

Physiological activity, severity of neurotic symptoms and personality traits of patients in a psychiatric day ward in the initial and final phases of the psychodynamic psychotherapy process. Quasi-longitudinal pilot study.

Magdalena Konop, Jerzy Sobański, Katarzyna Klasa, Michał Mielimąka, Edyta Dembinska, Krzysztof Rutkowski

Abstract

Aim: The aim of the study was to explore HR (heart rate) and EDA (electrodermal activity) activity of patients in the initial and final phase of a 12-week psychodynamic psychotherapy process. The physiological data obtained were correlated with psychological variables (questionnaire results of patients).

Material and methods: Data from 12 patients with a diagnosis of neurotic disorders and/or personality disorders were analysed. Patients were examined with the MMPI-2 (Minnesota Multiphasic Personality Inventory), KON-2006 (Neurotic Personality Questionnaire) and Symptom Checklist "O". Physiological data were collected using a galvanometer and a pulsometer.

Results: The results of psychological questionnaires in the final phase of psychotherapy showed a reduction in symptoms in most of the scales compared to the initial questionnaires. Patients' EDA and HR scores decreased in the final phase of psychotherapy compared to the initial phase. Most of scores of personality disorder traits showed a negative correlation with EDA and a positive correlation with HR, neurotic personality traits correlated positively with EDA and negatively with HR. At the end of the psychotherapy process, a positive correlation was observed between personality traits and physiological measures.

Discussion: The obtained results suggest that psychotherapy can lower the intensity of the physiological activity of patients. Psychotherapy probably has the potential to change the direction of physiological responses of patients with personality disorder traits.

Conclusions: Physiological activity can potentially be used as an objective measure of the effectiveness of psychotherapy. The study should be repeated on a larger group of subjects to confirm the results we obtained.

galvanic skin response; heart rate; psychophysiology; personality traits; psychodynamic psychotherapy

Magdalena Konop, Jerzy Sobański, Katarzyna Klasa, Michał Mielimąka, Edyta Dembinska, Krzysztof Rutkowski: Department of Psychotherapy, Jagiellonian University Medical College, Kraków, Poland.

Correspondence address: magdalenakonop@gmail.com

INTRODUCTION

Psychotherapy is a skilled and intentional treatment process in which the thoughts, emotions,

and behavior of a patient are modified with the intention of facilitating increased functioning and life adjustment. Years of clinical research have provided convincing evidence of the value of psychotherapy as a treatment method. Regarding to the effectiveness of psychotherapy, studies confirms that patients benefit from treatment in a various areas of functioning [1].

Decades of research have produced a wealth of results regarding the effectiveness of psychotherapy. They have provided a wide range of methods and results for the systematic evaluation of therapeutic outcomes and processes.

Many of these important findings depend heavily on methodologies involving tools such as self-report measures. These include, among others, the effects of the ability, awareness and motivation to report certain processes. Such methods have both many advantages and shortcomings – the data are relatively easy to obtain, but self-report methods tend to be less objective and do not include the inter – and intrapersonal psychotherapeutic processes as they unfold over time, between and within sessions [2]. There has never been a gold standard when it comes to using diagnostic tools to examine the effectiveness of psychotherapy. However, the research results clearly indicate that the assessment should not be limited only to symptoms, but should also include the assessment of personality traits. To achieve this, appropriate personality assessment questionnaires can be used. Although their use is time-consuming, they allow for a more complete assessment of personality functioning in many aspects. At this point, it is worth mentioning some of the most important tools that are most often used in research: Cattell's 16 PF, EPQ, TCI, NEO-FFI, NEO-PI-R and MMPI [3].

In recent years, more objective, interdisciplinary methods have been introduced to capture the richness of therapeutic processes and other intra – and interpersonal processes that is not possible with self-report and observational measures [2, 4]. These approaches include, but are not limited to, non-verbal aspects, affective, hormonal and physiological measures. These approaches rely on knowledge from other disciplines that has only recently been imported into psychotherapy research [2].

Growing evidence indicates that psychological factors relevant to the effectiveness of psy-

chotherapy are related to physiological activity. By monitoring patients' physiological responses during the psychotherapy process, researchers can delineate new areas in our understanding of therapeutic mechanisms that promote client change and development, an important contribution to ongoing efforts to increase the effectiveness and efficiency of clinical interventions. Knowledge of the physiological correlates of variables in the therapeutic process can potentially provide unique insights into how psychotherapy works. At present, however, little is known about the physiological basis of the specific therapeutic processes that facilitate patient change and development [4].

Research on physiological responses in psychotherapy may focus on one of the individuals in treatment, on the interdependence between two or more partners in the therapeutic relationship, or at the dyadic or group level [2]. In terms of research on the interdependence of physiological responses of participants in a therapeutic interaction, many such publications have addressed the topic of synchronization between these responses [5, 6]. The synchrony of the therapist's and patient's physiological responses facilitates the establishment of a therapeutic alliance [7], positively correlates with therapy outcome and symptom reduction [8, 9, 10]. There are fewer current studies on the impact of the effectiveness of psychotherapy and its impact on individual physiological reactions of patients, or on the course of these reactions in the process of psychotherapy [6]. The available articles concern therapeutic interventions, trainings, rather than the entire psychotherapeutic process [11-13]. Publications where the process of psychotherapy was taken into account concerned shorter processes – several sessions [14] or longer ones additionally comparing different types of therapy [15], or examining patients' reactions to given stimuli related to their difficulties [16].

The two most commonly used physiological parameters in psychotherapy research are heart rate (HR) and electrodermal activity (EDA). HR and derived measures of heart rate variability are mainly used in psychophysiological studies on stress and its relation to cardiovascular disease occurrence, behavioural functions, emotional responses and cognitive functions [17]. HR is a complex signal that reflects the antagonistic in-

teraction of the sympathetic and parasympathetic autonomic nervous system [18]. EDA is a general term used to describe autonomic changes in the electrical properties of the skin (via sweat produced in the sweat glands) that are controlled solely by the sympathetic nervous system. Measurements of EDA are used in a variety of applications, including the study of attention, learning, emotional responses, EDA scores in a correlation with the occurrence of psychiatric symptoms, as an indicator of response to psychiatric medical treatment [19]. In psychophysiology, the most commonly used measure is skin conductance (SC). SC is a recording of exosomatic electrodermal activity, involving skin contact with a direct current. SC unit of measurement is microsiemens (μS). According to the literature, different components of SC may be encountered – slowly varying tonic activity (SCL) or rapid phase components (SCR), which reflect a response to a given stimulus or a non-specific response. SCR can be determined by, inter alia, its amplitude (SCR amp), rise time (SCR ris.t.), frequency (SCR freq.), half-time recovery (SCR rec.tc). Skin conductance is preferably measured on the surface of the palm, where there is a high concentration of the eccrine sweat glands, which usually results in good signal quality and high sensitivity [20, 21].

