating that gestures are not redundant to speech but rather add information that would otherwise not be found in the spoken words (Goldin-Meadow, 2005; Kendon, 2004; McNeill, 2000). Research also shows that presentations are better understood when the speaker uses gestures to reinforce the statements (Goldin-Meadow, 1999; Hostetter, 2011; Krauss et al., 1991).

However, gestures do not only serve communicative purposes. McNeill's theory proposes that gestures are an integral part of the thinking process (McNeill, 2000). Supporting this, research indicates that students who gesture while solving mathematical or spatial problems perform better on these tasks (Cook & Goldin-Meadow, 2006; Ehrlich et al., 2006). The same is true for adults when solving geometrical problems (Sassenberg et al., 2011).

Based on such findings, it can be assumed that gestures are closely related to cognition and thought processes. In everyday life, it can sometimes be observed that people also gesture during self-talk or on when on the phone. Since the person on the other end of the phone cannot see the person gesticulating, the movements must be part of the thought process. Recent approaches in cognitive science expand on this assumption, proposing that thinking does not only take place within the brain's biological boundaries, but also in body movements or even in the environment (Paul, 2021). The close interplay between brain processes and body movements is also evident in neuropsychological studies. For instance, while the right hemisphere is involved in emotional processing, gestures associated with emotions are often performed by the left hand (Lausberg, 2022).

In summary, nonverbal behaviors such as self-touch and hand gestures are closely linked to cognitive and emotional states. They play a vital role in regulating emotions and stress as well as in enhancing communication, problem-solving and cognitive processes. Given this, the topic holds particular relevance for psychotherapy research.

1.2 Relevance

In psychotherapy, there is often a great emphasis on verbal expression (Philippot et al., 2003). However, it is estimated that 60 to 65 percent of interpersonal communication is conveyed via nonverbal behavior (Burgoon et al., 2009). Despite the known importance of nonverbal behavior, it remains underexplored in psychotherapy research (Ramseyer, 2023). Especially in cognitive behavioral therapy, the nonverbal behavior of patients has not yet been thoroughly studied (Ramseyer, 2023). Given that cognitive behavioral therapy is widely regarded as the gold standard for treating depression (David et al., 2018), advancing research in this area is crucial. Even more, when acknowledging that major depression is among the most prevalent mental health conditions globally. The World Health Organization (2023) estimates that approximately 5% of adults worldwide suffer from depression. Therefore, the urge for effective therapies is high.

Studies have demonstrated that when therapists gain deeper insights into their patients thought and behavior patterns and use continuous feedback to monitor progress, therapy outcomes are significantly improved (Barkham et al., 2021). Furthermore, research on nonverbal cues showed that therapists who are attentive to their patient’s nonverbal behavior can better understand their emotional states. This additional information has been found to enhance the overall effectiveness of therapy (Ramseyer, 2010). In addition, nonverbal behavior such as self-touch or gestures can almost continuously be observed in therapy (Lausberg, 2022), offering a valuable source of information.

Another important characteristic of nonverbal behavior is that it is almost always performed unconsciously, providing a less filtered and more immediate representation of a patient's mental state (Knapp & Hall, 2010; Schacter, 1992). As a result, nonverbal communication is often considered more authentic than spoken language (Navarro & Karlins, 2011). This is not only relevant regarding the conversation in psychotherapy, but also when considering how improvements in therapy is assessed. Typically, patients complete self-report questionnaires to evaluate therapy outcomes. While questionnaires have several advantages, including efficiency, standardization, cost-effectiveness, and the ability to capture subjective insights (Raven, 1995), they also have notable limitations. These include the impact of social desirability, response bias, non-linear scales, and the requirement for patients to be self-aware of their symptoms (Lally & Testa 2015; Schwarz, 1999). Both, verbal statements in therapy as well as filling out questionnaires, require patients to verbalize emotional states and engage in conscious reflection, whereas body movements can convey information without the patient's awareness, therefore, more directly.

To summarize, the link between body movements and mental states, the high prevalence and density of information in body movements, as well as their direct and implicit nature, make them a valuable source of information—particularly in psychotherapy settings, where additional information can contribute to a more effective therapy.

1.3 Theoretical foundation

A substantial body of research has demonstrated correlations between self-touch and negative affect, discomfort, or stress (Densing et al., 2018; Grunwald et al., 2014; Heubach, 2016; Kreyenbrink et al., 2017; Lausberg, 2013; Reinecke et al., 2020). Reinecke et al. (2020) found that patients diagnosed with both anxiety and depressive disorders exhibited more fidgeting behavior—a form of self-touch characterized by small hand movements—compared to patients with only an anxiety disorder. Similarly, research on patients with anxiety disorders revealed that self-touch behavior decreased during successful psychodynamic psychotherapy (Kreyenbrink et al., 2017).

In the context of depression, studies with patients in a stationary setting have shown that self-touch behavior is more frequent at the beginning of therapy and tends to decrease during successful treatment (Ekman & Friesen, 1974;Wallbott, 1989). Besides self-touch behavior, also hand gestures of depressive patients have been studied. Ekman and Friesen

(1974) observed that severely depressed patients in inpatient settings used fewer communicative gestures compared to non-depressed individuals. They further noted that improvements in therapy were accompanied by more fluid gestures. Supporting this, Pavlidou et al., (2021) found that depressive patients exhibited impaired gesture performance compared to healthy controls, with two-thirds of the depressed patients demonstrating significant gesture deficits.

While these studies provide valuable insights into the movement behavior of depressive patients, they predominantly focused on the stationary settings or psychodynamic therapies. To my knowledge, no study has examined self-touch behavior and hand gestures in depressive patients undergoing cognitive behavioral therapy in an outpatient setting. This is particularly significant, as most individuals diagnosed with major depression are treated in outpatient care (Kurt, 2016), and CBT is widely regarded as the first-line treatment for depression (David et al., 2018). Given the high prevalence of depression as a common mental disorder and the limited research on self-touch movements and hand gestures in cognitive behavioral therapy, further exploration in this field is vital.

1.4 Research questions and hypotheses

This study investigates the research question: “How do self-touch behavior and hand gestures of patients with major depression change over the course of a successful cognitive behavioral psychotherapy?” Based on the existing literature and the functions associated with self-touch and hand gestures, two overarching hypotheses were developed.

The first hypothesis assumes that self-touch behavior in depressive patients will decrease over the course of successful psychotherapy. This assumption is grounded in the idea that a reduction in symptom severity will reduce the need for stress and emotion regulation, which are typically associated with self-touch behavior. The second hypothesis concerns hand gestures, proposing that depressive patients will show an increase in hand gestures during successful psychotherapy. In the Diagnostic and Statistical Manual of Mental Disorders (DSM) it is noted that depression also affects cognitive abilities, such as thinking and concentrating. While symptoms of depression decrease over a successful therapy, thinking processes might improve. This change in cognitive processes could possibly be expressed in the use of more gestures, as gestures are linked to cognition and can support thinking processes.

To test these hypotheses, the NEUROGES system was chosen as the analytical tool due to its reliability and validity in classifying nonverbal behavior. The system enables the categorization of all movements occurring in a psychotherapy session (Lausberg, 2022).

In the NEUROGES system, self-touch behavior is operationalized as movements acting on the body surface, coded as *on body*. Three forms of self-touch can be distinguished: *irregular on body*, *repetitive on body* and *phasic on body*. The values *irregular, repetitive* and *phasic* describe the movement path of the hand, also called trajectory. One can observe different phases within this trajectory. For *repetitive* and *phasic* movements, there are three distinct phases: a transport phase (e.g., the hand moves to the nose), a complex phase (e.g., scratching the nose), and a retraction phase (e.g., the hand returns to rest on the lap). These trajectories are based on a motor plan and therefore require higher motor planning processes. In contrast, *irregular* movements lack phases and occur wherever the hand happens to be (e.g., small finger movements while the hand rests on the lap). These movements do not require motor planning processes of high complexity (Lausberg, 2022).

The difference between *repetitive* and *phasic* units also lies in the movement path. *Repetitive* movements involve a trajectory with repetition (e.g., scratching the arm). *Phasic* units on the other hand have a unique one-way path with no repetition (e.g., drawing a circle in the air). Having no repetition involves inhibition, making *phasic* movements the most complex in terms of motor planning, compared to *repetitive* and *irregular* movements. Consequently, the structure of a movement provides insights into mental states. *Irregular* movements, for example, reflect a state dominated by dysregulation, whereas *repetitive* and *phasic* units are indicative of more productive mental processes, as they involve higher motor planning (Lausberg, 2022).

While self-touch movements are coded *on body* and can be divided into 3 forms based on the trajectory, the same applies for gesture. Gestures are coded as *in space* and can also be further divided based on the trajectory into *repetitive in space* and *phasic in space* gestures. Unlike self-touch, *irregular* movements are not possible for hand gestures *in space*, as in *irregular* movements, the hand is not going anywhere.

Given this differentiation, the overarching hypotheses are further specified as follows:

1. **Over the course of a successful cognitive behavioral psychotherapy, self-touch movements will decrease**
   1.1. Over the course of a successful cognitive behavioral psychotherapy, *irregular on body* movements will decrease

1.2. Over the course of a successful cognitive behavioral psychotherapy, *repetitive on body* movements will decrease

1.3. Over the course of a successful cognitive behavioral psychotherapy, *phasic on body* movements will decrease

2. Over the course of a successful cognitive behavioral psychotherapy, hand gestures will increase

2.1. Over the course of a successful cognitive behavioral psychotherapy, *repetitive in space* movements will increase

2.2. Over the course of a successful cognitive behavioral psychotherapy, *phasic in space* movements will increase

Whether the therapy was successful was operationalized with the Beck-Depression Inventory (BDI-II). This is a widely used and reliable tool for assessing depressive symptoms and will be further explained in the method section (Beck Depression Inventory-II, 2010; Wang & Gorenstein, 2013)

2 Method

This chapter provides an overview of the most important steps and decisions taken during this study. It begins with a description of the video material. Next, the inclusion criteria for the sample are outlined, followed by a presentation of the characteristics of the final sample. This is followed by a detailed introduction to the NEUROGES-ELAN measurement instrument. Finally, the procedures for data collection and analysis are explained.

2.1 Video Data

The video data was provided by the University of Berne and recorded in the therapeutic practice of the University of Berne. Patients with various mental disorders can receive ambulant treatment there. The videos were recorded in 2017 and 2018, showing psychotherapy sessions in a naturalistic setting. Patients gave their written consent for the video material to be used for research purposes. Importantly, at the time of video recording, patients did not know that their self-touch and hand gesture behavior would be analyzed later, reducing potential biases. In order to be allowed to use the videos, I completed a confidentiality module and committed myself to strict confidentiality.

Each therapy session was recorded from two different angles. Viewpoint A showed the patient well centered and in close-up. Whenever possible, the video footage from this angle was later coded. In the rare cases where video data from this angle was not available, angle B was used instead, providing a moderately more distant perspective of the patient. As many videos were slightly blurred, the video quality was assessed by Professor Hedda Lausberg from the German Sport University in Cologne and deemed good enough to be analyzed with the NEUROGES-ELAN coding system.

2.2 Inclusion criteria

The original available data set (n = 104) consisted of patients suffering from various mental illnesses. Several exclusion criteria were then applied. Patients had to be diagnosed with depression (n = 48). Patients diagnosed with dysthymia (n = 7) were excluded as only patients with major depression were to be studied. Some patients (n = 4) discontinued therapy and were therefore excluded as no pre-post measurement could be made. As the movement data was later to be contextualized with questionnaire data, further patients (n = 7) were excluded as no post-questionnaire data was available. Whilst nonverbal communication also strongly depends on the interaction and thus on the dyad with the therapist (Flückiger & Znoj, 2009), further patients (n = 2) were excluded due to a change of therapist during therapy. The data set then comprised 28 patients who were diagnosed with major depression, who completed baseline and post questionnaire and who had not changed therapist.

All 28 patients were subsequently coded. Importantly, video data for all 28 patients was coded without prior knowledge of therapy outcomes, minimizing confirmation bias in the coding process.

2.3 Defining success post-hoc

Therapy success was then measured post-hoc using the Beck Depression Inventory. The BDI-II consists of 21 self-report items and includes cut-off scores for categorizing symptom severity. A score of 13 or lower indicates minimal depression (Dozois et al., 1998). This threshold has also been used in prior studies to define therapeutic success, such as Reinecke et al. (2020). This study also operationalized a successful therapy with a BDI cut-off ≤13. Also, the BDI data was fully provided by the University of Berne.

The post-hoc analyses based on the BDI-II cut-off ≤13 showed that 22 patients decreased their depressive symptoms below this value. These therapies were therefore classified as successful. Therapies of 6 patients were not classified successful according to these criteria. Due to the unequal group sizes, a comparative analysis between these groups — which could have provided valuable context regarding the movement behavior of successful patients — was not feasible. Consequently, it was decided to focus the statistical analysis solely on the movement data of the 22 patients who demonstrated improvement in alignment with the research question. Thus, the final sample consisted of 22 depressive patients, all of whom showed improvement in depressive symptoms at the end of therapy.

2.4 Sample

The final sample included 14 women and 8 men and ages ranged from 22 to 56 years (see Table 1). Even though all patients were diagnosed with major depression, some had a depression for the first time (single-episode depression) and others had experienced depression before (recurrent depression). Diagnoses were made using the Structured Clinical Interview for DSM Disorders (SCID), which was conducted by a trained clinician prior to therapy. For all but two patients, German was the primary language. The duration of therapy varied from person to person and ranged from 16 to 34 sessions.

