Integrating Theory-Based and Data-Driven Methods to Case Conceptualization: A Functional Analysis Approach with Ecological Momentary Assessment

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Author contributions

S.SCH. developed the study concept, was responsible for the project administration and implementation, performed data collection, analysis and interpretation and drafted the manuscript. T.L. and J.A.G. contributed to the study design. T.L. supervised data collection and analysis. J.A.G. supervised the project and provided critical revisions to the manuscript. All authors approved the final version of the paper for submission.

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Abstract

Background: Ecological momentary assessment (EMA) and network analysis are promising empirical developments for psychotherapy research and practice, but they lack a therapeutic rationale that could guide case conceptualization and treatment planning. **Aim:** We developed an assessment strategy that aims to assess functional analysis with EMA. **Method:** The assessment strategy was applied to a series of three N-of-1 assessments with participants with emotional disorders in a proof-of-concept study. After selecting a personalized set of items, EMA was implemented with three measurement time points per day for a period of 30 days. The participants evaluated feasibility and acceptance. Additionally, practicing psychotherapists discussed clinical implications in a focus group. **Results:** The implementation of the assessment strategy was feasible and accepted; participants did not report any side effects. Principal component and network analyses indicated interpretable components (e.g., participant 1: hopelessness, procrastination, coping, avoidance). The focus group appreciated the potential of the approach, but raised some questions, too. **Discussion:** The presented assessment strategy has the potential to enhance the scientific quality of case conceptualization empowering therapists' decision-making regarding treatment planning. At the same time, it is a concrete demonstration of the challenges that arise on the way and need to be addressed in future research.

Clinical Significance

An empirical approach to case conceptualization is presented capturing components of functional analysis with ecological momentary assessment. The assessment holds the

potential to enhance the scientific quality of case conceptualization and to empower therapists' decision-making regarding treatment planning.

Key words

Cognitive Behavior Therapy; Process Research; Test development; Case conceptualization, Ecological Momentary Assessment

A common experience among psychotherapists in clinical practice is that the presented symptoms of their clients do not suit into diagnostic categories due to multiple problems and comorbidities. Lacking a straightforward categorization, evidence for treatment manuals evaluated in randomized control trials (RCTs) cannot be generalized to their clients because of the narrow inclusion criteria implemented in most RCTs (Shapiro, 2002). Practicing psychotherapists must proceed on their own. This is the gap between mental health research and clinical practice (Burger et al., 2020; Wensing & Grol, 2019).

By now, the "protocol-for-disorder strategy" has also been criticized in psychotherapy research (Hofmann, 2020). Effect sizes for cognitive behavior therapy (CBT) are mostly moderate, with variance depending on the disorder, moderators, and the treatment (Carpenter et al., 2018; Cuijpers et al., 2020). Idiographic research considering transdiagnostic perspectives, specific mental health problems, and mechanisms has received more attention in recent years (Boswell, 2013; Flink et al., 2020). The goal is to "tailor," "individualize," and "personalize" psychotherapy (Wright & Woods, 2020), for example with process-based psychotherapy (PBP; Hofmann & Hayes, 2019b; McCracken, 2020). Shifting the focus from the group-level to idiographic approaches, from treatment manuals to treatment modules or PBP is a necessary first step to foster psychotherapy research. In addition, empirical strategies need to be developed that support and enhance clinical decision-making. Equipping practitioners with empirically supported assessment strategies might help close the gap between research and practice. In the present proof-of-concept study, we present such a strategy for clinical assessment that can be implemented into the therapy process. It integrates theoretical approaches to case conceptualization that are well-established in clinical practice with empirical approaches to data assessment and modeling, offering the potential to complement informed clinical decision-making.

Back to the Roots: Theoretical approaches to case conceptualization

The core of every psychotherapy is its case conceptualization because it includes an explanatory model of the development and maintenance of the disorder and is the basis of theory-based clinical decisions on intervention planning and implementation (Dudley et al., 2011). Also, it has been shown that a well-applied case conceptualization impacts symptom reduction positively (Abel et al., 2016; Easden & Fletcher, 2020; Easden & Kazantzis, 2018).