Studies on EDA and HR parameters in the effectiveness of medical interventions concerned various fields of medicine, for example dermatological treatment. In terms of psychiatric treatment, there are EDA and HR studies on pharmacological psychiatric treatment. However, there are fewer studies on the effectiveness of psychotherapy using physiological parameters. Physiological parameters have so far been used by researchers to study the differences between control groups and patients with psychiatric disorders, including anxiety, depression, schizophrenia, psychopathy and other personality disorders, although these are relatively few [21].

Aim

The aim of the presented study was to analyze the results of psychological questionnaires and the patients' physiological responses at the beginning and end of 12-week psychodynamic psychotherapy process. This was done for diagnostic purposes (determining the initial physiological reactivity of patients) and in order to

study the relationship between the effects of psychotherapy treatment obtained using self-report methods (questionnaires) and obtained using objective methods (physiological responses). We examined the physiological responses of HR, SCL, SCR freq., SCR amp., and we used the following psychological questionnaires: the clinical scales of the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) [22], the KON-2006 Questionnaire [23] and the Symptom Checklist "O" [24]. It was decided to use these questionnaires because they were the most common methods used in similar studies (in Poland) on the effectiveness of psychotherapy [3, 25 – 28]. Moreover, these methods make it possible to determine the severity of neurotic symptoms, neurotic personality traits and the general personality profile of the patients. According to the literature, the above factors – both the severity of symptoms and personality traits – should be examined when it comes to the effectiveness of psychotherapy [3].

Research Hypotheses

It was hypothesized that the psychotherapy conducted would have a positive effect, lowering the level of symptoms and reducing the severity of the dysfunctional personality traits of the patients, which could be ascertained through the results of the questionnaires.

According to a further hypothesis, the initial psychotherapy sessions, compared to the final sessions, will be characterised by more intense physiological reactions of patients. It was assumed that the progressive process of psychotherapy would be associated with a decreasing strength of physiological reactions [8].

It was hypothesized that the physiological reactivity of the patients would negatively correlate with higher scores on the clinical scales of the MMPI-2 Inventory [22]. This assumption was related to the fact that individuals with the greatest difficulties in relationships, for example with antisocial tendencies, show a lower intensity of physiological reactions [21].

It was hypothesised that patients' physiological reactivity would be positively correlated with global symptom severity on the 'O' Checklist (OWK variable) and KON-2006 scores [23] in

the initial phases of therapy (greater reactivity in individuals with anxiety disorders and neurotic personality traits) [21]. It was assumed that in the final phase of the therapeutic process, these correlations would be similar but of lesser strength.

METHODS

Participants

Patients who participated in the study had a diagnosis of neurotic disorder (F40-F48) and/or personality disorder (F60-F61) according to ICD-10. Participants were hospitalised for a period of 12 weeks in a day hospital for neurotic and behavioral disorders treatment, where they participated in group psychotherapy 5 times a week (3 sessions a day) and in individual psychotherapy once a week (180 sessions of group psychotherapy and 12 sessions of individual psychotherapy during the entire treatment). In exceptional cases, psychotherapy was extended for 14 weeks in case the patient needed an extension of the process.

Psychotherapy was led by two psychotherapists (a woman and a man). Psychotherapy was conducted using a psychodynamic approach. Therapeutic interventions used included: stimulation for exploration, clarification, confrontation, and interpretation. During psychotherapy, transference processes were induced by avoiding transparency. Interpretations of transference and work with the resistance (including its interpretation) were used. The symbolic meaning and function of the reported symptoms were also analyzed. Psychotherapists were making patients aware of the defense mechanisms related to the symptoms they presented. They strengthened the power of ego of the patients by building their independence and autonomy. They were correcting disorders in the area of self-esteem/self-image. They avoided giving direct advice, guidance. Psychotherapists were limiting their own verbal and non-verbal activity to the minimum necessary to achieve the specific intervention objective. Psychotherapy also included compliance with the setting (attendance at all meetings, punctuality), as well as maintaining secrecy and other rules resulting from the department's regulations [25, 27].

The data of 12 patients were analysed. The patients whose data were analysed had attended at least four or more individual psychotherapy sessions. The possible lack of data was due to the fact that not all subjects were present at every psychotherapy session (among others due to COVID-19 pandemic), not every recording was correctly registered by the device, some data were excluded after visual analysis identified them as artefacts [21].

The mean age of the subjects was M=32.8, SD=6.5. The median score was 34.5 years. Women represented 66.7% (n=8) of this group and men 33.3% (n=4) – Table 1. The majority of patients had an anxiety disorder (F41) or specific personality disorder (F60). 75% (n=9) of the subjects were receiving pharmacotherapy (Table 2). This included a variety of medications: SNRI, SSRI, hydroxyzine, spamilan, neuroleptic, pregabalin, lamotrigine, dibenzodiazepine.

Table 1. Sociodemographic Characteristics of Participants

| | <i>n</i> | % | <i>M</i> | <i>SD</i> |
|---------|----------|------|----------|-----------|
| Age: | 12 | 100 | 32.8 | 6.5 |
| Gender: | | | | |
| Woman | 8 | 66.7 | | |
| Men | 4 | 33.3 | | |

Table 2. Characteristics of the Study Group – Diagnosis and Pharmacotherapy

| | <i>n</i> | % |
|---|----------|------|
| Diagnosis: | | |
| F40 Phobic anxiety disorders | 1 | 8.3 |
| F41 Other anxiety disorders | 9 | 75 |
| F45 Somatoform disorders | 1 | 8.3 |
| F50 Eating disorders | 1 | 8.3 |
| F60 Specific personality disorder | 8 | 66.7 |
| F61 Mixed and other personality disorders | 1 | 8.3 |
| Pharmacotherapy: | | |
| No | 3 | 25 |
| Yes | 9 | 75 |

Note. Some patients had more than one diagnosis.

INSTRUMENTATION

Apparatus

EDA was measured using a galvanometer (GRS logger sensor NUL-217) [29]. The unit of measurement was microsiemens (μS). SC data were collected at 5 Hz. HR was measured with a pulsometer (Heart Rate & Pulse logger sensor NUL-208) [29], which allowed data to be collected on heart beats per minute. The devices were manufactured by NeuLog [29].

Questionnaires

The following questionnaires were used in the study: Symptom Checklist "O" [24], KON-2006 Neurotic Personality Questionnaire [23], MMPI-2 Inventory [22].