Table 1

[redacted]

Aus Datenschutzgründen darf diese Tabelle nicht veröffentlicht werden

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2.5 Study design

Two measurement time points were selected for the analysis of self-touch and hand gesture behavior. As the aim of this study is to observe possible changes in self-touch and hand gestures over the course of successful therapy, one session was chosen at the very beginning and one session at the very end of therapy.

For the pre-measurement time point the second non-probationary session was selected. As it is crucial to interpret nonverbal behavior within the given context (Knapp et al., 1978), the first therapy session was not chosen because it would reflect the moment where the patient and therapist meet for the first time. Self-touch behavior and hand gestures observed during this session may be more influenced by the novelty of the situation rather than reflecting the patient's emotional or mental state related to depression. In addition, observation of video material revealed that many other things than the actual problem were discussed in the first session, e.g., therapy conditions, psychoeducation or questionnaire results. For all these reasons, the second therapy session was chosen as the pre-measurement time for the analysis of self-touch and hand gestures.

Because the very last therapy session also differs considerably in terms of content, the second-last therapy session was chosen for the second measurement point.

Once the second-first and second-last therapy session was selected as pre- and post-measurement time points, the next step was to determine which part of the approximately 50 minutes lasting session should be coded. Since nonverbal behaviors such as self-touch and hand movements are very rich in information, it is usually sufficient to code only a small interval that can be generalized for the entire session (Lausberg & Sloetjes, 2009). I opted for 3 minutes in each selected session. This resulted in 6 minutes of coding per patient. Although the length of the interval was then set, it still had to be decided where to start the interval. Various criteria were considered for selecting a starting point. Because I wanted to measure body movements that are linked to emotional or mental states corresponding to the depressive symptomatic, it was important to find intervals where the patient actively deals with his or her issue. Small talk, organizational matter or parts where the therapist speaks a lot should be avoided. Therefore, I decided on the following criteria: Coding starts after the therapist first asks a question inquiring about the patient's current mental or emotional condition. For example: “How do you feel today?”. This criterion was also chosen to ensure that the patient played as active a role as possible, since sequences in which the therapist asked further questions or made comments were coded nonetheless.

To find an individual starting point in each session, the second-first and second-last therapy sessions were watched with sound from the beginning. For each patient an individual starting point was set and the movements for the subsequent 3 minutes were later coded.

2.6 Measurement instrument for movement behavior

Analyzing movement is a challenge because movement is a continuous flow. In order to analyze this movement stream, it must be divided into different units. While different coding systems do this in different ways, not all are equally supported by empirical research. Some coding systems use non-valid time limits or jump directly to assigning a function to the movement (Lausberg, 2013). For this study, the NEUROGES analysis system for nonverbal behavior and gestures was chosen, because it addresses many of the shortcomings of previous systems. It was developed in a long-term funding project and has been continuously tested and optimized in empirical studies over the years. NEUROGES is currently an objective, reliable and valid tool for analyzing video recordings of body movements (Lausberg & Sloetjes, 2016). It has also proven to be suitable for the analysis of movement behavior in therapeutic settings (Kreyenbrink et al., 2017; Kryger & Lausberg, 2011; Reinecke et al., 2020). In this study NEUROGES Module 1 (NEUROGES *Activation-, Structure- and Focus Category*) was used, because it is able to measure all hand movements occurring in psychotherapy, including self-touch behavior and hand gestures. Table 2. provides an overview of the different categories and their corresponding movement values, along with examples. In the following the different categories are briefly explained.

The goal of the *Activation Category* is to measure the extent of an individual's motor activity. The *Structure Category* assesses the movement trajectory, providing insight into mental states. Finally, the *Focus Category* determines where a person directs their attention and detects the loci of sensory-motor impression (Lausberg, 2013). The system has a step-by-step approach and it is getting more fine-grained with every step. This ensures that each coding decision is precise and objectively justified.

To ensure that I can apply this system correctly for my master's thesis, I attended a one-week training course in Cologne in February 2024. In July 2024, I successfully obtained certification as a trained NEUROGES rater (see certification in appendix).

2.7 Data collection

After determining the starting points of the time intervals for each selected therapy session, the videos were imported to ELAN (Version 5.9). This is the software that enables to code movements based on the NEUROGES system. Since the research question focuses on self-touch and hand gesture behavior, it was sufficient to code movements of the upper limbs. In the NEUROGES coding system, the upper limbs include fingers, hands, wrists, elbows, and shoulder articulations. Movements were coded separately for the right and left hand. To adhere to the coding manual, the audio track was muted during the coding process to ensure that movements were coded independently of verbal statements. The videos were analyzed on a 27-inch monitor, enabling the detection of even small finger movements in most cases. The three categories (*Activation, Structure, Focus*) were coded one after the other for the entire sample. This was done to equalize training effects over the whole sample. Additionally, the videos were randomized three times, for each category, to further balance training effects, ensuring that improved coding skills over time would not bias the results.

In the *Activation Category*, the presence or absence of movement in the upper limbs was assessed. In order to do so, the movement stream was segmented into units of movement and units of rest/pose. All identified movement units were then carried forward to the next step, where the *Structure Category* was coded. Here, the movement path was analyzed and five possible values (*irregular, repetitive, phasic, shift, aborted*) were assigned, with only the first three being relevant for this study. Lastly, the focus of *irregular, repetitive*, and *phasic* units was coded by assigning one of five possible values (*within, on body, on attached object, on separate object, in space*). Also here, only the values *on body* and *in space* are of importance for this study. However, coding everything independently of the research interest is a further strength of this coding system. For example, if the interest would lie on pointing gestures, unusual movements corresponding to this category (e.g., pinkie finger lifts from the table and points somewhere) might easily be overlooked. However, NEUROGES registers all movements and is therefore very precise. The last step in the coding process was then to combine the values from the *Structure Category* with the values from the *Focus Category.* This resulted in the creation of the *StructureFocus Category* (see Table 2), which leads to values such as "*phasic in space*".

Table 2

Brief Description of the Categories Activation, Structure, Focus and StructureFocus from the NEUROGES System for Nonverbal Behavior and Gesture, Including an Overview of Coded and Analyzed Values in this Master's Thesis

Category	Values	Description	Coded	Analysed
Activation	Movement	Part of body in active motion, potentially including transient motionless phases in an actively held position (against gravity)	yes	no
	Rest/Pose	Part of the body rests or poses	no	no
Structure	Irregular	Movement with no phase structure, trajectory with short path in various directions with practically no displacement, potentially continuous in time	yes	no
	Repetitive	Movement with a phase structue, the hand is transported to the place of action and moves at least twice in the same direction (repetitive complex phase), then hand is retracted	yes	no
	Phasic	Movement with a phase structure, the hand is tranporte to the place of action and moves either on a one-way path with no repetition (dynamic compex phase) or adopts a distinct shape and remains static (static complex), then hand is retracted	yes	no
	Shift	Movement with no phase structure, the hand or body is moved from one rest position to the next rest position in the most direct way, e.g., hand moves from knee to lap	yes	no
	Aborted	Only transport- or retraction phase without compex phase, movement is stoped before complex phase can start	yes	no
Focus	Within body	Acting on body-internal structures (muscle tendons, joints…), e.g., turning wrist, shoulder shrug	yes	no
	On body	Hand is acting on the body surface e.g., touching face, scratching ellbow, finger-to-finger movements of one hand, both hand dynamically touch each other	yes	yes
	On attached object	Hand is acting on an object that is attached to the body, e.g., ring, scarf, watch, clothing, glasses	yes	no
	On seperate object	Hand is acting on an object that is seperate from the body e.g., chair, table, glass of water, pen	yes	no
	In space	Hand is acting in the body-external free space mostly without touching anything, e.g., hand gestures in space in front of thorax	yes	yes
StructureFocus	Irregular within body	Movement with irregular structure within body, e.g., shoulders move in an irregular manner	yes	no
	Repetitive within body	Movement with repetitive structure within body, e.g., several shoulder shrugs in a row	yes	no
	Phasic within body	Movement with phasic structure within body, e.g., fingers are streched and relaxed again	yes	no
	Irregular on body	Movement with irregular structure on body surface, e.g., small movement with the fingers on the other hand	yes	yes
	Repetitive on body	Movement with repetitive structure on body surface, e.g., one hand scratches the other arm repetitively	yes	yes
	Phasic on body	Movement with phasic structure on body surface, e.g., hand moves to the face and touches the cheek once	yes	yes
	Irregular on attached object	Movement with irregular structure on attached object, e.g., finger make little movements on watch	yes	no
	Repetitive on attached object	Movement with repetitive structure on attached object, e.g., fingers turn ring on finger repetitively	yes	no
	Phasic on attached object	Movement with phasic structure on attached object, e.g., hand moves to the glasses and adjusts them with one push	yes	no
	Irregular on seperate object	Movement with irregular structure on seperate object. e.g., fingers make small movements on armrest	yes	no
	Repetitive on seperate object	Movements with repetitive structure on seperate object, e.g., hand taps repetitively on book	yes	no
	Phasic on seperate object	Movement with phasic structure on seperate object, e.g., hand reaches water glass and takes it	yes	no
	Repetitive in space	Movements with repetitive structure in space, e.g., hand beats to the beat of the music in the air	yes	yes
	Phasic in space	Movements with phasic structure in space, e.g., hand draws a circle in the air, points in one direction	yes	yes

Adapted from Lausberg (2019)

Once coding was completed, all data was exported to Excel. For each movement unit, the mean frequency (number/minute) and proportion of time (PoT) (seconds/minute) were calculated. Frequency is considered the most sensitive value to detect changes in movement behavior (Lausberg, 2013). Proportion of time was calculated as an additional measure. It describes how much time was occupied by a certain behavior. It would also have been possible to calculate a third value, the mean duration of a movement unit, however this metric has been shown to be less sensitive to change (Lausberg, 2013). The data was then organized and imported into IBM SPSS Statistics for further statistical analysis.

2.8 Statistical analysis

First, descriptive statistics with mean values and standard deviations were calculated for the movement units of the *Focus Category* (*on body, in space*) and for the movement units of the *StructureFocus Category* (*irregular on body, repetitive on body, phasic on body, repetitive in space, phasic in space*). This was done for each individual patient as well as for the total sample of 22 patients. This provided an initial overview of how the movement units changed over a successful therapy.

Next, inferential statistics were calculated by performing paired-samples t-tests to assess significant changes in movement units from pre- to post-measurement within the total sample. The analyses were again conducted separately for the movement units of the *Focus*- and *StructureFocus Category*.

In addition, paired sample t-tests were conducted for different sample variations for exploratory purposes. These sample variations were based on observations of the original data set and included different subgroups based on language or BDI scores.

Furthermore, t-tests for independent samples were performed to compare subgroups within the sample. These subgroups were defined by gender (female vs. male), age (young vs. old), type of depression (single vs. recurrent) and duration of therapy (short vs. long). The aim of these analyses was to identify potential moderating variables that could influence the observed changes in self-touch behavior or hand gestures. However, due to the small sample size and the exploratory nature of these analyses, the results have to be interpreted with caution.

It is important to note that all of the above calculations were performed using both metrics: frequency (number/minute) and proportion of time (seconds/minute). At this point, I would also like to point out that there is a methodological weakness in some calculations, as the normal distribution was violated for some variables and other statistical methods would have been more appropriate. However, this is discussed in more detail in the limitation section. For now, it should only be noted that significant findings for the variable *in space* should be interpreted with a certain amount of skepticism.

3 Results

Following the analysis and evaluation of movement data from 22 patients with depression undergoing cognitive behavioral therapy in an ambulant setting, the results are presented below. First, a bar chart will be presented as an overview over the different movement variables of the *Focus Category* and the *Structure Focus Category* which are the center of my research question. This is followed by a detailed overview of each patient's movement behavior, which provides valuable insight into the unique changes that occur during psychotherapy. Then inference statistics will be presented to examine whether the dependent movement variables significantly changed over the course of therapy. Lastly, exploratory analyses of sample variations and group comparisons will be presented to further explore factors beyond depressive symptom severity that might influence self-touch and hand gesture behavior. Both frequency as well as PoT values will be presented.