In practice, there exist different theoretical approaches to case conceptualization: On a *descriptive level*, the five-part model is a robust approach to case conceptualization that can be used with any client issue asking for its thoughts, behaviors, physical reactions, moods, and environmental/situational factors (Padesky, 2020). The box/arrow in/arrow out method can guide analysis of triggers and maintenance factors for specific issues on a *cross-sectional level* (Padesky, 2020). Similarly, Ellis' ABC-model offers a framework to analyze antecedent situations, beliefs, consequences (Ellis, 1958). An early approach that combines descriptive and cross-sectional levels of case conceptualization in psychotherapy practice is functional, or behavioral, analysis (FA; Kanfer & Saslow, 1965; Lincoln et al., 2017). Its roots go back to the early days of pure behaviorism when Watson conceptualized mental health problems as stimulus-response (S-R) and Skinner's S-R-Consequence (C) mechanisms (Watson, 1970). FA can be used for assessment and treatment planning (Mumma et al., 2018), to decrease dysfunctional behavior, and to increase functional behavior, for example, in dialectic-behavioral therapy (Linehan, 1993), cognitive-behavioral analysis system therapy (McCullough, 2003), and nonsuicidal self-injury (Bentley et al., 2017). Since then, numerous theoretical models have been developed to explain the development and maintenance of different disorders that could serve as basis for case conceptualization (e.g., Beck, 1987; Ehlers & Clark, 2000). More recently, Hayes and colleagues (2019) proposed a multi-

dimensional, multi-level evolutionary approach to construct a conceptual space for the examination of adaptive and maladaptive change processes.

Out of all the presented approaches to case conceptualization, FA stands out because it offers a compellingly simple framework to foster flexible idiographic exploration (bottom-up elements) based on nomothetic conceptual sets (top-down elements like behavioral principles) on a descriptive and cross-sectional level (Burger et al., 2020). However, empirical research has widely ignored FA in the past decades for several reasons: the absence of suitable technology to regularly record client processes over time, bulky assessment instruments not designed for repeated use, the absence of extensive and high-density longitudinal datasets, the failure of classical statistical models to deal with the individual, and limited data on treatment components (Hofmann & Hayes, 2019a). Yet, these methodological restrictions can be addressed with recent technological and statistical developments. Therefore, we agree with other authors (Bentley et al., 2017; Burger et al., 2020; Davison, 2019; Hofmann & Hayes, 2019a) that it is time to refocus on FA in psychotherapy research.

New Empirical Opportunities: Ecological Momentary Assessment and Network Analysis

Ecological momentary assessment (EMA) and network analysis (NA) are contemporary and promising developments in psychotherapy research that are suited to support clinical practice (Epskamp, van Borkulo, et al., 2018). With EMA, self-reported symptoms, cognitions, emotions, and behavioral responses can be assessed with mobile or computer-assisted devices numerous times per day in the natural environment of the clients (Ebner-Priemer & Trull, 2009). Thus, EMA enhances ecological validity, minimizes retrospective bias, and increases measurement precision (Wright & Zimmermann, 2019). This

procedure is suited to examine temporal associations between context, experience, and behavior and might allow more powerful predictions about future behavior or the future course of symptoms (Arean et al., 2016; Myin-Germeys et al., 2018; Nelson et al., 2017; Wright & Zimmermann, 2019). Thus, more personalized processes of assessment in mental health leading to more precise models may enhance informed clinical decision making, for example about treatment options that are tailored to patients' needs (Arean et al., 2016; van Os et al., 2017; Wright & Zimmermann, 2019). Even simple graphical feedback of EMA data may enrich clinical practice (van Os et al., 2017). Above that, EMA fosters more active and empowered patients with self-monitoring as a main component of self-management and shared decision-making as a core element of the therapy process (van Os et al., 2017).