Symptom Checklist "O", is a widely used tool in studies on mental disorders in Poland. The tool was used to measure the intensity of neurotic symptoms. It includes a very wide range of neurotic and personality disorders symptoms, owing to which it is characterized with high sensitivity. Moreover, this tool is also useful in the assessment of changes in the severity of symptoms in the course of psychotherapy [30]. Symptom Checklist allows for detailed assessment of the type and severity of symptoms experienced by patient during 7 days preceding the examination. It includes 138 items (68 items refer to symptoms from the area of experiencing e.g. anxiety, depression, loneliness; 23 items refer to behavioral disorders e.g. obsessive activities, sexual activities dysfunction; 47 items refer to somatic disorders e.g. diarrhea, tinnitus). Three items out of the whole set are repeated in identical or similar wording in order to assess the fairness of patient's answers. The Patient assesses the severity of each 135 symptoms, during the last 7 days, on a four-point scale. The theoretical maximum possible score is 966. On the basis of conducted studies it is stipulated that the population of women with neurotic disorders is characterised by the value of OWK > 200 points, respectively the population of men with neurotic disorders is characterised by the value of OWK > 190 points [23].

Neurotic Personality Questionnaire KON-2006 was used to measure the intensity of neurotic

personality [23]. The psychometric features of the questionnaire are documented and indicate its usefulness for both clinical trial and scientific studies [24]. This tool consists of 243 statements which are assessed by the patient as true or false. Accordingly selected sets of statements constitute the 24 scales of questionnaire, which examine the severity of particular traits of neurotic personality. Global severity of these traits is reflected by the X-KON index. According to the results of studies conducted by the authors of the tool, the cut-off value for healthy population is 8 points. The population of people with neurotic disorders is characterized by the X-KON index value higher than 18 points [23]. The tool is used not only for diagnosis, but also gives the opportunity for observation and empirical verification of the changes occurring in patients, including the occurrence and severity of personality characteristics (comorbid/responsible for the presence of neurotic disorders) [26].

MMPI-2 Inventory was used to measure the intensity of personality traits in patients. The following clinical scales were used in the presented study: Hypochondria (Hs), Depression (D), Hysteria (Hy), Psychopathic Deviation (PD), Masculinity/Femininity (Mf), Paranoia (Pa), Psychasthenia (Pt), Schizophrenia (Sc), Hypomania (Ma), Social Introversion (Si) and the Supplementary Scale Ego Strength. Ego strength is defined as the ability to maintain one's own mental stability and identity, regardless of experienced discomfort, suffering, and conflicts between internal needs and external requirements. This ability to maintain ego stability, based on a relatively stable set of personality traits, translates into mental health [28]. The highest levels of scores on clinical scales are associated with the most severe and pathological symptoms and behaviors. Less extremely elevated scores generally indicate less severe symptoms and problems, as well as specific personality traits. Several studies have shown [32] that low scores on clinical scales suggest better overall adjustment, but are unlikely to be related to characteristics specific to what each clinical scale is intended to measure. The exception are scales 0 (Social Introversion) and 5 (Masculinity-Femininity) – people scoring low on these scales have features that are the opposite of those of people scoring high. Regarding the Ego Strength scale, the higher the

score on the scale, the better the psychological adaptation. The reliability indicators obtained in the Polish standardization sample, both estimated using the test-retest method and using the Cronbach's alpha coefficient, compared to the data published in the American textbook, have similar, and for many scales higher, values (0.7–0.9). Polish validation studies were conducted on people from various clinical groups [32].

PROCEDURES

Dry Ag-AgCl electrodes placed on the fingertips of the second and fourth fingers of the non-dominant hand were used to measure SC levels. It was decided to use dry electrodes for reasons of measurement length and patient comfort, which has also been used in other studies [21, 31]. BPM (beats per minute) was measured using a sensor consisting of an infrared LED transmitter and a matching infrared phototransistor receiver. The sensor was placed on the second finger of the non-dominant hand.

A quasi-experimental research procedure with repeated measurement was performed. Physiological responses were measured every second individual psychotherapy session (lasting 45 minutes each time). It was decided to start with the measurement of the second psychotherapy session because the first session is an organisational meeting to define the goals of psychotherapy and to introduce the patient to the treatment procedures. The patients' physiological reactions were not examined during group psychotherapy because it could disturb the assessment of an individual patient's progress and might not be adequate during a session where the patient was not active and/or did not develop a topic consistent with his own problems, but with the problems of another patient.

In addition, participants were surveyed before treatment and during the last week of treatment with the KON-2006 [23] and MMPI-2 [22] questionnaires. The Symptom Checklist "O" [24] was conducted at the beginning of each week of treatment.

DATA ANALYSIS

The EDA Evaluation Software

The EDA-Para program by F. Schaefer, recommended by Boucsein (2012), was used to process the raw SC data [21]. This program extracts the raw EDA data by automatically detecting and parameterising SCRs, calculating the tonic level of SCL conductance, identifying and excluding possible SC response artefacts, as recommended by the Society for Psychophysiological Research (SPR). Although various SC parameters can be obtained automatically, it is advisable to perform such assessment under visual control, as not all types of abnormalities can be detected automatically. The EDA-Para program allows such analysis. The original version of the program was used in the study by Schneider et al. (2003) [35].

The raw EDA data were processed in software. A scaling factor of 10 was used to obtain the appropriate SCL and SCR amplitudes and to provide the possibility of using the recommended standard criterion of 0.01 μ S [21]. A low-pass filter with a cut-off frequency of 0.5 Hz (due to the low sampling frequency of 5 Hz) was used to obtain sufficiently smooth curves. SCL, SCR freq., SCR amp. values were calculated for each minute, of each psychotherapy session.

Statistical Analysis

The licensed statistical package STATISTICA PL was used to perform the statistical analysis. The Wilcoxon signed-ranks test, Spearman's rank correlation, The Kruskal-Wallis one-way ANOVA on ranks, and Mann Whitney U test were used. A significance level of 0.05 was applied in each analysis. Data analysis included 8 initial and 20 final sessions of patients.

Bioethics Committee

The information obtained from this study was used with the consent of the patients. All data were kept and processed anonymised. Analyses were performed with the approval of the Jagiellonian University Bioethics Committee No. 1072.6120.66.2020.

RESULTS

The first part of the statistical analyses focused on changes in MMPI-2, KON-2006 and Symptom Checklist 'O' scores, which were taken as a measure of the effectiveness of the therapeutic process. The results of the questionnaires in the initial (2-3) and final psychotherapy sessions (9-14) were compared. As shown in Table 3, statistics showed a statistically significant decrease in medians and mean values for the following

MMPI-2 scales: Hypochondria, Depression, Psychopathic deviate, Paranoia, Psychasthenia, Social Introversion and Masculinity/Femininity and for the neurotic personality factor (XKON in the KON-2006 questionnaire). Scores of the Hysteria and Hypomania significantly increased towards the end of treatment. The level of symptoms in Symptom Checklist 'O' did not change, nor did the results on the Ego Strength and Schizophrenia scales (MMPI-2).