3.1 Movement profiles

Figure 1

Mean Frequency (number/minute) of Focus Units at Pre- and Post-Measurement with Error Bars Indicating Standard Error for the Total Sample (N = 22)

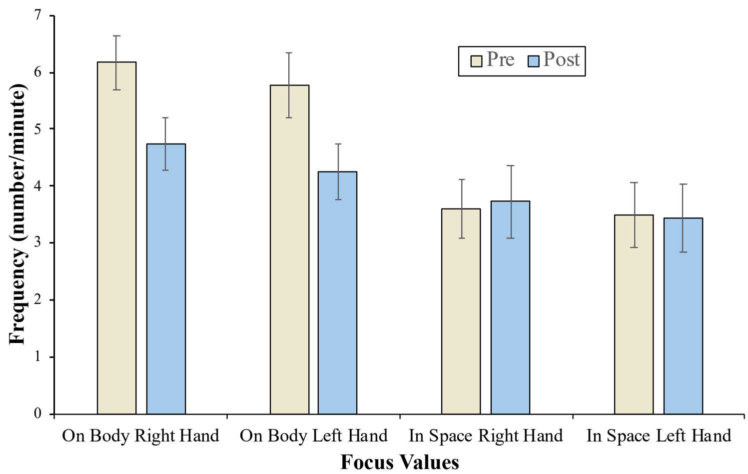
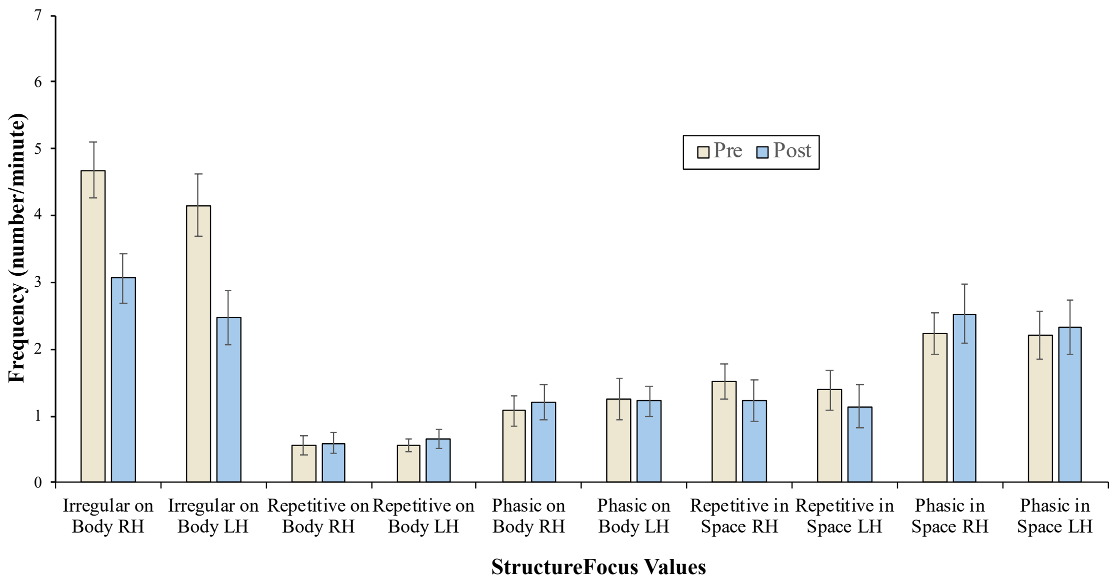


Figure 1. shows the mean frequency of the dependent variables *on body* and *in space* for the right and left hand both at pre and at post measurement for the total sample. The bar chart shows that the movements *on body* were performed more frequently at the beginning of therapy and that their frequency decreased towards the end of therapy. This pattern applied to both the right and left hand. In general, hand movements *in space* were performed less

frequently than movements *on body*. Also, no clear trend in *in space* movements was visible from pre to post.

Figure 2

Mean Frequency (number/minute) of StructureFocus Units at Pre- and Post-Measurement with Error Bars Indicating Standard Error for the Total Sample (N = 22)



In Figure 2. the *Focus* values are differentiated by adding information about the structure of the movement. This provides a more detailed insight into the movement data. It becomes clear that the movements *on body* are not the most frequent units per se, but that the frequency of self-touch movements can vary depending on the structure. For example, *irregular on body* movements were by far the most frequently performed units concerning self-touch. In contrast, *repetitive on body* and *phasic on body* units had a lower mean frequency.

If the units *in space* are divided according to their structure, it can be observed that *phasic in space* movements had a higher frequency than *repetitive in space* units.
When looking at the change from pre to post, the decrease in *irregular on body* movements stands out the most. Both the right and left hand showed this steep decrease. When looking at the other self-touch variables *repetitive on body* and *phasic on body*, only minimal visual differences can be observed. The hand gestures *repetitive in space* show a slight decrease from pre to post, which contradicts the hypothesis. However, a slight increase from pre to post can be observed for the variable *phasic in space*.

As bar charts of the same dependent variables for the *Focus*- and *Structure Focus Category* in PoT are comparable to those in frequency, they are not listed here for further illustration and can be found in the appendix (Figure 3 & 4).

3.2 Unique changes for each patient

After examining the overall distribution of self-touch and hand gestures variables for the entire sample with bar charts, the next step was to analyze the individual data more closely. Table 3. illustrates how each patient changed across the movement variables from pre- to post-measurement.

Table 3

Consistency of Changes with Hypotheses of Different Movement Variables from Pre- to Post-Measurement, Based on Frequency Data for Individual Patients (N = 22)

Hypothesis	Variable	Hand	Patient																					
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Decrease	On body	Right hand																						
		Left hand																						
Decrease	Irregular on body	Right hand																						
		Left hand																						
Decrease	Repetitive on body	Right hand																						
		Left hand																						
Decrease	Phasic on body	Right hand																						
		Left hand																						
Increase	In space	Right hand																						
		Left hand																						
Increase	Repetitive in space	Right hand																						
		Left hand																						
Increase	Phasic in space	Right hand																						
		Left hand																						

Note. Green cells indicate changes consistent with the hypothesis, pink cells indicate changes contrary to the hypothesis, and white cells indicate no change from pre- to post-measurement. The colors are dummy coded and do not reflect the magnitude of change.

The aim was to visualize the trends of these changes. For this purpose, the changes for each patient on a given variable were dummy-coded. For example, an increase in *phasic in space* movements of patient 2 was coded in green, because it was aligned with the hypothesis.

The intention behind this approach was to visually identify potential patterns in the data. However, as the table shows, the results reveal a highly mixed picture of individual changes, with no clear overarching pattern. Another table, based on proportion of time data, showing a similar pattern, can be found in the appendix (Table 4).

3.3 Inferential statistics

After visual analysis with bar charts and an overview over individual change patterns, inferential statistics were calculated. The alpha level was set to .05 to determine statistical significance. Cohen's *d* was used to indicate effect sizes. Effect sizes are classified as small ($d = 0.2$), medium ($d = 0.5$), and large ($d \geq 0.8$) (Cohen, 1992). First, the calculations for the variables *on body* and *in space* using the frequency values were conducted. A paired-samples t-test was performed for this purpose.

Table 5

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for the Total Sample (N = 22)

Variable	Pre		Post		*t(21)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	6.17	2.27	4.74	2.19	2.73	0.006	0.58
On body left hand	5.77	2.69	4.24	2.31	2.79	0.006	0.59
In space right hand	3.61	2.41	3.73	2.99	-0.24	0.407	-0.05
In space left hand	3.48	2.68	3.44	2.80	0.10	0.460	0.02

*p < .05

Table 5. shows that the depressive sample significantly decreased in the frequency of *on body* units from pre to post. This was true for both the right and left hand. Effect sizes were medium. Movement units for *in space* did not significantly change over the course of therapy.

Table 6

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for the Total Sample (N = 22)

Variable	Pre		Post		*t(21)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	26.04	11.03	20.46	14.70	1.75	0.047	0.37
On body left hand	27.22	13.31	22.99	14.85	1.01	0.161	0.22
In space right hand	8.72	5.77	9.10	8.28	-0.26	0.397	-0.06
In space left hand	8.49	6.90	9.41	8.96	-0.54	0.298	-0.11

*p < .05

Then the same calculations were made using the value proportion of time (PoT) instead of the frequency. While there was still a decrease in *on body* units, it was no longer significant for the left hand (Table 6).

Table 7

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for the Total Sample (N = 22)

Variable	Pre		Post		*t(21)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	4.68	1.96	3.06	1.74	3.78	0.001	0.81
Irregular on body left hand	4.15	2.16	2.47	1.90	3.97	0.000	0.85
Repetitive on body right hand	0.56	0.69	0.59	0.73	-0.15	0.442	-0.03
Repetitive on body left hand	0.56	0.49	0.65	0.65	-0.52	0.305	-0.11
Phasic on body right hand	1.08	1.02	1.21	1.25	-0.49	0.314	-0.10
Phasic on body left hand	1.26	1.43	1.23	1.06	0.09	0.466	0.02
Repetitive in space right hand	1.52	1.27	1.23	1.47	1.11	0.140	0.24
Repetitive in space left hand	1.39	1.39	1.14	1.50	0.85	0.202	0.18
Phasic in space right hand	2.23	1.46	2.53	2.03	-0.77	0.225	-0.16
Phasic in space left hand	2.21	1.67	2.33	1.91	-0.38	0.354	-0.08

*p < .05

Next, the *on body* and *in space* movements were analyzed in more detail, taking into account not only the focus but also the structure of the movement. The evaluation of the frequency values shows that the decrease of *on body* movements was driven by a decrease in *irregular on body* movements. They significantly decreased from pre ($M = 4.68$, $SD = 1.96$) to post ($M = 3.06$, $SD = 1.74$), $t(21) = 3.78$, $p = .001$ while all other variables did not show a significant change (see Table 7).

Table 8

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for the Total Sample (N = 22)

Variable	Pre		Post		*t(21)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	21.25	11.20	13.37	13.18	2.73	0.006	0.58
Irregular on body left hand	21.37	12.92	13.59	13.18	2.38	0.014	0.51
Repetitive on body right hand	2.20	3.20	3.34	6.01	-0.87	0.197	-0.19
Repetitive on body left hand	2.23	2.11	5.08	6.41	-2.07	0.025	-0.44
Phasic on body right hand	2.59	2.22	3.75	4.22	-1.33	0.099	-0.28
Phasic on body left hand	3.62	4.31	4.22	4.07	-0.49	0.316	-0.10
Repetitive in space right hand	4.66	4.43	4.10	5.27	0.57	0.289	0.12
Repetitive in space left hand	4.19	4.18	4.12	6.09	0.06	0.475	0.01
Phasic in space right hand	4.06	2.94	4.99	4.71	-0.96	0.173	-0.21
Phasic in space left hand	4.29	3.56	5.26	4.74	-1.07	0.149	-0.23

*p < .05

Lastly, the same variables were analyzed using PoT values (Table 8). While results were almost identical to the results in frequency values, only one difference is notable. Against hypothesis, *repetitive on body* units performed by the left hand significantly increased from pre (M = 2.23, SD = 12.11) to post (M = 5.08, SD = 6.41), $t(21) = -2.07$, $p = .025$. However, effect size was small.

3.4 Exploratory Analysis

In the following exploratory data analysis, the variables *on body* and *in space* of the *Focus Category* and the variables *irregular on body, repetitive on body, phasic on body, repetitive in space* and *phasic in space* from the *StructureFocus Category* were further examined with the aim of gaining a deeper insight into the data and identifying possible differences or relevant factors. Different samples, regarding possible cultural differences or with a different BDI-II cut-off, were formed and the analyses were carried out again. In addition, group comparisons were made based on gender, age, type of depression (single episode vs. recurrent episode) and number of therapy sessions. It is important to note that these results are exploratory and not confirmatory.

Sample Variations

Native German speaking patients

During research process it was noticed that two of the 22 participants did not speak German as their native language. One participant's native language was French, and therapy was also in French. Even though she could speak in her mother language, she was now excluded for possible cultural differences, that might also reflect in movement behavior. Another participant's native language was Italian, however she spoke German in therapy. It became clear from therapy records that this patient did not speak German very well. As gestural expression could be limited due to the foreign language, this patient was also excluded. A new sample of 20 patients with German as their native language was built and analyses were run again.

Same as with the original sample, paired t-tests were conducted for the variables using both the frequency values and the proportion of time values. All tables with results of the exploratory analyses can be found in the appendix (Table 9 – 36). The following section reports only significant deviations from the original sample.

When looking at the changes in the frequency of the variable *irregular on body* in the sample of native German speaking patients (Table 11) the decrease in *irregular on body* movements became even more significant. For example the left hand decreased in *irregular* *on body* movements from pre (M = 4.37, SD = 2.14) to post (M = 2.50, SD = 1.95), t(19) = 4.39, p = <.001. Also, the effect size was notably higher d = 0.98, indicating a large effect. Next, the same variables were tested using the proportion of time values. Interestingly, the sample of native German speaking patients showed a significant increase in *phasic in space* movements from pre (*M* = 3.61, *SD* = 2.88) to post (*M* = 5.17, *SD* = 4.92), *t*(19) = -1.75, *p* = .048 by the left hand. The effect size was small to medium d = -.039 (see Table 13).

BDI Score 8 or lower

In the overall sample, an improvement in depressive symptoms was operationalized with a BDI-II cut-off value of 13 or less. However, the BDI-II offers different cut-offs. While a value of less than 13 can still indicate minimal depression, values of 0-8 are considered as no depression. Based on a new BDI-II cut-off of 8 points or lower at the end of therapy, 17 patients from the original sample of 22 were reselected for the new analysis.

The same significant decrease for the *irregular on body* movements like in the original and native German speaking sample was found, with the only difference, that in the new sample with the lower BDI cut-off, the decrease for the left hand in frequency values from pre (*M* = 4.41, *SD* = 2.30) to post (*M* = 2.45, *SD* = 1.90), *t*(16) = 5.17, *p* < .001 had an even higher effect size of *d* = 1.25, indicating a very large effect (Table 15).

Native German speaking and BDI lower than 8

After this analysis, a final variation of the sample was carried out. I combined the criteria for a BDI score of 8 or lower at post and excluded the two participants with French and Italian as their native language. This resulted in a sample of N = 16 who no longer exhibited depression at post measurement based on the new BDI cutoff and spoke native German. Results showed that the only difference compared to the original sample lied in the significant increase of the variable *phasic in space* measured in proportion of time. *Phasic in space* increased from pre (*M* = 3.51, *SD* = 2.83) to post (*M* = 5.53, *SD* = 5.36), *t*(15) = -1.96, *p* = .034 for the left hand. Effect sizes were small to medium (see Table 20).