Sophisticated approaches to data modelling and statistical analyses for idiographic research have evolved based on these moment-to-moment individual time-series data (Nelson et al., 2017). Among them, the network approach to psychopathology seems particularly useful for clinical practice (Borsboom, 2008, 2017; Borsboom & Cramer, 2013; Hofmann & Curtiss, 2018). It views psychopathology as an interconnected system of symptoms that—after the activation of one or more symptoms—spreads across the network and maintains itself through mutually reinforcing dependencies (Borsboom, 2017; Borsboom & Cramer, 2013). Phenomena such as comorbidity are explained as the interconnection, through *bridge* symptoms between different groups or subgroups of symptoms (Contreras et al., 2019). These symptom dynamics can be modeled statistically using NA. In a nutshell, these psychological networks visualize the dynamic relations (*edges)*, usually statistical coefficients such as partial correlation coefficients, of multiple variables (*nodes)*, e.g., 'fatigue' or 'sadness', at the same time (cf., Bringmann et al., 2013; Fisher et al., 2017). Variables can be elements that are part of the system, e.g., difficulties to concentrate, and features of the external field that

influence the system from outside, e.g., a stressful work environment (Fried & Cramer, 2017). Besides the strength to model and visualize the interconnected system of multiple variables at a time, NA allows to analyze the interrelations of symptoms including the relative importance of nodes in the structure of the network as indicated by *centrality measures* (Bringmann et al., 2019).

Recently, the network approach has been extended to idiographic science (Epskamp, van Borkulo, et al., 2018). In personalized symptom networks, temporal associations are estimated using vector autoregression analyses (VAR) and contemporaneous associations (relationships that occur in the same window of measurement) are estimated using the residuals of the VAR model (van der Krieke et al., 2015; Wild et al., 2010). The analyses result in *temporal networks* that reflect how one variable predicts another variable in the next window of measurement and *contemporaneous (partial correlation) networks* that represent the links between two nodes after controlling for temporal effects and all other variables in the same window of measurement (Epskamp, van Borkulo, et al., 2018). Such personalized networks may be discussed with the patient, offering insights into resources and difficulties (Epskamp, van Borkulo, et al., 2018). Regarding clinical decision-making, *centrality measures* that intend to indicate the relative importance of nodes in the structure of the network and empirically validated, perceived causal relations scaling may be useful to identify and prioritize target symptoms or relations and to construct informed treatment interventions (Borsboom & Cramer, 2013; Bringmann et al., 2019; Contreras et al., 2019; Rubel et al., 2018). In recent years, efforts to individualize and objectify treatment planning based on time-series data have accumulated (David et al., 2018; Fernandez et al., 2017; Fisher et al., 2019). For example, Fisher and colleagues (2019) conducted an open trial for a personalized modular treatment for depression. They developed an algorithm that selects

modules of the unified treatment protocol and also proposes an order for treatment (Fernandez et al., 2017). Thus, a data-based translation of person-specific network models into personalized treatments is a promising perspective for future research and practice (Rubel et al., 2018).

From a psychotherapist's perspective, there is one major caveat to these promising developments. Most studies investigate the mutual interaction of symptoms as defined by Diagnostic and Statistical Manual of Mental Disorders (DSM; Fried & Cramer, 2017). Thus, mental health problems are reduced to symptoms and psychopathological networks. This includes the fact that up till now these models as well as centrality measures fail to differentiate symptoms regarding their responsiveness to psychological treatment and their impact on psychosocial functioning (Fried & Cramer, 2017). Suicidal thoughts may for example have "low centrality" in the network while they are crucial to psychotherapy. Also, precipitating and reinforcing conditions that trigger and perpetuate dysfunctional behavior and actual change mechanisms as the starting points for psychotherapy are not considered. Thus, analysis remain of exploratory and descriptive nature and clinicians cannot incorporate prior knowledge or expertise (Burger et al., 2020).

From our point of view, the empirical developments outlined above are perfectly suited to reline case conceptualizations. Enriching the theoretical and personal heuristics of psychotherapists with the individual data of their patients could contribute to close the gap between psychotherapy research and practice and move our profession forward.