Table 3. Comparison of MMPI-2, KON-2006, Symptom Checklist "O" Scores at the Beginning and at the End of the Psychotherapy Process

| | Sessions | <i>M</i> | <i>SD</i> | <i>T</i> | <i>Z</i> | <i>p</i> |
|----------|----------|----------|-----------|------------|----------|----------|
| Hs | Initial | 57.46 | 9.48 | 1898445.00 | -3.32 | .001 |
| | Final | 57.06 | 8.87 | | | |
| D | Initial | 63.42 | 9.00 | 673263.00 | -14.44 | <.001 |
| | Final | 59.34 | 9.80 | | | |
| Hy | Initial | 62.20 | 9.66 | 617583.00 | -25.05 | <.001 |
| | Final | 65.08 | 11.10 | | | |
| Pd | Initial | 61.73 | 8.62 | 888298.00 | -20.54 | <.001 |
| | Final | 58.93 | 9.83 | | | |
| Pa | Initial | 57.55 | 9.46 | 954342.00 | -11.64 | <.001 |
| | Final | 55.60 | 4.82 | | | |
| Pt | Initial | 64.73 | 8.61 | 1523016.00 | -11.84 | <.001 |
| | Final | 62.78 | 8.62 | | | |
| SC | Initial | 57.25 | 7.81 | 1731335.00 | -1.36 | .17 |
| | Final | 57.53 | 6.42 | | | |
| Ma | Initial | 50.17 | 6.62 | 794725.00 | -16.49 | <.001 |
| | Final | 52.94 | 7.76 | | | |
| Si | Initial | 58.28 | 8.95 | 1039650.00 | -15.32 | <.001 |
| | Final | 54.91 | 8.40 | | | |
| MF-F | Initial | 49.84 | 13.49 | 1145562.00 | -15.03 | <.001 |
| | Final | 48.31 | 14.34 | | | |
| SE | Initial | 51.04 | 10.12 | 2024097.00 | -0.46 | .65 |
| | Final | 51.34 | 8.58 | | | |
| KON-2006 | Initial | 23.07 | 2.91 | 157641.00 | -21.26 | <.001 |
| | Final | 14.12 | 11.82 | | | |
| OWK | Initial | 278.40 | 130.04 | 2035227.00 | -0.20 | .84 |
| | Final | 278.45 | 143.11 | | | |

Note. The Wilcoxon signed-ranks test was used. A significance level of 0.05 was applied. Initial sessions $n=8$, final sessions $n=20$.

MMPI-2 scales: Hs – hypochondriasis, D – depression, Hy – hysteria, Pd – psychopathic deviate, Mf-F – masculinity/femininity, Pa – paranoia, Pt – psychasthenia, Sc – schizophrenia, Ma – hypomania, Si – social introversion. OWK – global anxiety symptoms severity. KON-2006 – neurotic personality traits.

The analysis carried out (Table 4) showed statistically significant differences in terms of patients' physiological reactivity at the beginning and end of the treatment. Differences were shown for all parameters: HR ($Z=-3.13, p<0.05$), SCL ($Z=-3.76, p<0.05$), SCR freq. ($Z=-6.81, p<0.05$) and SCR amp. ($Z=-3.07, p<0.05$).

Table 4. Comparison of Physiological Reactivity of Patients in Initial and Final Psychotherapy Sessions

| | Sessions | M | SD | Z |
|-----------|----------|-------|-------|----------|
| HR | Initial | 87.92 | 8.33 | -3.13** |
| | Final | 87.12 | 8.97 | |
| SCL | Initial | 32.82 | 26.59 | -3.76*** |
| | Final | 23.97 | 13.13 | |
| SCR freq. | Initial | 6.24 | 3.01 | -6.81*** |
| | Final | 5.31 | 2.66 | |
| SCR amp. | Initial | 7.78 | 9.92 | -3.07** |
| | Final | 5.21 | 6.29 | |

Note. The Mann Whitney U test was used. A significance level of 0.05 was applied. Initial sessions $n=8$, final sessions $n=20$. * $p < .05$. ** $p < .01$. *** $p < .001$. HR – heart rate, SCL – skin conductance level, SCR freq. – skin conductance responses frequency, SCR amp. – skin conductance responses amplitude.

It should be noted that the median scores for the patients' physiological reactivity parameters are significantly lower in the final phase of psychotherapy compared to the initial phase. These large differences mainly concern parameters such as EDL and SCR. For HR, the values of the descriptive statistics were statistically significantly different, but the differences were not as large as for the other physiological reactivity parameters.

Subsequent analyses aimed to investigate the relationship between the MMPI-2, KON-2006 and Symptom Checklist 'O' scores and the patients' physiological reactivity in the initial and final psychotherapy sessions.

Analysing the results (Table 5), it can be seen that most of the MMPI-2 scales correlate negatively with SCL and SCR, but positively with HR. KON-2006 scores correlated positively with SCL ($\rho(8)=0.14, p<0.05$) and SCR freq. ($\rho(8)=0.25, p<0.05$), and negatively with HR ($\rho(8)=-0.15, p<0.05$).

Table 5. Relationship Between MMPI-2, KON-2006 and Symptom Checklist 'O' Scores and Patients' Physiological Reactivity in Initial Psychotherapy Sessions

| | HR | SCL | SCR freq. | SCR amp. |
|----------|---------|----------|-----------|----------|
| Hs | -0.16** | 0.17** | 0.14** | 0.05 |
| D | 0.14* | -0.40*** | -0.17** | -0.36*** |
| Hy | -0.08 | 0.06 | 0.04 | -0.03 |
| Pd | 0.44*** | -0.43*** | -0.11* | -0.45*** |
| Pa | 0.20*** | -0.25*** | -0.11* | -0.26*** |
| Pt | 0.27*** | -0.34*** | -0.23*** | -0.28*** |
| SC | 0.31*** | -0.21*** | -0.20*** | -0.22*** |
| Ma | 0.26*** | -0.16** | -0.30*** | -0.20*** |
| Si | 0.35*** | -0.61*** | -0.35*** | -0.56*** |
| MF-F | -0.09 | 0.14* | -0.05 | 0.22*** |
| SE | 0.13* | -0.06 | 0.05 | -0.08 |
| KON-2006 | -0.15** | 0.14** | 0.26*** | -0.01 |
| OWK | -0.06 | 0.01 | 0.07 | 0.08 |

Note. The Spearman's rank correlation test was used. A significance level of 0.05 was applied. Parameters were calculated for initial sessions $n=8$, in 12 patients. * $p < .05$. ** $p < .01$. *** $p < .001$. HR – heart rate, SCL – skin conductance level, SCR freq. – skin conductance responses frequency, SCR amp. – skin conductance responses amplitude. MMPI-2 scales: Hs – hypochondriasis, D – depression, Hy – hysteria, Pd – psychopathic deviate, MF-F – masculinity/femininity, Pa – paranoia, Pt – psychasthenia, Sc – schizophrenia, Ma – hypomania, Si – social introversion. OWK – global anxiety symptoms severity. KON-2006 – neurotic personality traits.