It can be said that the sample variations offered mostly similar results to the original sample while controlling for language and setting BDI scores at a lower level led to stronger decreases in *irregular on body* movements with higher effect sizes. Also, in two sample variations, the sample with only native German speaking patients (N = 20), as well as the sample which combined a lower BDI score with the language criterion (N = 16), a significant increase in the *phasic in space* variable was found.

Group comparisons

After analyzing different variations of the original sample with paired samples t-test, the analysis was switched to group comparisons within the original sample (N = 22). Independent samples t-tests were conducted with the aim of comparing different subgroups and gain further insight into the movement data. Since a large number of comparisons were conducted in the group analyses, it is possible that significant results may occur by chance. To address this, the alpha significance level for group comparisons was lowered to 0.01 to make the analyses more stringent.

Gender

The total sample of 22 patients was split with regard to gender. The two groups consisted of 9 male and 13 female patients. Results show no significant differences between male and female participants concerning self-touch or hand gestures neither at pre nor at post measurement (see Table 21-24).

Age

The patients ranged in age from 22 to 56 years (M = 32.23, SD = 8.61), with a median age of 30 years. The sample of 22 patients was divided into two groups: those aged 29 years or younger and those aged 30 years or older. The only significant difference was found for the variable *repetitive on body*. Older patients performed significantly more *repetitive on body* movements with the right hand at post measurement (M= 0.97, SD = 0.70) compared to the younger group (M = 0.27, SD = 0.31), t(20 = 2.94, p = .008. Cohen's d indicates a very large effect size d = 1.26 (see Table 27).

Type of depression

One of the criteria that led to the inclusion of the 22 patients for the original sample was that they had to be diagnosed with major depression. However, major depression can be further subdivided into single-episode depression and recurrent depression. The original sample was divided accordingly into patients diagnosed with major depression with a single-episode (N = 9) and patients diagnosed with a recurrent episode (N = 13). The results show that the two groups did not differ significantly on any variable, neither at pre- nor at post measurement (see Table 29 – 32).

Number of therapy sessions

The duration of therapy varied greatly among the 22 patients in the original sample. The shortest therapy lasted 15 sessions. The longest therapy comprised 34 sessions (M = 24.25, SD = 5.02). It was investigated whether the length of therapy would lead to differences in the movement variables. Two groups were formed based on the median, which was 25 sessions. One group included all patients with 25 or more sessions. The other group included all patients with 24 sessions or less. Analyses showed no significant differences between short and long therapies for any of the variables (see Table 33 – 36).

Summarizing the results from the group comparisons it can be said that gender, type of depression and length of therapy had no influence on any movement variable. Only age seemed to have a significant influence on the frequency of *repetitive on body* movements.

4 Discussion

The present study investigated self-touch and hand gesture behavior of depressive patients based on video recordings at the beginning and at the end of a successful cognitive behavioral therapy. In the following, the hypotheses are answered and the results are placed in the context of related research. The strengths and limitations of one's own work are pointed out and implications for future research are formulated.

The first hypothesis concerned the self-touch behavior of depressive patients. It was hypothesized, that during a successful psychotherapy, self-touch behavior in depressive patients will decrease. Results show that *on body* movements significantly decreased towards the end of psychotherapy.

When breaking down *on body* movements into the three forms of self-touch, it becomes evident that the reduction in *on body* movements was primarily driven by the decrease in *irregular on body* movements. For this type of self-touch, the findings were remarkably consistent: in the original sample of 22 depressed patients *irregular on body* movements significantly decreased for both hands and across both measures (frequency and proportion of time). This is in line with other studies, showing a significant decrease in *irregular on body* movements in anxiety and depressive patients over the course of a successful therapy (Freedman, 1972; Kreyenbrink, 2017; Kryger, 2010; Lausberg & Kryger, 2011). Exploratory analyses further revealed that when the sample was more homogeneous regarding native language (all participants with German as their first language) or when a stricter BDI post-score cutoff was applied, the reduction in *irregular on body* movements became even more pronounced, with larger effect sizes.

The decrease in *irregular on body* movements suggests that these movements are closely linked with depression severity. This is supported by a study conducted by Reinecke et al., (2020) which examined patients with anxiety disorders, with and without comorbid depression. The study found that *irregular on body* movements were significantly more frequent in those patients with comorbid depression. In other words, the higher the symptom burden, the more *irregular on body* movements occur. This reinforces the link between *irregular* self-touch and the severity of depressive symptoms.

The hypothesis regarding *repetitive on body* movements also predicted a decrease. However, the results did not confirm this prediction. With only one exception, *repetitive on body* movements did not change significantly, regardless of whether they were analyzed for the left or right hand, or whether frequency or proportion of time values were considered. The one exception was an increase in *repetitive on body* movements for the left hand in the original sample when measured in proportion of time. This finding contradicts the hypothesis. Although this was the only significant result, an examination of the bar charts revealed a tendency for an increase in the frequency of *repetitive on body* movements for both the right and left hands (Figure 2). This tendency becomes even more striking when considering Figure 4. in the appendix, which depicts proportion of time values. Here, a clear visual increase of *repetitive on body* movements can be observed for both hands.

A comparison with the literature, however, suggests that this result is not entirely surprising. Heubach (2016) found that better test performance correlated with an increase in *repetitive on body* movements, indicating that these movements might serve as an effective self-regulation strategy. Further support comes from studies on individuals with alexithymia. These individuals are characterized by limited emotional awareness and usually experience stress in tasks where they have to recognize emotions. In comparison to healthy individuals, female alexithymic patients exhibited fewer *repetitive on body* movements in stressful situations (Lausberg et al., 2016). Additionally, studies have shown that *repetitive on body* movements may enhance well-being by triggering oxytocin release (Croy et al., 2016). These studies indicate that *repetitive* self-touch, unlike *irregular* self-touch, is more often performed in states of well-being or enhanced cognitive performance. This suggests that *repetitive on body* movements might rather increase than decrease in a successful therapy.

A similar trend emerged for *phasic on body* movements. The hypothesis predicted a decrease in these movements. However, no significant changes were observed over the course of therapy. Contradictory to hypothesis, an examination of the bar charts showed a tendency for *phasic on body* movements to increase during therapy. Evidence from other studies are also indicating an increase. The study of Heubach (2016) shows that *phasic on body* movements are negatively correlated with stress levels. Put another way, *phasic on body* movements are more likely to occur when individuals are not experiencing stress. Adapting these results to the present study, *phasic on body* movements should appear more often at the end of therapy.

Conversely, a study by Grunwald et al., (2014) investigating healthy participants found that *phasic on body* movements increased under acute auditory stress. A potential explanation for this phenomenon is proposed by Bucci and Freedman (1981). They suggest that *phasic self-touch* helps to select and differentiate sensory input and can be understood as a way of coping with unpleasant affect. However, a difference between Grunwald's study and the present study may lie in the type of stress being examined. While Grunwald induced acute auditory stress experimentally, patients undergoing psychotherapy in a naturalistic setting are likely experiencing a less acute form of stress, possibly manifesting more in nervousness, discomfort, or prolonged emotional strain.

In summary, *phasic* and *repetitive* self-touch appears to be associated with adaptive self-regulation and is more frequently exhibited by healthy individuals. In contrast, *irregular* self-touch is predominantly observed in individuals under psychological distress and is linked to the severity of their symptom burden.

The second overarching hypothesis addressed *in space* movements, predicting an increase in these behaviors during successful psychotherapy. However, the data did not support this hypothesis, as *in space* movements did not increase. Visual examination of the bar charts further revealed that *repetitive in space* movements tended to decrease. This is consistent with the results of a case study conducted by Kryger and Lausberg (2011). They analyzed the hand movement behavior of a patient with mild depression and anorexia in an outpatient setting, also with the NEUROGES system. They reported a decrease in *repetitive in space* gestures toward the end of therapy, which corresponds to the visual trend in this study. A possible explanation is, that *repetitive in space* gestures are often generated when the speaker wants to convey something to the listener in a sustained way, because the rhythmic character of repetitive movements can reinforce the verbal statement (Lausberg, 2022). Such gestures can also often be observed in public speeches by politicians (Trotta et al., 2021). The authors hypothesized that a decrease in *repetitive in space* gestures may indicate that patients, by the end of therapy, have greater confidence that the therapist is listening and understanding them. As a result, they might feel less need to use these gestures to emphasize their messages (Lausberg & Kryger, 2011).

The last hypothesis concerned the change of *phasic in space* movements and anticipated an increase towards the end of therapy, as they may be associated with cognitive improvement. While the visual examination of the bar charts confirmed this assumption, inferential statistics showed that this trend was not significant in the original sample.

In other studies, however, increases in *phasic in space* movements have been found. A study by Reinecke et al., (2020) which utilized the same coding scheme as the present study found a significant increase in pointing gestures - a subcategory of *phasic in space* movements. They found that patients with improved symptoms exhibited a higher proportion of time and duration for pointing gestures at the end of therapy, suggesting an enhancement in their ability to express thoughts. Interestingly, they also observed an increase in the frequency of pointing gestures among non-improved patients. The authors hypothesized that this frequency increase might reflect frequent explicit references to external targets, potentially signaling avoidance behaviors. Another study examined illustrative gestures – also a subcategory of *phasic in space* - in depressive patients during stationary treatment and found an increase toward the end of therapy (Ekman & Friesen, 1974). Findings like this highlight that *in space* movements encompassed a wide variety of more detailed gestures (e.g., pointing gesture, illustrative gesture…) which could be linked to different mental states, not all indicating an improvement.

Even tough in the original sample no significant increase in *phasic in space* was found, in the exploratory analysis such an increase was noted in two of the sample variations. Once in the sample of native German speaking patients and another time in the sample which combined the native German patients with the criterion of BDI-II score ≤8. However, the subgroup with only the lower BDI-II ≤8 cutoff did not exhibit this significant increase. This suggests that in this study, the uniformity of language rather than symptom severity may have influenced the increase in *phasic in space* movements.

Previous research supports the idea that language and culture can impact hand movement behavior. Kim and Lausberg (2018) found that Germans used more gestures when presenting their personal appreciation of dance stimuli than Koreans. Research also shows that cultural factors such as the degree of individualism or the power distance within a culture can substantially influence hand movement behavior (Hofstede, 2011).

As the above findings show, there are many different factors that influence patient's self-touch and hand gesture behavior. Be it the symptom severity, the native language or culture, the value in which the movement is measured (frequency, PoT, duration), as well as the level of detail in the categorization of *in space* movements. More research is needed on this topic to gain a clearer understanding. Based on the findings of this study and the comparison with other studies, suggestions for future research are formulated below.

4.1 Implications

Larger, more homogenous sample

It goes without saying that a large, homogenous sample is essential in research. Especially when examining subtle differences in nonverbal behavior, as even minor variations between participants can significantly impact movement patterns. In clinical nonverbal research, it is crucial not only to control for factors such as native language and cultural similarities, but also to account for comorbidities and medication use. Also, in the exploratory analysis an age effect was found. A larger sample and group comparisons are needed to investigate whether this is also true in other samples.

With a larger sample also questions regarding the correlation of movement behavior with questionnaire data could be better investigated. For example, groups at different questionnaire cut-off points could be built and compared. This would further enhance the understanding of the connection between symptom severity and different movement behaviors. While the link for *irregular* self-touch and symptom severity has already been researched and revealed consistent results, less is known for *repetitive*- and *phasic* self-touch. Additionally, the inclusion of multiple questionnaires could provide valuable insights, as previous research has shown that movement behavior does not always correspond to questionnaire responses (Lausberg, 2012). A promising area of research could therefore be to test the correlation between movement data and different clinical questionnaires.

Collect more data

Once the sample selection has been made, the choice of sessions is of particular importance. In this study, a pre-post comparison was conducted, and the second-first and second-last therapy sessions were selected for this purpose. The selection of the second session was based on the assumption that patients might feel particularly nervous during the first session due to the unfamiliar situation, which could influence movement behavior not only due to the condition but also because of situational factors. However, it could also be that patients are still somewhat tense in the second or third session due to situational factors. Thus, it would be very interesting to examine the changes in self-touch behavior and hand gestures more continuously throughout the therapy process. Instead of a pre-post design, a design with several time points could be beneficial to better understand changes in movements (e.g., every third session).

Like other studies, using the NEUROGES system, also this study found that *in space* movements occur with a considerably lower frequency and proportion of time than e.g., *irregular on body* movements, it would be beneficial to examine a longer time interval to obtain more *in space* data. A longer time frame for coding movement data could also be achieved by excluding time intervals where the therapist is speaking. While self-touch behavior, which has no communicative function, can still occur during these intervals, *in space* hand gestures are rarely observed when the patient is not speaking. Therefore, coding could focus exclusively on segments where the patient is actively speaking. Alternatively, *in space* gestures could be analyzed in relation to the number of spoken words, offering a more precise understanding of how these gestures change over the course of therapy (Kryger & Lausberg, 2011).

Additionally, studies have shown that when one person gestures frequently, their interaction partner tends to mirror this behavior. This highlights the importance of also coding and controlling for the therapist's movement behavior, as it could impact the patient's hand gestures.

Differentiate *on body* more precisely

The NEUROGES system's Module 1 allows the classification of three types of direct self-touch movements. However, indirect forms of self-touch, such as touching an attached objects (e.g., a scarf or ring), also provide sensomotoric stimulation, which may contribute to stress reduction. Future research on self-touch could benefit from including these indirect forms of touch to gain a more comprehensive understanding. It would also be essential to differentiate between self-touch behaviors with psychological versus physical functions. For example, *irregular on body* movements are only linked to psychological regulation, while *repetitive* and *phasic* self-touch may serve both psychological and physical purposes (Lausberg, 2022), such as scratching an itch or adjusting hair. By differentiating, psychologically motivated self-touch could be measured more reliably. Moreover, it would also be valuable to further explore the neurophysiological correlates of different forms of self-touch, as this could provide deeper insights into the mental states associated with specific types of touch.

Differentiate *in space* more precisely

Comparing the results of this study with other research has shown that *in space* movements might be too broad of a category to study changes in cognition, as they serve various functions. Pointing to an external object, illustrating an abstract concept or emphasizing a statement with a gesture would all fall under the variable *in space* (Lausberg, 2022). Therefore*, in space* movements should be analyzed more precisely. Future research could benefit from distinguishing between these subcategories to better understand their specific role in therapy and mental health.

Investigating technological solutions

Analyzing body movements is highly time-intensive due to the density of information they contain. Research aimed at developing technological solutions, such as automated measurements using artificial intelligence (AI) would be of significant interest. Since body movements are often unconscious, immediate and highly sensitive to changes, they could provide valuable feedback to the therapist. In that sense, automated measurements could complement self-reports by providing objective and reliable data on the patient's nonverbal behavior. This feedback could enhance therapeutic decision-making and ultimately improve therapy outcomes.

4.2 Strengths and limitations

One of the main strengths of this study lies in the use of a highly reliable and valid research instrument for the analysis of nonverbal behavior. The required skills for using this instrument were acquired through a one-week training course and a certification as a rater was successfully acquired. Steps were taken to minimize potential biases, such as confirmation bias or training effects, by randomizing video sequences.

Another strength is the thoughtful selection of the therapy sessions. Efforts were made to choose video segments in which patients were emotionally or mentally engaged with their issues, as the connection between movement and mental states was a key focus.

An additional strength of the study is its contribution to a relatively under-researched area. Despite the importance of nonverbal behavior in various aspects of everyday life as well as in psychotherapy, there exists limited research on self-touch and hand gestures of depressive patients undergoing outpatient CBT therapy. Furthermore, the videos used in this study were originally recorded primarily for documentation purposes. This study, therefore, highlights the amount of information that can be derived from analyzing nonverbal behavior and thus underlines its potential for understanding emotional or mental states.

On the other hand, several limitations of this study are noteworthy. First, inter-rater reliability was not established. Typically, when using the NEUROGES system, a second rater codes 25% of the material, and inter-rater reliability is calculated for each category (*Activation, Structure, Focus*). Unfortunately, for this master's thesis, it was not possible for another individual to code the videos due to data protection constraints and limited resources.

The second limitation is that only 3 minutes from both the pre- and post-sessions were coded. While this may seem brief, the NEUROGES system can effectively be applied to such short segments. However, this approach has the drawback that unusual occurrences can have a disproportionately large impact on the analysis. The starting point for coding was determined by the therapist asking a question aimed at the patient's emotional or mental state linked to depression. Although this criterion helped to exclude much of the small talk, these questions often occurred at the beginning of the session. Consequently, some sequences included patients removing their jackets or sweaters. These movements were also coded even though they are not linked to the mental or emotional state. However, such movements usually fell under *on attached object* or *on separate object* categories and were therefore not relevant to the analysis. Additionally, sequences where the therapist was speaking were not excluded.

A further limitation concerns the video quality. Overall, the quality of the recordings was suboptimal, and at times it was challenging to identify very small movements. Another limitation concerns data availability. Previous studies showed that body movements are influenced by the hemisphere, however data on handedness were not available.

Another limitation of this study is related to potential confirmation bias. Initially, I coded therapy videos of 28 depressive patients without knowing whether they had improved or not. However, I was not blind to whether the video was recorded at pre- or post. This could have introduced a confirmation bias during the coding process, particularly for videos at pre time point. However, efforts were made to minimize this risk by adhering strictly to the NEUROGES coding guidelines and consulting supervision for ambiguous cases.

Another methodological limitation concerns the data analysis. Paired samples t-tests were used for pre-post comparisons, and independent samples t-tests were conducted for group comparisons. These tests rely on the assumption of normally distributed data. However, based on the Shapiro-Wilk test, the assumption of normality was violated for some variables (see Table 37 & 38 in the appendix). Nevertheless, a visual inspection of the Q-Q plots indicated that deviations from normality were not extreme and only affected certain variables. Importantly, for the variables where significant results were found (e.g., *on body, irregular on body*), normality was satisfied. In contrast, for the *in space* variables, particularly at the post-measurement time point, normality was often violated. Since no significant effects were identified for these variables in the original sample, the issue is less critical. Besides, t-tests are robust to minor violations of normality, especially in samples with more than 20 participants (Field, 2024; Schmider et al., 2010). Still, it would be essential to conduct supplementary non-parametric tests, such as the Wilcoxon signed-rank test for pre-post comparisons and the Mann-Whitney U test for group comparisons, to confirm the robustness of the findings.

5 Conclusion

This study investigated how self-touch behavior and hand gestures of depressive patients changed over the course of a successful psychotherapy. For this purpose, video recordings of 22 patients attending a cognitive behavioral psychotherapy in an outpatient setting were analyzed. The NEUORGES system, which has been extensively tested for its reliability and validity, yielding excellent results (Lausberg & Sloetjes, 2016), was used for the analysis.

The first hypothesis predicted a decrease in self-touch behavior, as self-touch is often associated with discomfort and stress. This hypothesis was confirmed based on the data collected. However, it is important to note that this decline was mainly driven by the decrease of *irregular* self-touch movements. A comparison with findings from other studies suggests that *repetitive* and *phasic* self-touch is possibly associated with distinct psychological processes, potentially reflecting effective self-regulation mechanisms more frequently observed in healthy individuals.

The second hypothesis concerned hand movements *in space* and predicted an increase over the course of therapy, as such movements are often associated with thought processes of higher cognitive complexity. However, this hypothesis could not be confirmed. While *repetitive in space* movements slightly decreased over therapy, *phasic in space* movements increased, however not significantly. A look into the literature also showed mixed findings. It would be essential in future research to subdivide such movements *in space* even more precisely based on their function. This would be possible with NEUROGES Module 3.

In conclusion, it can be said that nonverbal behavior is a valuable source of information about patient's emotional or mental state. Studying these movements is therefore of particular relevance in psychotherapy research. This study contributes to a better understanding of self-touch and hand gestures of depressive patients in outpatient CBT psychotherapy and its connection to depressive symptoms. By knowing which movements are associated with which emotional or mental states, the analysis of nonverbal behavior could be integrated more profoundly into therapy and possibly enhance the depth and effectiveness of psychotherapy.

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7 Appendix

7.1 Figures & tables

Fig 3

Proportion of Time (seconds/minute) on Focus Units at Pre- and Post-Measurement with Error Bars Indicating *Standard Error for the Total Sample (N = 22)*

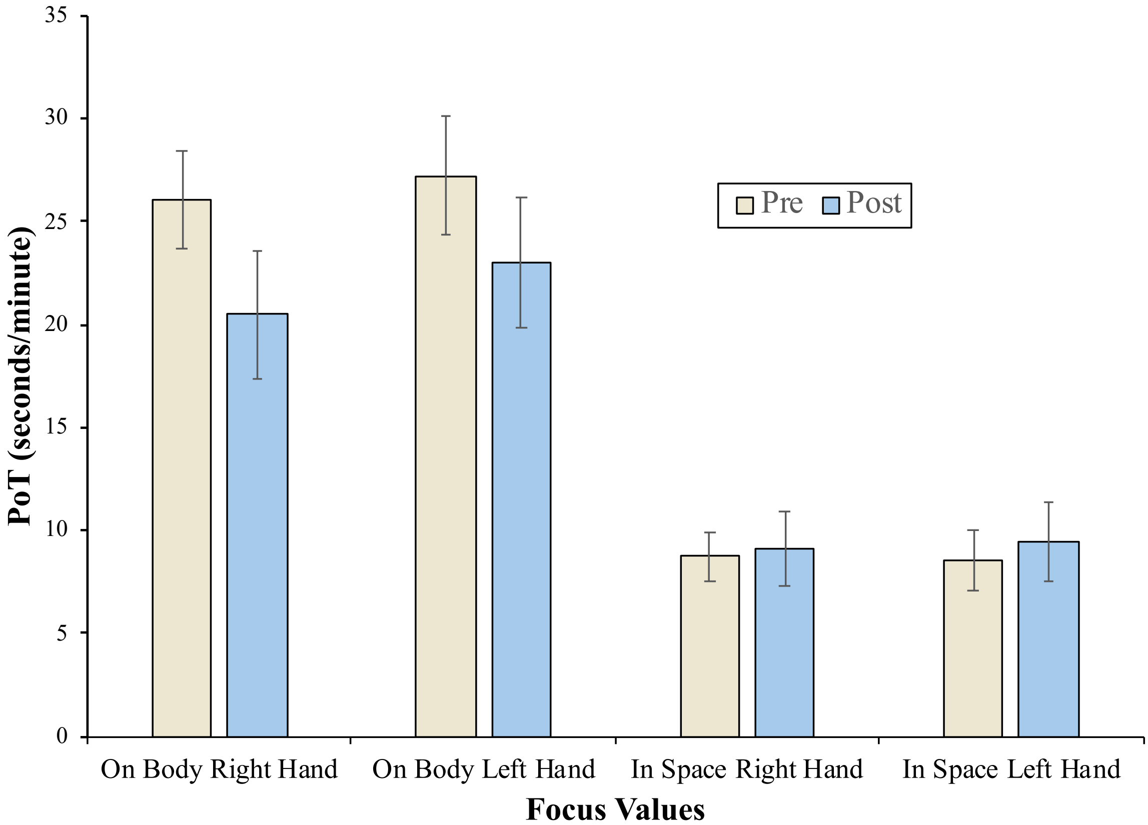

Fig 4

Proportion of Time (seconds/minute) on StructureFocus Units at Pre- and Post-Measurement with Error Bars Indicating *Standard Error for the Total Sample (N = 22)*

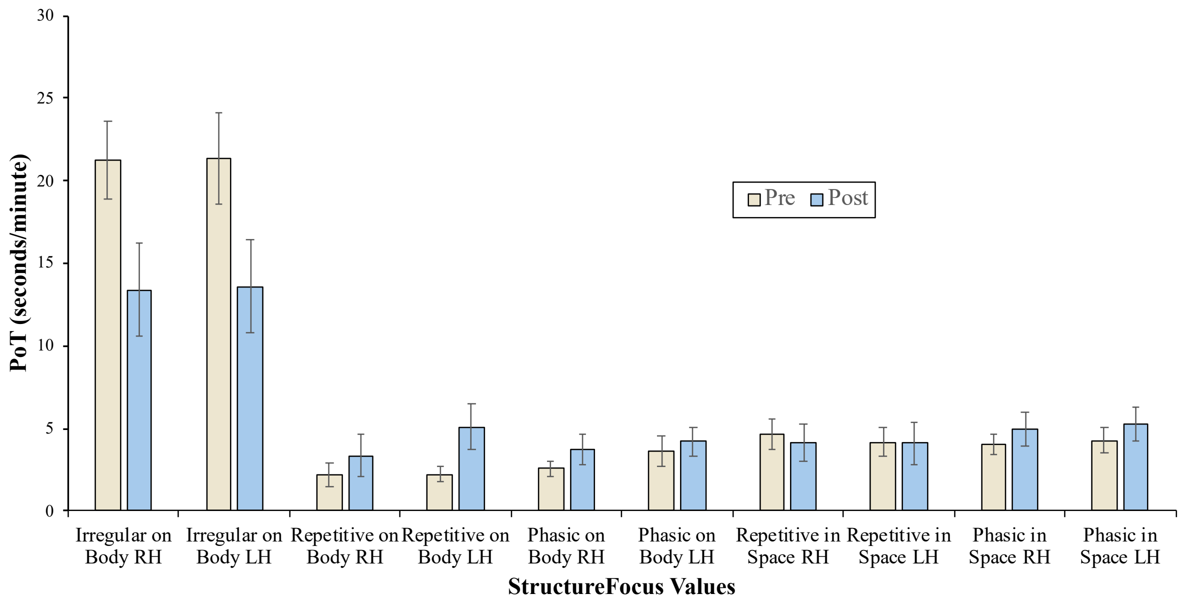

Table 4

Consistency of Changes with Hypotheses of Different Movement Variables from Pre- to Post-Measurement, Based on Proportion of Time Data for Individual Patients (N = 22)

Hypothesis	Variable	Hand	Patient																					
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Decrease	On body	Right hand																						
		Left hand																						
Decrease	Irregular on body	Right hand																						
		Left hand																						
Decrease	Repetitive on body	Right hand																						
		Left hand																						
Decrease	Phasic on body	Right hand																						
		Left hand																						
Increase	In space	Right hand																						
		Left hand																						
Increase	Repetitive in space	Right hand																						
		Left hand																						
Increase	Phasic in space	Right hand																						
		Left hand																						

Note. Green cells indicate changes consistent with the hypothesis, pink cells indicate changes contrary to the hypothesis, and white cells indicate no change from pre- to post-measurement. The colors are dummy coded and do not reflect the magnitude of change.