Table 6. Relationship Between MMPI-2, KON-2006, Symptom Checklist 'O' Scores and Patients' Physiological Reactivity in Final Psychotherapy Sessions

| | HR | SCL | SCR freq. | SCR amp. |
|----------|----------|----------|-----------|----------|
| Hs | -0.04 | -0.02 | 0.06 | -0.27*** |
| D | 0.39*** | 0.12*** | 0.15*** | -0.13*** |
| Hy | 0.16*** | 0.02 | 0.04 | -0.30*** |
| Pd | -0.04 | -0.41*** | 0.14*** | -0.46*** |
| Pa | -0.03 | 0.15*** | 0.16*** | 0.02 |
| Pt | 0.46*** | 0.10** | 0.20*** | -0.10** |
| SC | 0.16*** | -0.24*** | 0.19*** | -0.37*** |
| MA | 0.09** | 0.06 | -0.15*** | -0.10** |
| Si | 0.42*** | 0.12*** | 0.10** | -0.13*** |
| MF-F | -0.26*** | 0.08* | -0.02 | 0.25*** |
| SE | -0.34*** | -0.20*** | -0.13*** | 0.13*** |
| KON-2006 | 0.37*** | -0.53*** | 0.29*** | -0.75*** |
| OWK | 0.04 | 0.14*** | 0.01 | -0.05 |

Note. The Spearman's rank correlation test was used. A significance level of 0.05 was applied. Parameters were calculated for

final sessions $n=20$, in 12 patients. * $p < .05$. ** $p < .01$. *** $p < .001$.
 HR – heart rate, SCL – skin conductance level, SCR freq. – skin conductance responses frequency, SCR amp. – skin conductance responses amplitude. MMPI-2 scales: Hs – hypochondriasis, D – depression, Hy – hysteria, Pd – psychopathic deviate, Mf-F – masculinity/femininity, Pa – paranoia, Pt – psychasthenia, Sc – schizophrenia, Ma – hypomania, Si – social introversion. OWK – global anxiety symptoms severity. KON-2006 – neurotic personality traits.

Compared to the correlations from the initial psychotherapy sessions, significantly more positive correlations are noticeable in the final sessions. Thus, the higher scores on the MMPI-2, KON-2006, Symptom Checklist "O" scales, the higher physiological reactivity of the patients and vice versa. In summary, in the initial psychotherapy sessions, higher OWK, was associated with higher physiological parameters, and higher scores on the MMPI-2 scales with lower physiological parameters. In the final psychotherapy sessions, higher OWK was associated with higher physiological parameters, and higher scores on the MMPI-2 scales were also associated with higher physiological parameters.

DISCUSSION

In the present study, the variation of physiological responses in patients during a 12-week psychodynamic psychotherapy process was analysed.

As we hypothesised, the treatment process proved to be effective in the majority of subjects. Significant improvements were observed in all MMPI-2 Inventory scales in initial sessions compared to the final psychotherapy sessions. The exceptions were the Hysteria and Hypomania scales, where mean scores increased in the final sessions, but this was not a significant increase from a clinical perspective, as it was not significantly above the inventory norms. A possible explanation for the above results is the fact that the Hysteria scale includes the need for emotional contact [33], which may increase during the psychotherapy process, when the most difficult events in the patient's life are discussed. This scale also includes a factor related to somatic complaints [33]. It is possible that if one of the main defense mechanisms used by the patient is somatization, this mechanism may intensify during the psychotherapy process, which arouses

intense emotions in patients. On the Schizophrenia and Ego Strength scales, scores did not change significantly. In the KON-2006, a significant decrease in the neurotic personality traits was observed. The mean level of global severity of neurotic symptoms in the Symptom Checklist "O" described by the coefficient OWK remained unchanged. This improvement in patient outcomes is consistent with other studies on this type of intervention [26]. The lack of change in the Symptom Checklist 'O' may be related to the sensitivity of the tool to situational changes [24], e.g. in this case the increase in symptoms may have been due to the end of the psychotherapy process.

As expected, all physiological parameters decreased in the patients when comparing the initial and final sessions. The above result may suggest that the psychotherapy process causes a decrease in the patients' overall physiological arousal. This result is consistent with the study of S. Leder (2004) [16], who examined EDA, ECG and EEG in patients with neurotic disorders before and after psychotherapy treatment. After psychotherapy, EDA responses and heart rate in reaction to emotional stimuli decreased compared to before treatment. In patients with long-term improvement, extinguishment of reactions especially to past emotional stimuli was found; in the case of short-term improvement, reduction of reactions was primarily related to current emotionally saturated stimuli [16]. The results of our study are also consistent with other, similar publications [4, 14, 34]. For example, in the study by Avdi and Evans (2020), the patient's physiological reactions decreased as the psychotherapy session progressed [39]. The patients' reduced physiological arousal during the course of the psychotherapy sessions may be related to a decreasing internal conflict, with successive interventions by the psychotherapist. This is consistent with the fact that physiological arousal can increase when emotional expression is suppressed, so a reduction in internal conflict can reduce physiological activity [40, 42].

The assumption that most of the initial MMPI-2 scale scores negatively correlated with SCL and SCR freq. and SCR amp. was also confirmed. The KON-2006 initial scores correlated positively with SCL and with SCR freq. according to our hypothesis, and negatively with

HR. This suggests the conclusion that the more prominent the personality disorder traits, the lower the EDA reactivity but the higher the HR. It is difficult to juxtapose this with the results of previous studies using the MMPI-2, as they are very few and used single scales of the inventory [36]. It is known, however, that HR and EDA responses can have opposite directions. This is related to the antagonism of the action of the behavioral approach system (BAS) and the behavioral inhibition system (BIS) and their correlations with EDA and HR. The opposite direction of the severity of ectodermal and cardiovascular system responses has also been linked to the fact that an increase in EDA is considered a specific indicator of anxiety (or introverted emotional lability), whereas an increase in HR reflects impulsivity (or extroverted emotional lability) [36]. Based on the above information, it can be hypothesised that the individuals examined, who had more pronounced personality disorder traits showed higher BAS activity and lower BIS activity, and a lower proportion of anxiety and higher impulsivity. Patients who, on the other hand, showed features of neurotic personality disorder were most likely to have greater BIS activity and less BAS activity and a lower level of impulsivity and greater anxiety. This is consistent with clinical knowledge of personality disorders and neurotic disorders [21, 38].

According to Boucsein's (2012) analysis of the literature, it seems questionable to assume that psychophysiological measures, such as some EDA parameters, can show some validity as universal indicators of personality dimensions [21]. In a study by Birket-Smith et al. (1993) [41], in line with Boucsein (2012) [21], no differences were found between tonic parameters or phasic measures of EDA of patients with anxiety disorders and the age of the subjects, medication taken, results of questionnaires examining symptoms and personality traits [35]. Although according to previous studies the relationships between physiological activity and the severity of personality disorder traits were considered insignificant, the results of our study suggest that these relationships do exist and may be a promising direction for further research.