Table 9

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Native German-Speaking Patients (N = 20)

Variable	Pre		Post		*t(19)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	6.25	2.37	4.77	2.25	2.64	0.008	0.59
On body left hand	5.97	2.75	4.33	2.34	2.79	0.006	0.62
In space roght hand	3.70	2.51	3.77	3.07	-0.12	0.452	-0.03
In space left hand	3.35	2.77	3.53	2.90	-0.40	0.348	-0.09

*p < .05

Table 10

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for Native German-Speaking Patients (N = 20)

Variable	Pre		Post		*t(19)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	26.13	11.25	21.28	14.98	1.49	0.076	0.33
On body left hand	27.22	13.96	23.86	14.83	0.76	0.229	0.17
In space right hand	8.84	5.95	9.48	8.58	-0.40	0.346	-0.09
In space left hand	7.58	6.41	9.68	9.35	-1.25	0.113	-0.28

*p < .05

Table 11

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Native German-Speaking Patients (N = 20)

Variable	Pre		Post		*t(19)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	4.78	2.02	3.08	1.82	3.63	0.001	0.81
Irregular on body left hand	4.37	2.14	2.50	1.95	4.39	0.000	0.98
Repetitive on body right hand	0.60	0.71	0.63	0.76	-0.15	0.442	-0.03
Repetitive on body left hand	0.55	0.46	0.67	0.67	-0.61	0.276	-0.14
Phasic on body right hand	1.03	1.03	1.18	1.29	-0.53	0.300	-0.12
Phasic on body left hand	1.25	1.51	1.28	1.09	-0.09	0.466	-0.02
Repetitive in space right hand	1.60	1.29	1.33	1.50	0.94	0.179	0.21
Repetitive in space left hand	1.37	1.39	1.22	1.56	0.49	0.316	0.11
Phasic in space right hand	2.25	1.53	2.47	2.04	-0.54	0.297	-0.12
Phasic in space left hand	2.08	1.70	2.35	1.97	-0.83	0.207	-0.19

*p < .05

Table 12

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for Native German-Speaking Patients (N = 20)

Variable	Pre		Post		*t(19)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	21.38	11.59	13.98	13.60	2.42	0.013	0.54
Irregular on body left hand	21.54	13.33	14.31	13.52	2.10	0.025	0.47
Repetitive on body right hand	2.33	3.33	3.56	6.26	-0.85	0.202	-0.19
Repetitive on body left hand	2.04	1.62	5.09	6.54	-2.03	0.028	-0.45
Phasic on body right hand	2.42	1.98	3.75	4.41	-1.50	0.075	-0.34
Phasic on body left hand	3.64	4.52	4.37	4.22	-0.53	0.302	-0.12
Repetitive in space right hand	4.86	4.52	4.47	5.40	0.37	0.358	0.08
Repetitive in space left hand	3.97	4.22	4.47	6.30	-0.39	0.349	-0.09
Phasic in space right hand	3.98	3.06	4.99	4.92	-0.96	0.174	-0.21
Phasic in space left hand	3.61	2.88	5.17	4.92	-1.75	0.048	-0.39

*p < .05

Table 13

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Patients with a BDI Score ≤ 8 at Post-Measurement (N = 17)

Variable	Pre		Post		*t(16)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	6.16	2.56	4.75	2.43	2.22	0.021	0.54
On body left hand	5.96	2.97	4.20	2.54	2.62	0.009	0.63
In space right hand	3.47	2.59	3.43	3.07	0.06	0.476	0.02
In space left hand	3.45	2.99	3.39	2.90	0.12	0.454	0.03

*p < .05

Table 14

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for Patients with a BDI Score ≤ 8 at Post-Measurement (N = 17)

Variable	Pre		Post		*t(16)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	25.98	11.12	21.37	16.30	1.21	0.122	0.29
On body left hand	27.87	14.69	23.44	16.44	0.83	0.209	0.20
In space right hand	8.50	6.47	8.87	8.90	-0.21	0.420	-0.05
In space left hand	7.97	6.94	9.44	9.20	-0.84	0.206	-0.20

*p < .05

Table 15

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Patients with a BDI Score ≤ 8 at Post-Measurement (N = 17)

Variable	Pre		Post		*t(16)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	4.57	2.13	3.12	1.82	3.28	0.002	0.80
Irregular on body left hand	4.41	2.30	2.45	1.90	5.17	0.000	1.25
Repetitive on body right hand	0.63	0.76	0.57	0.80	0.24	0.408	0.06
Repetitive on body left hand	0.55	0.49	0.63	0.68	-0.39	0.352	-0.09
Phasic on body right hand	1.16	1.13	1.22	1.39	-0.17	0.432	-0.04
Phasic on body left hand	1.24	1.57	1.27	1.16	-0.09	0.464	-0.02
Repetitive in space right hand	1.53	1.41	1.22	1.50	1.05	0.155	0.25
Repetitive in space left hand	1.37	1.50	1.12	1.42	0.96	0.176	0.23
Phasic in space right hand	2.12	1.53	2.25	2.09	-0.29	0.388	-0.07
Phasic in space left hand	2.20	1.84	2.31	2.08	-0.29	0.389	-0.07

*p < .05

Table 16

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for Patients with a BDI Score ≤ 8 at Post-Measurement (N = 17)

Variable	Pre		Post		*t(16)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	20.77	11.11	13.86	14.33	2.10	0.026	0.51
Irregular on body left hand	22.38	13.77	13.89	13.72	2.20	0.021	0.53
Repetitive on body right hand	2.42	3.61	3.70	6.80	-0.77	0.227	-0.19
Repetitive on body left hand	1.98	1.75	4.87	6.94	-1.68	0.057	-0.41
Phasic on body right hand	2.79	2.37	3.81	4.79	-0.93	0.182	-0.23
Phasic on body left hand	3.51	4.80	4.68	4.49	-0.76	0.230	-0.18
Repetitive in space right hand	4.70	5.04	4.19	5.41	0.45	0.331	0.11
Repetitive in space left hand	4.10	4.57	3.95	5.49	0.14	0.444	0.03
Phasic in space right hand	3.80	3.22	4.67	5.03	-0.74	0.236	-0.18
Phasic in space left hand	3.87	3.12	5.43	5.20	-1.46	0.082	-0.35

*p < .05

Table 17

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Native German-Speaking Patients with a BDI Score ≤ 8 at Post (N = 16)

Variable	Pre		Post		*t(15)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	6.21	2.63	4.85	2.47	2.01	0.032	0.50
On body left hand	6.08	3.02	4.35	2.54	2.41	0.015	0.60
In space right hand	3.54	2.66	3.56	3.13	-0.03	0.488	-0.01
In space left hand	3.42	3.08	3.52	2.94	-0.21	0.420	-0.05

*p < .05

Table 18

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for Native German-Speaking Patients with a BDI Score ≤ 8 at Post (N = 16)

Variable	Pre		Post		*t(15)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
On body right hand	25.50	11.30	22.44	16.22	0.83	0.211	0.21
On body left hand	27.74	15.16	24.76	16.02	0.55	0.296	0.14
In space right hand	8.79	6.58	9.23	9.06	-0.23	0.410	-0.06
In space left hand	7.65	7.04	9.74	9.41	-1.22	0.121	-0.30

*p < .05

Table 19

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Native German-Speaking Patients with a BDI Score ≤ 8 at Post (N = 16)

Variable	Pre		Post		*t(15)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	4.67	2.16	3.17	1.87	3.21	0.003	0.80
Irregular on body left hand	4.52	2.33	2.54	1.92	4.91	0.000	1.23
Repetitive on body right hand	0.67	0.77	0.60	0.81	0.24	0.408	0.06
Repetitive on body left hand	0.58	0.48	0.67	0.68	-0.39	0.353	-0.10
Phasic on body right hand	1.08	1.13	1.25	1.43	-0.49	0.316	-0.12
Phasic on body left hand	1.23	1.62	1.31	1.19	-0.19	0.427	-0.05
Repetitive in space right hand	1.63	1.40	1.29	1.51	1.05	0.155	0.26
Repetitive in space left hand	1.44	1.53	1.17	1.45	0.96	0.176	0.24
Phasic in space right hand	2.10	1.58	2.31	2.14	-0.42	0.342	-0.10
Phasic in space left hand	2.10	1.86	2.40	2.12	-0.74	0.237	-0.18

*p < .05

Table 20

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for Native German-Speaking Patients with a BDI Score ≤ 8 at Post (N = 16)

Variable	Pre		Post		*t(15)*	*p*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Irregular on body right hand	20.44	11.39	14.59	14.48	1.77	0.049	0.44
Irregular on body left hand	22.06	14.16	14.70	13.74	1.87	0.040	0.47
Repetitive on body right hand	2.57	3.67	3.94	6.95	-0.77	0.228	-0.19
Repetitive on body left hand	2.11	1.73	5.17	7.05	-1.68	0.057	-0.42
Phasic on body right hand	2.49	2.09	3.91	4.92	-1.33	0.102	-0.33
Phasic on body left hand	3.58	4.94	4.89	4.55	-0.80	0.217	-0.20
Repetitive in space right hand	5.00	5.05	4.46	5.47	0.44	0.331	0.11
Repetitive in space left hand	4.14	4.72	4.16	5.60	-0.02	0.491	-0.01
Phasic in space right hand	3.79	3.32	4.77	5.18	-0.78	0.224	-0.19
Phasic in space left hand	3.51	2.83	5.53	5.36	-1.96	0.034	-0.49

*p < .05

Table 21

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Male Patients (N = 9) *and Female Patients (N = 13)*

Variable	Time	Male		Female		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	6.85	2.47	5.69	2.09	1.19	0.249	0.52
	Post	5.11	2.54	4.49	1.97	0.65	0.524	0.28
On body left hand	Pre	6.33	3.10	5.38	2.42	0.81	0.430	0.35
	Post	4.52	2.64	4.05	2.14	0.46	0.652	0.20
In space right hand	Pre	4.00	3.04	3.33	1.95	0.63	0.536	0.27
	Post	3.37	3.12	3.97	2.99	-0.46	0.652	-0.20
In space left hand	Pre	3.56	3.17	3.44	2.43	0.10	0.921	0.04
	Post	3.00	2.25	3.74	3.17	-0.60	0.553	-0.26

*p < .01

Table 22

Proportion of Time (seconds/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Male Patients (N = 9) and Female Patients (N = 13)

Variable	Time	Male		Female		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	27.48	12.35	25.04	10.43	0.50	0.622	0.22
	Post	23.44	18.13	18.39	12.15	0.79	0.441	0.34
On body left hand	Pre	25.45	15.69	28.44	11.91	-0.51	0.616	-0.22
	Post	25.95	17.07	20.94	13.44	0.77	0.450	0.33
In space right hand	Pre	9.39	7.21	8.25	4.80	0.45	0.660	0.19
	Post	8.37	9.94	9.61	7.31	-0.34	0.740	-0.15
In space left hand	Pre	8.21	7.29	8.68	6.91	-0.15	0.880	-0.07
	Post	7.40	8.63	10.81	9.27	-0.87	0.394	-0.38

*p < .01

Table 23

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Male Patients (N = 9) and Female Patients (N = 13)

Variable	Time	Male		Female		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	5.15	1.75	4.36	2.11	0.92	0.367	0.40
	Post	3.56	1.96	2.72	1.56	1.12	0.277	0.48
Irregular on body left hand	Pre	4.96	2.57	3.59	1.71	1.51	0.147	0.65
	Post	2.93	2.28	2.15	1.60	0.94	0.360	0.41
Repetitive on body right hand	Pre	0.63	0.79	0.51	0.63	0.38	0.704	0.17
	Post	0.56	0.62	0.62	0.83	-0.18	0.856	-0.08
Repetitive on body left hand	Pre	0.59	0.52	0.54	0.48	0.25	0.805	0.11
	Post	0.74	0.78	0.59	0.58	0.52	0.607	0.23
Phasic on body right hand	Pre	1.26	1.44	0.95	0.64	0.69	0.497	0.30
	Post	1.19	1.47	1.23	1.14	-0.08	0.936	-0.04
Phasic on body left hand	Pre	0.96	1.12	1.46	1.62	-0.80	0.436	-0.34
	Post	1.00	0.78	1.38	1.22	-0.83	0.414	-0.36
Repetitive in space right hand	Pre	1.67	1.55	1.41	1.09	0.46	0.653	0.20
	Post	1.04	1.48	1.36	1.51	-0.50	0.626	-0.21
Repetitive in space left hand	Pre	1.56	1.80	1.28	1.10	0.41	0.691	0.19
	Post	0.78	1.12	1.38	1.72	-0.93	0.365	-0.40
Phasic in space right hand	Pre	2.41	1.80	2.10	1.23	0.47	0.641	0.21
	Post	2.30	1.70	2.69	2.28	-0.44	0.664	-0.19
Phasic in space left hand	Pre	2.11	1.70	2.28	1.71	-0.23	0.820	-0.10
	Post	2.19	1.38	2.44	2.26	-0.30	0.771	-0.13

Table 24

Proportion of Time (seconds/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Male Patients (N = 9) and Female Patients (N = 13)

Variable	Time	Male		Female		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	22.72	11.43	20.23	11.38	0.51	0.619	0.22
	Post	17.32	16.96	10.64	9.61	1.18	0.252	0.51
Irregular on body left hand	Pre	21.15	13.36	21.52	13.15	-0.06	0.949	-0.03
	Post	17.30	17.04	11.03	9.63	1.10	0.283	0.48
Repetitive on body right hand	Pre	1.95	2.74	2.38	3.59	-0.31	0.761	-0.13
	Post	3.00	4.74	3.57	6.93	-0.21	0.833	-0.09
Repetitive on body left hand	Pre	2.08	2.09	2.34	2.21	-0.28	0.781	-0.12
	Post	5.24	6.80	4.98	6.41	0.09	0.928	0.04
Phasic on body right hand	Pre	2.81	2.66	2.43	1.96	0.38	0.706	0.17
	Post	3.12	4.82	4.18	3.90	-0.57	0.577	-0.25
Phasic on body left hand	Pre	2.22	2.97	4.58	4.92	-1.28	0.214	-0.56
	Post	3.21	2.75	4.93	4.76	-0.97	0.342	-0.42
Repetitive in space right hand	Pre	4.74	5.24	4.60	3.99	0.07	0.943	0.03
	Post	3.51	5.43	4.50	5.34	-0.43	0.675	-0.18
Repetitive in space left hand	Pre	4.29	5.12	4.13	3.61	0.08	0.934	0.04
	Post	2.71	4.49	5.09	7.00	-0.89	0.382	-0.39
Phasic in space right hand	Pre	4.65	4.01	3.65	1.99	0.69	0.505	0.34
	Post	4.82	4.72	5.10	4.89	-0.13	0.894	-0.06
Phasic in space left hand	Pre	3.93	3.17	4.55	3.91	-0.40	0.697	-0.17
	Post	4.60	4.33	5.72	5.13	-0.54	0.598	-0.23

*p < .01

Table 25

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Patients Aged 29 Years or Younger (N = 10) and Patients Aged 30 Years or Older (N = 12)

Variable	Time	Young		Old		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	5.60	2.51	6.64	2.04	1.07	0.297	0.46
	Post	4.53	2.27	4.92	2.20	0.40	0.693	0.17
On body left hand	Pre	5.83	2.23	5.72	3.12	-0.09	0.926	-0.04
	Post	3.57	2.50	4.81	2.07	1.27	0.218	0.54
In space right hand	Pre	3.07	2.98	4.06	1.82	0.96	0.350	0.41
	Post	3.37	2.67	4.03	3.31	0.51	0.617	0.22
In space left hand	Pre	3.43	3.32	3.53	2.17	0.08	0.937	0.03
	Post	3.30	3.17	3.56	2.58	0.21	0.837	0.09

*p < .01

Table 26

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for Patients Aged 29 Years or Younger (N = 10) and Patients Aged 30 Years or Older (N = 12)

Variable	Time	Young		Old		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	24.54	10.35	27.30	11.88	0.57	0.572	0.25
	Post	19.79	12.49	21.01	16.86	0.19	0.851	0.08
On body left hand	Pre	30.05	14.45	24.86	12.40	-0.91	0.376	-0.39
	Post	20.87	14.38	24.75	15.64	0.60	0.556	0.26
In space right hand	Pre	7.73	7.98	9.54	3.13	0.67	0.514	0.31
	Post	8.39	7.19	9.69	9.37	0.36	0.723	0.15
In space left hand	Pre	8.93	8.14	8.12	6.03	-0.27	0.791	-0.11
	Post	8.01	8.74	10.59	9.36	0.66	0.515	0.28

*p < .01

Table 27

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Patients Aged 29 Years or Younger (N = 10) and Patients Aged 30 Years or Older (N = 12)

Variable	Time	Young		Old		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	3.63	1.37	5.56	2.00	2.57	0.018	1.10
	Post	3.03	1.49	3.08	1.99	0.07	0.948	0.03
Irregular on body left hand	Pre	3.63	0.99	4.58	2.77	1.11	0.287	0.44
	Post	2.40	1.83	2.53	2.03	0.15	0.879	0.07
Repetitive on body right hand	Pre	0.67	0.86	0.47	0.52	-0.65	0.521	-0.28
	Post	0.40	0.62	0.75	0.81	1.12	0.276	0.48
Repetitive on body left hand	Pre	0.53	0.53	0.58	0.47	0.23	0.817	0.10
	Post	0.27	0.31	0.97	0.70	2.94	0.008	1.26
Phasic on body right hand	Pre	1.40	1.34	0.81	0.59	-1.39	0.181	-0.59
	Post	1.27	1.36	1.17	1.22	-0.18	0.857	-0.08
Phasic on body left hand	Pre	1.90	1.85	0.72	0.66	-1.92	0.082	-0.88
	Post	0.93	0.81	1.47	1.20	1.20	0.242	0.52
Repetitive in space right hand	Pre	1.30	1.76	1.69	0.69	0.67	0.518	0.31
	Post	1.17	1.40	1.28	1.59	0.17	0.865	0.07
Repetitive in space left hand	Pre	1.17	1.65	1.58	1.17	0.69	0.497	0.30
	Post	1.03	1.38	1.22	1.65	0.29	0.777	0.12
Phasic in space right hand	Pre	1.83	1.50	2.56	1.40	1.17	0.256	0.50
	Post	2.17	1.63	2.83	2.33	0.76	0.456	0.33
Phasic in space left hand	Pre	2.37	2.12	2.08	1.26	-0.39	0.701	-0.17
	Post	2.27	2.28	2.39	1.65	0.15	0.886	0.06

*p < .01

Table 28

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for Patients Aged 29 Years or Younger (N = 10) and Patients Aged 30 Years or Older (N = 12)

Variable	Time	Young		Old		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	18.30	9.13	23.71	12.51	1.14	0.269	0.49
	Post	13.67	9.80	13.12	15.90	-0.09	0.925	-0.04
Irregular on body left hand	Pre	22.29	14.30	20.60	12.24	-0.30	0.769	-0.13
	Post	14.60	11.20	12.76	15.07	-0.32	0.752	-0.14
Repetitive on body right hand	Pre	2.91	4.18	1.61	2.12	-0.95	0.356	-0.40
	Post	1.93	4.58	4.51	6.96	1.00	0.329	0.43
Repetitive on body left hand	Pre	1.98	2.08	2.45	2.21	0.51	0.614	0.22
	Post	2.80	4.78	6.99	7.15	1.58	0.131	0.67
Phasic on body right hand	Pre	3.33	2.74	1.97	1.53	-1.47	0.158	-0.63
	Post	4.19	4.48	3.38	4.16	-0.44	0.667	-0.19
Phasic on body left hand	Pre	5.79	5.43	1.81	1.86	-2.21	0.050	-1.02
	Post	3.29	3.25	5.00	4.64	0.98	0.337	0.42
Repetitive in space right hand	Pre	4.73	6.35	4.60	2.09	-0.06	0.953	-0.03
	Post	3.82	4.58	4.33	5.98	0.22	0.828	0.09
Repetitive in space left hand	Pre	4.28	5.27	4.12	3.25	-0.09	0.932	-0.04
	Post	3.71	5.51	4.45	6.77	0.28	0.784	0.12
Phasic in space right hand	Pre	3.00	2.47	4.94	3.10	1.59	0.127	0.68
	Post	4.54	4.51	5.36	5.04	0.40	0.692	0.17
Phasic in space left hand	Pre	4.65	3.94	4.00	3.36	-0.42	0.680	-0.18
	Post	4.21	4.08	6.14	5.25	0.94	0.356	0.40

*p < .01

Table 29

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Patients with Single-Episode *Depression (N = 9) and Patients with Recurrent Depression (N = 13)*

Variable	Time	Singel-Episode Depression		Recurrent Depression		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	5.85	2.19	6.38	2.39	-0.53	0.601	-0.23
	Post	5.22	2.41	4.41	2.05	0.85	0.405	0.37
On body left hand	Pre	6.30	3.02	5.41	2.50	0.75	0.462	0.33
	Post	4.30	2.87	4.21	1.95	0.09	0.930	0.04
In space right hand	Pre	2.67	1.73	4.26	2.65	-1.58	0.131	-0.68
	Post	2.96	2.69	4.26	3.17	-1.00	0.330	-0.43
In space left hand	Pre	3.26	2.67	3.64	2.79	-0.32	0.752	-0.14
	Post	2.96	3.34	3.77	2.45	-0.66	0.520	-0.28

*p < .01

Table 30

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for Patients with Single-Episode *Depression (N = 9) and Patients with Recurrent Depression (N = 13)*

Variable	Time	Singel-Episode Depression		Recurrent Depression		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	30.91	11.56	22.67	9.69	1.81	0.085	0.79
	Post	25.03	16.29	17.29	13.22	1.23	0.234	0.53
On body left hand	Pre	33.42	12.78	22.92	12.33	1.94	0.067	0.84
	Post	25.43	15.20	21.29	14.98	0.63	0.536	0.27
In space right hand	Pre	6.61	5.08	10.17	5.96	-1.51	0.149	-0.63
	Post	6.11	5.77	11.17	9.30	-1.45	0.164	-0.63
In space left hand	Pre	7.59	6.06	9.11	7.60	-0.50	0.621	-0.22
	Post	7.30	9.44	10.88	8.69	-0.90	0.379	-0.40

*p < .01

Table 31

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Patients with Single-Episode Depression (N = 9) and Recurrent Depression (N = 13)

Variable	Time	Singel-Episode Depression		Recurrent Depression		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	4.70	2.21	4.67	1.87	0.04	0.967	0.02
	Post	3.44	2.00	2.79	1.56	0.86	0.402	0.37
Irregular on body left hand	Pre	4.70	2.51	3.77	1.89	1.00	0.331	0.43
	Post	2.67	2.24	2.33	1.71	0.40	0.695	0.17
Repetitive on body right hand	Pre	0.44	0.53	0.64	0.79	-0.65	0.522	-0.28
	Post	0.52	0.69	0.64	0.79	-0.38	0.710	-0.16
Repetitive on body left hand	Pre	0.41	0.40	0.67	0.53	-1.24	0.228	-0.54
	Post	0.44	0.33	0.79	0.79	-1.25	0.225	-0.54
Phasic on body right hand	Pre	1.04	0.90	1.10	1.13	-0.14	0.887	-0.06
	Post	1.37	1.31	1.10	1.26	0.48	0.634	0.21
Phasic on body left hand	Pre	1.44	1.96	1.13	0.99	0.50	0.623	0.22
	Post	1.19	1.44	1.26	0.75	-0.15	0.881	-0.07
Repetitive in space right hand	Pre	1.11	1.14	1.79	1.32	-1.26	0.223	-0.55
	Post	0.52	0.50	1.72	1.73	-2.36	0.032	-0.87
Repetitive in space left hand	Pre	1.15	1.14	1.56	1.56	-0.68	0.504	-0.30
	Post	0.52	0.99	1.56	1.68	-1.83	0.082	-0.72
Phasic in space right hand	Pre	1.63	1.03	2.64	1.60	-1.67	0.111	-0.72
	Post	2.44	2.36	2.59	1.87	-0.16	0.873	-0.07
Phasic in space left hand	Pre	2.22	2.03	2.21	1.46	0.02	0.982	0.01
	Post	2.48	2.66	2.23	1.29	0.30	0.771	0.13

*p < .01

Table 32

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for Patients with Single-Episode Depression (N = 9) and Recurrent Depression (N = 13)

Variable	Time	Singel-Episode Depression		Recurrent Depression		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	27.22	11.07	17.12	9.62	2.28	0.034	0.99
	Post	18.70	16.68	9.69	9.08	1.64	0.117	0.71
Irregular on body left hand	Pre	28.49	12.73	16.44	10.94	2.38	0.028	1.03
	Post	18.78	16.50	10.01	9.39	1.44	0.176	0.69
Repetitive on body right hand	Pre	0.99	0.95	3.05	3.94	-1.81	0.092	-0.66
	Post	2.83	4.71	3.69	6.93	-0.32	0.749	-0.14
Repetitive on body left hand	Pre	1.54	1.31	2.72	2.46	-1.31	0.205	-0.57
	Post	3.58	4.84	6.12	7.31	-0.91	0.373	-0.39
Phasic on body right hand	Pre	2.70	2.48	2.51	2.13	0.19	0.848	0.08
	Post	3.51	2.84	3.91	5.07	-0.22	0.830	-0.09
Phasic on body left hand	Pre	3.40	5.44	3.76	3.57	-0.19	0.853	-0.08
	Post	2.87	3.46	5.16	4.32	-1.32	0.201	-0.57
Repetitive in space right hand	Pre	3.64	4.41	5.36	4.47	-0.89	0.384	-0.39
	Post	1.63	2.13	5.81	6.15	-2.26	0.038	-0.84
Repetitive in space left hand	Pre	3.20	2.57	4.88	4.99	-0.92	0.366	-0.40
	Post	2.02	4.64	5.57	6.71	-1.47	0.158	-0.59
Phasic in space right hand	Pre	2.97	2.25	4.81	3.20	-1.49	0.153	-0.64
	Post	4.44	5.15	5.36	4.56	-0.44	0.663	-0.19
Phasic in space left hand	Pre	4.38	4.11	4.23	3.30	0.10	0.925	0.04
	Post	5.28	6.10	5.25	3.82	0.01	0.989	0.01

*p < .01

Table 33

Mean Frequency (number/minute) and Standard Deviation of Focus Units at Pre- and Post-Measurement for Patients with Therapy Sessions *≤ 24 (N = 8) and Patients with ≥ 25 Sessions (N = 14)*

Variable	Time	Short therapy		Long therapy		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	6.88	2.05	5.76	2.36	1.11	0.279	0.49
	Post	4.88	2.35	4.67	2.18	0.21	0.836	0.09
On body left hand	Pre	5.13	2.17	6.14	2.96	-0.85	0.407	-0.38
	Post	4.21	2.36	4.26	2.37	-0.05	0.960	-0.02
In space right hand	Pre	4.25	2.75	3.24	2.21	0.95	0.355	0.42
	Post	4.00	3.41	3.57	2.84	0.32	0.755	0.14
In space left hand	Pre	3.38	2.78	3.55	2.73	-0.14	0.889	-0.06
	Post	3.83	2.27	3.21	3.11	0.49	0.629	0.22