Our finding that patients with neurotic symptoms and neurotic personality traits show higher EDA but lower HR is not surprising in the

context of other studies on this topic, in which EDA is an objective measure of perceived stress [45] and is increased in individuals with neurotic personality traits [43] and in patients with anxiety disorders [38]. The results of studies on this topic regarding cardiac activity are inconsistent [43], which may be related to the antagonistic effects of the sympathetic and parasympathetic autonomic nervous system in this case [18].

Regarding the correlations from the final psychotherapy sessions and their relation to physiological reactivity and questionnaire results, we obtained surprising results, especially for the MMPI-2 inventory. Correlations opposite to those assumed were obtained. Compared to the correlations at the beginning of psychotherapy, there were significantly more positive correlations indicating that the higher the scores on the clinical scales MMPI-2, KON-2006, Questionnaire 'O', the higher the physiological reactivity of the patients. It can be concluded that the psychotherapy process probably causes an increase in sympathetic nervous system activity and a change in the direction of physiological reactivity in patients with personality disorders. The change proceeds from the initial sessions, when the severity of personality disorder symptoms was associated with lower EDA reactivity and higher HR, to the final sessions, in which the severity of personality disorder symptoms was associated with higher EDA reactivity and HR. In the view of psychodynamic psychotherapy theory, the result can be understood as an improvement – perhaps patients with personality disorders, who may have suppressed intense emotions, disclose physiological mental stimuli more strongly after the psychotherapy process, allowing them into consciousness [44]. Most of the results had a low correlation level. In terms of performance in the initial psychotherapy sessions, three scales stood out – Psychopathy, Social Introversion and Psychasthenia. The strength of correlation was the highest in these scales. The following scales had very low correlations: Hysteria, Masculinity-Femininity, Ego Strength and OWK. As for the results in the final phase of psychotherapy, the highest correlation strength (moderately or strongly correlated) was demonstrated by the following scales: Psychopathy, Social Introversion, Psychasthenia and the results of KON-2006. Very

weak correlations were observed for the scales of Hypochondria, Hysteria, Paranoia, Hypomania and the OWK variable.

As for the results on the Psychopathy scale, it is not surprising that the highest correlations were obtained here. Many studies have analyzed the physiological responses of individuals with psychopathic personality traits, paying particular attention to EDA hypoactivity and higher levels of HR in these individuals [37, 45]. Similar results obtained for Social Introversion [47] and Psychasthenia. One of the higher correlation results for the KON-2006 factor during the final psychotherapy sessions is probably related to the fact that this method examines neurotic personality traits, which, as other studies show, decrease with the psychotherapy process [25-27]. The lowest levels of correlation obtained for the OWK scores are not surprising – the Symptom Checklist “O” measures the current level of symptoms, which may be related to situational factors. The low level of correlation for the M-F scale may be related to the fact that this scale examines intensification with a given gender rather than mental well-being [48]. Low correlations of the Hysteria and Hypomania scales may be due to the fact that the results of these scales increased in the final phase of treatment compared to the initial phase. Hypochondria, Paranoia, Ego Strength were low correlated, maybe due to the fact that these personality traits have less potential to change in terms of physiological activity. More studies on that topic are needed to verify that hypothesis.

One of the strengths of the presented study, was the use of several physiological parameters of EDA (SCR amp., SCR req., SCL), HR and questionnaire data. Wiltshire et al. (2020) suggested that in the study of interpersonal physiology, it is important to juxtapose physiological scores across modalities to better understand their dynamics in the psychotherapy process [6.] Furthermore, studies that have used SC measurement in psychotherapy have tended to use a single parameter – SCL [47]. In general, in psychophysiological studies of EDA, it is common to use a different parameter especially SCR, as SCL can have different individual baseline levels [21]. Another advantage of the study is the measurement of data across a longer period of time – 12 weeks. There is a tendency in the literature to

conduct studies during a single psychotherapy session, which makes it difficult to study changes in psychotherapy over time, as it is a long-term process [6, 49]. An additional advantage of the study was the comparison of patients’ physiological reactions with the results of psychological questionnaires (the results of which can be treated as a method of examining the effectiveness of psychotherapy), since according to the literature, it would be beneficial to study physiological responses in relation to the effectiveness of psychotherapy [6, 50].

The most important limitation of the presented study was the fact that the study group was very diverse in many respects, and these variables were difficult to control during statistical analysis, because this group was relatively small (12 patients). Patients differed, among others, in diagnosis. Moreover, we did not analyze how EDA and HR changed between patients receiving and not receiving pharmacotherapy. However, according to the study by Birket-Smith et al. [41], patients with anxiety disorders did not differ in the tonic and phasic parameters of EDA, depending on the fact that they were receiving medication, or the group of medication they were receiving (benzodiazepines, tricyclic antidepressants, SSRIs, antipsychotics). Moreover, the fact of taking medications did not change the possibility that patients’ physiological reactions may change during psychotherapy. In our study, we did not examine the individual level of patients’ physiological reactions, but their changes in the initial phase of psychotherapy compared to the final phase regardless of the diagnosis and medications taken.

Another disadvantage of the study is the fact that the data was collected during individual psychotherapy, but patients also participated in group psychotherapy during hospitalization, which could also have falsified the results of the study. Due to the above facts, the pilot nature of the study and the consistent and interesting results, we believe that it would be worth repeating such a study on a larger group of patients in the future.

Another limitation of our study was the lack of information about possible somatic conditions that may affect the outcome of the study. For example, COVID-19 undergone during psychotherapy could affect the reactivity of the sym-

pathetic nervous system of patients [51]. On the other hand, patients who were qualified for psychotherapy treatment in this department could not have serious somatic diseases (which was one of the conditions for admission to the department) [52].

Other limitations of the study were: the use of basic statistical analysis methods, compared to other similar studies on this topic [6]. However, we believe that in the context of our research hypotheses and the results obtained, the statistical methods used were adequate and sufficient. Another disadvantage of the study was the fact that galvanometer we used had a very low sampling frequency of 5 Hz. This is a considerably lower frequency compared to other studies [53].

Another disadvantage was that the measurements were done every 2 weeks. Probably this could have disturbed the continuity of the results presented and the possibility of drawing conclusions from them. However, when analysing the results of our study, the measurements appear to be consistent enough to provide a sufficient data set for the purposes of this study.

Our study seems relevant to potential areas for future research. Research on the effectiveness of psychotherapy has occupied researchers for decades. Currently available research methods allow not only the analysis of the subjective effects of psychotherapy, but also the objective ones. Combining these two methods, as used in our study, could provide extensive data on the effects of psychotherapy. Research on a larger group of subjects and the standard of collecting physiological data at each session of the psychotherapy treatment process could provide more detailed information on this topic.