*p < .01

Table 34

Proportion of Time (seconds/minute) and Standard Deviation on Focus Units at Pre- and Post-Measurement for Patients with Therapy *Sessions ≤ 24 (N = 8) and Patients with ≥ 25 Sessions (N = 14)*

Variable	Time	Short therapy		Long therapy		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
On body right hand	Pre	25.84	12.87	26.16	10.37	-0.06	0.950	-0.03
	Post	21.77	18.73	19.71	12.59	0.31	0.761	0.14
On body left hand	Pre	22.03	13.03	30.18	12.99	-1.41	0.173	-0.63
	Post	23.32	17.90	22.80	13.55	0.08	0.939	0.03
In space right hand	Pre	10.44	7.02	7.73	4.94	1.06	0.301	0.47
	Post	9.60	8.69	8.82	8.36	0.21	0.838	0.09
In space left hand	Pre	8.72	7.40	8.36	6.88	0.12	0.909	0.05
	Post	9.55	7.55	9.34	9.95	0.05	0.958	0.02

*p < .01

Table 35

Mean Frequency (number/minute) and Standard Deviation of StructureFocus Units at Pre- and Post-Measurement for Patients with Therapy *Sessions ≤ 24 (N = 8) and Patients with ≥ 25 Sessions (N = 14)*

Variable	Time	Short therapy		Long therapy		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	4.83	1.46	4.60	2.25	0.27	0.792	0.12
	Post	3.21	1.60	2.98	1.86	0.29	0.771	0.13
Irregular on body left hand	Pre	3.88	1.41	4.31	2.53	-0.44	0.661	-0.20
	Post	2.33	2.17	2.55	1.80	-0.25	0.806	-0.11
Repetitive on body right hand	Pre	0.63	0.86	0.52	0.60	0.33	0.748	0.14
	Post	0.50	0.69	0.64	0.78	-0.43	0.671	-0.19
Repetitive on body left hand	Pre	0.42	0.53	0.64	0.46	-1.05	0.306	-0.47
	Post	0.67	0.47	0.64	0.76	0.08	0.937	0.04
Phasic on body right hand	Pre	1.54	1.42	0.81	0.62	1.68	0.108	0.75
	Post	1.38	1.46	1.12	1.17	0.45	0.656	0.20
Phasic on body left hand	Pre	1.04	1.13	1.38	1.61	-0.53	0.605	-0.23
	Post	1.38	0.95	1.14	1.14	0.49	0.632	0.22
Repetitive in space right hand	Pre	1.75	1.59	1.38	1.09	0.65	0.526	0.29
	Post	1.75	1.78	0.93	1.23	1.28	0.215	0.57
Repetitive in space left hand	Pre	1.38	1.63	1.40	1.30	-0.05	0.963	-0.02
	Post	1.58	1.77	0.88	1.33	1.06	0.303	0.47
Phasic in space right hand	Pre	2.75	1.53	1.93	1.38	1.29	0.211	0.57
	Post	2.33	1.83	2.64	2.19	-0.34	0.740	-0.15
Phasic in space left hand	Pre	2.13	1.60	2.26	1.76	-0.18	0.858	-0.08
	Post	2.29	1.13	2.36	2.29	-0.08	0.941	-0.03

*p < .01

Table 36

Proportion of Time (seconds/minute) and Standard Deviation on StructureFocus Units at Pre- and Post-Measurement for Patients with *Therapy Sessions ≤ 24 (N = 8) and Patients with ≥ 25 Sessions (N = 14)*

Variable	Time	Short therapy		Long therapy		*t(20)*	*p*	*Cohen's d*
		M	*SD*	*M*	*SD*			
Irregular on body right hand	Pre	19.17	12.63	22.44	10.61	-0.65	0.523	-0.29
	Post	14.44	16.30	12.76	11.68	0.28	0.782	0.12
Irregular on body left hand	Pre	16.53	12.31	24.13	12.85	-1.36	0.190	-0.60
	Post	13.99	16.71	13.37	11.39	0.10	0.919	0.05
Repetitive on body right hand	Pre	3.27	4.61	1.60	2.01	0.98	0.356	0.53
	Post	2.78	5.14	3.66	6.62	-0.32	0.749	-0.14
Repetitive on body left hand	Pre	1.66	2.00	2.56	2.18	-0.96	0.348	-0.43
	Post	4.74	5.10	5.28	7.23	-0.19	0.852	-0.08
Phasic on body right hand	Pre	3.40	3.14	2.12	1.41	1.32	0.201	0.59
	Post	4.55	4.85	3.29	3.94	0.67	0.513	0.30
Phasic on body left hand	Pre	3.84	4.63	3.49	4.29	0.18	0.857	0.08
	Post	4.59	3.28	4.01	4.57	0.31	0.757	0.14
Repetitive in space right hand	Pre	5.32	5.59	4.28	3.79	0.52	0.607	0.23
	Post	5.18	5.95	3.48	4.97	0.72	0.479	0.32
Repetitive in space left hand	Pre	4.65	5.33	3.93	3.57	0.38	0.709	0.17
	Post	5.40	7.34	3.38	5.42	0.74	0.469	0.33
Phasic in space right hand	Pre	5.12	3.55	3.45	2.47	1.30	0.209	0.58
	Post	4.41	4.15	5.32	5.12	-0.42	0.676	-0.19
Phasic in space left hand	Pre	4.07	3.06	4.42	3.92	-0.22	0.829	-0.10
	Post	4.05	1.80	5.95	5.76	-1.14	0.270	-0.40

*p < .01

Table 37

Tests of Normality for Focus- and StructureFocus Units in Frequency (number/minute) at Pre- and Post-Measurement for the Total Sample (N = 22)

Variable	Time	Tests of Normality Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
On body right hand	Pre	0.178	22	0.068	0.946	22	0.268
	Post	0.105	22	,200*	0.969	22	0.692
On body left hand	Pre	0.152	22	,200*	0.971	22	0.745
	Post	0.114	22	,200*	0.959	22	0.464
In space right hand	Pre	0.117	22	,200*	0.965	22	0.598
	Post	0.209	22	0.013	0.858	22	0.005
In space left hand	Pre	0.151	22	,200*	0.939	22	0.186
	Post	0.109	22	,200*	0.929	22	0.114
Irregular on body right hand	Pre	0.139	22	,200*	0.973	22	0.779
	Post	0.108	22	,200*	0.964	22	0.574
Irregular on body left hand	Pre	0.133	22	,200*	0.948	22	0.293
	Post	0.180	22	0.062	0.926	22	0.099
Repetitive on body right hand	Pre	0.312	22	0.000	0.747	22	0.000
	Post	0.274	22	0.000	0.746	22	0.000
Repetitive on body left hand	Pre	0.225	22	0.005	0.866	22	0.007
	Post	0.263	22	0.000	0.821	22	0.001
Phasic on body right hand	Pre	0.219	22	0.007	0.780	22	0.000
	Post	0.259	22	0.000	0.757	22	0.000
Phasic on body left hand	Pre	0.252	22	0.001	0.756	22	0.000
	Post	0.187	22	0.043	0.827	22	0.001
Repetitive in space right hand	Pre	0.117	22	,200*	0.919	22	0.071
	Post	0.244	22	0.001	0.768	22	0.000
Repetitive in space left hand	Pre	0.158	22	0.161	0.873	22	0.009
	Post	0.294	22	0.000	0.762	22	0.000
Phasic in space right hand	Pre	0.153	22	0.199	0.956	22	0.417
	Post	0.222	22	0.006	0.849	22	0.003
Phasic in space left hand	Pre	0.096	22	,200*	0.951	22	0.338
	Post	0.166	22	0.117	0.887	22	0.016

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 38

Tests of Normality for Focus- and StructureFocus Units in Proportion of Time (seconds/minute) at Pre- and Post-Measurement for the Total Sample (N = 22)

Variable	Time	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
On body right hand	Pre	0.108	22	,200*	0.957	22	0.435
	Post	0.139	22	,200*	0.920	22	0.077
On body left hand	Pre	0.134	22	,200*	0.967	22	0.644
	Post	0.139	22	,200*	0.943	22	0.227
In space right hand	Pre	0.105	22	,200*	0.950	22	0.313
	Post	0.185	22	0.049	0.855	22	0.004
In space left hand	Pre	0.147	22	,200*	0.928	22	0.110
	Post	0.196	22	0.027	0.869	22	0.007
Irregular on body right hand	Pre	0.167	22	0.112	0.951	22	0.333
	Post	0.183	22	0.053	0.831	22	0.002
Irregular on body left hand	Pre	0.124	22	,200*	0.956	22	0.411
	Post	0.198	22	0.025	0.877	22	0.011
Repetitive on body right hand	Pre	0.313	22	0.000	0.693	22	0.000
	Post	0.289	22	0.000	0.600	22	0.000
Repetitive on body left hand	Pre	0.145	22	,200*	0.881	22	0.013
	Post	0.289	22	0.000	0.787	22	0.000
Phasic on body right hand	Pre	0.174	22	0.082	0.871	22	0.008
	Post	0.197	22	0.027	0.808	22	0.001
Phasic on body left hand	Pre	0.201	22	0.021	0.776	22	0.000
	Post	0.208	22	0.014	0.831	22	0.002
Repetitive in space right hand	Pre	0.188	22	0.043	0.854	22	0.004
	Post	0.342	22	0.000	0.730	22	0.000
Repetitive in space left hand	Pre	0.198	22	0.024	0.862	22	0.006
	Post	0.339	22	0.000	0.708	22	0.000
Phasic in space right hand	Pre	0.110	22	,200*	0.934	22	0.152
	Post	0.207	22	0.015	0.818	22	0.001
Phasic in space left hand	Pre	0.166	22	0.118	0.914	22	0.056
	Post	0.192	22	0.035	0.857	22	0.005

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 39

Documentation how artificial intelligence was used

AI-based tools	Form of use	Affected parts
DeepL	Translating German words, sentences and paragraphs into English	Entire work
ChatGPT (OpenAI)	Correcting grammar, spelling and punctuation Reformulating sentences Searching synonyms Comprehension questions concerning statistical methods in SPSS and support with the use of SPSS	Entire work

7.2 NEUROGES certificate

Berlin Gesture Center
www.berlingesturecenter.de

NEUROGES® I Certificate

This is to certify that Larissa Puma has completed the NEUROGES® I training and successfully passed the NEUROGES® I exam. She is highly proficient in analyzing nonverbal behavior with Lausberg's NEUROGES® (Neuropsychological Gesture) Analysis System in the categories Activation, Structure, Focus and Contact for hand movements (Part I). She is sufficiently trained in NEUROGES® Part I to reliably apply it to research.

Cologne, 10 July 2024

Univ.-Prof. Dr. med. Hedda Lausberg
Board of directors of the Berlin Gesture Center, Head of the Department of Neurology, Psychosomatic Medicine, and Psychiatry, German Sport University Cologne

Berlin Gesture Center
www.berlingesturecenter.de

NEUROGES® I Exam Report

This is to confirm that Larissa Puma has successfully passed the NEUROGES® I exam on 5 Jul, 2024 in Cologne. The exam comprised the analysis of four films showing different individuals who spontaneously displayed hand movements while they talked. The NEUROGES® analysis of the individuals' hand movement behavior was conducted without sound.

Larissa Puma's results for the assessment of the NEUROGES® categories were as follows:

Task	score	reference scores	
		range (minimum, maximum)	mean ± standard deviation
Activation	10/12	9,17-11,69	10,56±0,73
Structure	10/12	5-10	6,77±1,59
Focus	15/15	6-14,5	11,5±1,91
Contact	9/9	5-9	8,28±1,12
Behavior segmentation	11/19	1-18	9,9±3,26
Overall performance in %	83%	50% - 87%	

Cologne, 10 July 2024

Univ.-Prof. Dr. med. Hedda Lausberg
Board of directors of the Berlin Gesture Center, Head of the Department of Neurology, Psychosomatic Medicine, and Psychiatry, German Sport University Cologne

7.3 Declaration of independence

„Ich erkläre hiermit, dass ich diese Arbeit selbstständig verfasst und keine anderen als die angegebenen Quellen benutzt habe. Alle Stellen, die wörtlich oder sinngemäss aus Quellen entnommen wurden, habe ich als solche gekennzeichnet. Als Hilfsmittel habe ich Künstliche Intelligenz verwendet. Sämtliche Elemente, die ich von einer Künstlichen Intelligenz übernommen habe, werden als solche deklariert und es finden sich die genaue Bezeichnung der verwendeten Technologie sowie die Angabe der «Prompts», die ich dafür eingesetzt habe. Mir ist bekannt, dass andernfalls die Arbeit mit der Note 1 bewertet wird bzw. der Senat gemäss Artikel 36 Absatz 1 Buchstabe r des Gesetzes vom 5. September 1996 über die Universität zum Entzug des auf Grund dieser Arbeit verliehenen Titels berechtigt ist.

Für die Zwecke der Begutachtung und der Überprüfung der Einhaltung der Selbständigkeitserklärung bzw. der Reglemente betreffend Plagiate erteile ich der Universität Bern das Recht, die dazu erforderlichen Personendaten zu bearbeiten und Nutzungshandlungen vorzunehmen, insbesondere die schriftliche Arbeit zu vervielfältigen und dauerhaft in einer Datenbank zu speichern sowie diese zur Überprüfung von Arbeiten Dritter zu verwenden oder hierzu zur Verfügung zu stellen."

Bern, 17. Januar 2025