CONCLUSIONS

According to the results of psychological questionnaires, the conducted 12-week psychodynamic psychotherapy was effective – it resulted in a reduction of symptoms in most of the examined scales. Patients' EDA and HR scores decreased in the final phase of psychotherapy compared to the initial one. The results suggest a positive effect of psychotherapy on patients' physiological activity.

Most of personality disorder traits in patients (measured in the MMPI-2 Inventory) show a negative correlation with EDA and a positive correlation with HR at the beginning of the psychotherapy process. In contrast, the neurotic personality traits (KON-2006) correlated positively with EDA and negatively with HR. At the final stage of the psychotherapy process, a positive correlation was observed between EDA and HR and personality traits in patients measured by clinical scales of the MMPI-2 inventory. This may demonstrate the effectiveness of psychotherapy and its potential impact on changing the direction of physiological reactions of patients with personality disorders.

REFERENCES

1. Lambert MJ, Bergin AE, Garfield SL. The effectiveness of psychotherapy. *Encyclopedia of psychotherapy*. 1994;(1) p. 709-714.
2. Zilcha-Mano S, Ramseyer FT. Innovative approaches to exploring processes of change in counseling psychology: Insights and principles for future research. *J Couns Psychol*. 2020;67(4),409–419.
3. Cyranka, K., Rutkowski, K., Mielimąka, M. (2016). Applicability of Polish adaptation of MMPI-2 questionnaire in diagnosis and monitoring of psychotherapy effectiveness of patients with neurotic and personality disorders. *Psychoterapia*, 177(2), 111-122.
4. Deits-Lebehn C, Baucom KJW, Crenshaw AO, Smith TW, Baucom, BRW. Incorporating physiology into the study of psychotherapy process. *J Couns Psychol*. 2020;67(4),488–499.
5. Kleinbub JR. State of the Art of Interpersonal Physiology in Psychotherapy: A Systematic Review. *Front Psychol*. 2017;8,2053.
6. Wiltshire TJ, Philippsen JS, Trasmundi SB, Jensen TW, Steffensen SV. Interpersonal coordination dynamics in psychotherapy: A systematic review. *Cogn Ther Res*. 2020;44(4),752-773.
7. Stratford T, Lal S, Meara A. Neuroanalysis of therapeutic alliance in the symptomatically anxious: the physiological connection revealed between therapist and client. *Am J Psychother*. 2012;66,1–21.
8. Marci CD, Ham J, Moran E, Orr SP. Physiologic correlates of perceived therapist empathy and social-emotional process during psychotherapy. *J Nerv Ment*. 2007;195,103-111.
9. Ramseyer F, Tschacher W. Nonverbal synchrony in psychotherapy: coordinated body movement reflects relationship quality and outcome. *J Consult Clin Psych*. 2011;79(3),284.
10. Ramseyer F, Tschacher W. Nonverbal synchrony of head – and body-movement in psychotherapy: Different signals

- have different associations with outcome. *Front Psychol.* 2014;5,979.
11. Taylor CI, Tompsett, C, Sanders R, Copley S. The effectiveness of structured exercise programmes on psychological and physiological outcomes for patients with psychotic disorders: A systematic review and meta-analysis. *Int J Sport Exerc Psychol.* 2020;18(3),336-361.
 12. Halamová J, Koróniová J, Kanovský M, Túniyová MK, Kupeľi N. Psychological and physiological effects of emotion focused training for self-compassion and self-protection. *Research in psychotherapy.* 2019;22(2),358.
 13. Park BJ, Shin CS, Shin WS, Chung CY, Lee SH, Kim DJ, Kim YH, Park CE. Effects of forest therapy on health promotion among middle-aged women: Focusing on physiological indicators. *Int J Environ Res Public Health.* 2020;17(12), p.4348.
 14. Kim W, Lim SK, Chung EJ, Woo JM. The effect of cognitive behavior therapy-based psychotherapy applied in a forest environment on physiological changes and remission of major depressive disorder. *Psychiatry Investig.* 2009;6(4),245.
 15. D'Andrea W, Pole N. A naturalistic study of the relation of psychotherapy process to changes in symptoms, information processing, and physiological activity in complex trauma. *Psychol Trauma: Theory Res Pract.* 2012;4(4),438-446.
 16. Leder S. *Psychoterapia, psychiatria społeczna. Wybrane zagadnienia.* Kraków: Biblioteka Psychiatrii Polskiej. 2nd ed. 2004;140-143.
 17. Marci CD, Riess H. Physiologic monitoring in psychodynamic psychotherapy research. In: Levy RA, Ablon JS. *Handbook of evidence-based psychodynamic psychotherapy.* Current Clinical Psychiatry. Humana Press. 2009;339-358.
 18. Tschacher W, Meier D. Physiological synchrony in psychotherapy sessions. *Psychother Res.* 2020;30(5),558-573.
 19. Fraguas Jr R, Marci C, Fava M, Iosifescu DV, Bankier B, Loh R, Dougherty DD. Autonomic reactivity to induced emotion as potential predictor of response to antidepressant treatment. *Psychiatry Res.* 2007;151(1-2),169-172.
 20. Benedek M, Kaernbach C. A continuous measure of phasic electrodermal activity. *J Neurosci Methods.* 2010;190(1),80-91.
 21. Boucsein W. *Electrodermal activity.* 2nd Ed. New York: Springer. 2012.
 22. Greene RL. *The MMPI-2: An interpretive manual.* 2nd ed. Allyn & Bacon. 2000.
 23. Aleksandrowicz J., Klasa, K., Sobański, J., Stolarska, D. KON-2006 neurotic personality questionnaire. *Archives of Psychiatry and Psychotherapy.* 2009;11(1).
 24. Aleksandrowicz JW, Hamuda G. Kwestionariusze objawowe w diagnozie iw badaniach epidemiologicznych zaburzeń nerwicowych. *Psychiatr Pol.* 1994;28,667-667.
 25. Mielimąka, M., Rutkowski, K., Cyranka, K., Sobański, J., Müldner-Nieckowski, Ł., Dembińska, E., Smiatek-Mazgaj, B., Klasa, K. Effectiveness of intensive group psychotherapy in treatment of neurotic and personality disorders. *Psychiatria Polska.* 2015; 49(1): 29-48. <https://doi.org/10.12740/PP/26093>
 26. Sobański JA, Müldner-Nieckowski Ł, Dembińska E, Smiatek-Mazgaj B, Klasa K. Effectiveness of intensive group psychotherapy in treatment of neurotic and personality disorders. *Psychiatr Pol.* 2015; 49(1), 29-48.
 27. Cyranka, K., Rutkowski, K., Mielimąka, M., Sobański, J. A., Smiatek-Mazgaj, B., Klasa, K., Dembińska, E., Müldner-Nieckowski, Ł., Rodziński, P. Changes in personality functioning as a result of group psychotherapy with elements of individual psychotherapy in persons with neurotic and personality disorders – MMPI-2. *Psychiatria Polska.* 2016; 50(1), 105–126.
 28. Cyranka, K., Rutkowski, K., Mielimąka, M., Sobański, J., Klasa, K., Müldner-Nieckowski, Ł., Edyta Dembińska, E., Smiatek-Mazgaj, B., Rodziński, P. Zmiany w zakresie siły ego u pacjentów z zaburzeniami nerwicowymi i zaburzeniami osobowości leczonych krótkoterminową kompleksową psychoterapią psychodynamiczną. *Psychiatria Polska.* 2018; 52(1).
 29. NeuLog <https://neulog.com/> (25)
 30. Aleksandrowicz JW. Kwestionariusz S-II. *Psychiatr. Pol.* 2000; 34(6): 945–959
 31. Marci CD, Orr SP. The effect of emotional distance on psychophysiologic concordance and perceived empathy between patient and interviewer. *Appl Psychophysiol Biofeedback.* 2006;31,115–128.
 32. Cyranka, K., Rutkowski, K., Mielimąka, M., Sobański, J. A., Klasa, K., Müldner-Nieckowski, Ł., Dembińska, E., Smiatek-Mazgaj, B., and Rodziński, P. Zmiany w zakresie siły ego u pacjentów z zaburzeniami nerwicowymi i zaburzeniami osobowości leczonych krótkoterminową kompleksową psychoterapią psychodynamiczną. *Psychiatria Polska.* 2018; 52(1): 115-127. <https://doi.org/10.12740/PP/OnlineFirst/40020>
 33. Butcher JN, Graham JR, Ben-Porath YS, Tellegen A, Dahlstrom WG. *Wersja Polska: Brzezińska U, Koć-Januchta M, Stańczak J. Minnesocki Wielowymiarowy Inwentarz Osobowości®-2 – MMPI®-2.* Warszawa: Pracownia Testów Psychologicznych PTP; 2012.
 34. Kreibig SD. Autonomic nervous system activity in emotion: A review. *Biological Psychology.* 2010; 84, 394–421. DOI: 10.1016/j.biopsycho.2010.03.010
 35. Schneider R, Schmidt S, Binder M, Schaefer F, Walach H. Respiration-related artifacts in EDA recordings: Introducing a standardized method to overcome multiple interpretations. *Psychol Rep.* 2003;93,907–920.
 36. Weinstein, J., Averill, J. R., Opton, E. M., & Lazarus, R. S. Defensive style and discrepancy between self-report and physiological indexes of stress. *J Pers Soc Psychol.* 1968;10,406–413.
 37. Fowles DC. The three arousal model: Implications of Gray's two-factor learning theory for heart rate, electrodermal activity, and psychopathy. *Psychophysiology.* 1980;17, 87–104.

38. Diemer J, Mühlberger A, Pauli P, Zwanzger P. Virtual reality exposure in anxiety disorders: Impact on psychophysiological reactivity. *World J Bio Psychiatry*. 2014;15(6).
39. Avdi, E., & Evans, C. (2020). Exploring conversational and physiological aspects of psychotherapy talk. *Frontiers in Psychology*, 11, 591124. <http://dx.doi.org/10.3389/fpsyg.2020.591124>
40. Perrone-McGovern, K. M., Oliveira-Silva, P., Simon-Dack, S., Lefdahl-Davis, E., Adams, D., McConnell, J., Howell, D., Hess, R., Davis, A., & Gonçalves, O. F. (2014). Effects of empathy and conflict resolution strategies on psychophysiological arousal and satisfaction in romantic relationships. *Applied psychophysiology and biofeedback*, 39(1), 19–25. <https://doi.org/10.1007/s10484-013-9237-2>
41. Birket-Smith M, Hasle N, Jensen HH. Electrodermal activity in anxiety disorders. *Acta Psychiatr Scand*. 1993;88(5), 350-355.
42. Liu Y, Du S. Psychological stress level detection based on electrodermal activity. *Behav Brain Res*. 2018;341,50-53.
43. Norris CJ, Larsen JT, Cacioppo JT. Neuroticism is associated with larger and more prolonged electrodermal responses to emotionally evocative pictures. *Psychophysiology*. 2007;44,823–826.
44. Crider A. Personality and electrodermal response lability: An interpretation. *Appl Psychophysiol Biofeedback*. 2008;33(3),141–148.
45. Lorber, M. F. (2004). Psychophysiology of aggression, psychopathy, and conduct problems: A meta – analysis. *Psychological Bulletin*, 130, 531–552. <https://doi.org/10.1037/0033-2909.130.4.531>
46. Palumbo RV, Marraccini ME, Weyandt LL, Wilder-Smith O, McGee HA, Liu S, Goodwin MS. Interpersonal autonomic physiology: A systematic review of the literature. *Pers Soc Psychol Rev*. 2017;21(2),99-141.
47. Smith, B. D., Wilson, R. J., & Jones, B. E. (1983). Extraversion and multiple levels of caffeine-induced arousal: Effects of overhabituation and dishabituation. *Psychophysiology*, 20(1), 29–34. <https://doi.org/10.1111/j.1469-8986.1983.tb00896.x>
48. Woo, M., & Oei, T. P. S. (2006). The MMPI-2 Gender-Masculine and Gender-Feminine scales: Gender roles as predictors of psychological health in clinical patients. *International Journal of Psychology*, 41(5), 413–422.
49. Stratford T, Meara A, Lal S. Heart rate variability and the anxious client: cardiac autonomic and behavioral associations with therapeutic alliance. *J Nerv Ment*. 2014;202(8),613–619.
50. Rocco D, Gennaro A, Salvatore S, Stoycheva V, Bucci W. Clinical mutual attunement and the development of therapeutic process: A preliminary study. *J Constr Psychol*. 2016;30(4),371–387.
51. Stute, N. L., Stickford, J. L., Province, V. M., Augenreich, M. A., Ratchford, S. M., & Stickford, A. S. (2021). COVID-19 is getting on our nerves: sympathetic neural activity and haemodynamics in young adults recovering from SARS-CoV-2. *The Journal of physiology*, 599(18), 4269-4285.
52. Sobański, J. A., Klasa, K., Rutkowski, K., Dembińska, E., & Müldner-Nieckowski, Ł. (2011). Kwalifikacja do intensywnej psychoterapii w dziennym oddziale leczenia nerwic. *Psychiatria i Psychoterapia*, 7(4), 20-34.
53. Fu D, Incio-Serra N, Motta-Ochoa R, Blain-Moraes S. Interpersonal physiological synchrony for detecting moments of connection in persons with dementia: A Pilot study. *Front Psychol*. 2021;12.