The present proof-of-concept study

In the present proof-of-concept study, we aim to answer the question how FA as a well-established theoretical approach to case conceptualization can be integrated with EMA

and NA as empirical approaches to data assessment and modeling. We propose an assessment strategy that includes a personalized quantitative assessment of elements of FA with EMA. Then, personalized network modeling is used to analyze and depict the relations among variables of FA. Results should have the potential to inform clinical decision-making and enhance individualized treatment planning in psychotherapy practice. Therefore, we evaluated the assessment strategy in terms of feasibility and acceptance with a series of N-of-1 assessments. In addition, psychotherapists were asked for evaluation in a focus group on advantages and disadvantages for clinical practice.

Method

Participants

The study was conducted at a university psychotherapy outpatient clinic. Adults (age ≥ 18 years) with anxiety disorders and/or unipolar depression were included. We selected these conditions because of their high prevalence (Wittchen et al., 2011). Exclusion criteria were comorbid mental disorders, other than depression and anxiety, or suicidality as determined with the Brief Version of the Diagnostic Interview for Mental Disorders (Mini-DIPS; Margraf et al., 2017), as well as illiteracy, insufficient German knowledge, and age < 18 years. Participants were screened for eligibility during the first consultation at the university psychotherapy training center's outpatient clinic. Eligible participants were informed about the study and referred if they agreed to be contacted. The study incentive was an in-depth diagnostic assessment with feedback for both participants and therapists. Out of 10 participants that we screened and contacted, three did not return the questionnaire assessing situations and seven participants were assessed for eligibility. Two participants had to be excluded because they did not meet the inclusion criteria (one did not classify for a mental

disorder, one reported suicidal thoughts). We enrolled five participants in the trial. One participant discontinued the intervention because she was "currently too busy," and we excluded another participant's data from analysis because 49.90% of the data were missing, resulting in three participants being included in subsequent analyses. Figure 1 shows the CONSORT Participant Flow Chart.

Assessment strategy

We propose and evaluate an assessment strategy to assess FA with EMA and to analyze it with NA. It comprises five steps. We summarize the main aspects of the assessment strategy subsequently while a detailed description of the assessment strategy is outlined in the Supplemental Material 1.

(1) Assessment of functional analysis with a set of items

The "SORKC" concept was used to identify and compile a set of items representing variables of FA including situations (S), responses (R) on a behavioral (BR), cognitive (CR), emotional (ER), and physiological (PR) level, and consequences (C) (Kanfer & Saslow, 1965; Lincoln et al., 2017). We did not consider the "organism" (O) and contingency (K) component. Overall, we put together 119 situations, 12 emotional responses, 80 cognitive responses, 46 physiological responses, and 62 behavioral responses to assess elements of FA in a questionnaire. (A complete list of the items, including sources and adaptations can be found here: https://osf.io/6avqh/.)

(2) Personalized item selection for ecological momentary assessment

The lists of situations and responses to select and develop an individual set of 25–35 items for the EMA were assessed and discussed throughout two introductory sessions. The

most relevant situations and responses were selected for EMA and complemented by individually formulated consequences.

(3) Ecological momentary assessment of the personalized subset of items

Subsequently, the individual set of items was presented as a smartphone-enabled web-based survey (SoSci Survey GmbH, 2020). Participants received a reminder at three individually chosen times per day for a period of 30 days and were asked to respond thinking about the period since the last survey. One daily assessment took 3–5 minutes to complete.

(4) Application of network analysis

Descriptive statistics, principal component analysis (Molenaar & Nesselroade, 2009), and contemporaneous and temporal networks (Epskamp, van Borkulo, et al., 2018) were estimated to analyze and visualize relationships between variables. We discussed the results with the participant subsequently in a closing session.

(5) Using centrality measures to identify targets for treatment interventions

Node strength was estimated as an index of centrality (Bringmann et al., 2019). Most central nodes were considered from a clinical perspective as potential targets for treatment interventions.

Procedure

The outlined assessment strategy was applied to a series of N-of-1 assessments. Before and after the EMA, we assessed negative and positive mental health using the Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983) and the Positive Mental Health Scale (PMH; Lukat et al., 2016; see Supplemental Material 2 for more detail). (The procedure along with the respective assessment instruments is outlined in Table 1). Three advanced master's

students were trained and conducted the assessment under the supervision of a licensed psychotherapist following a standardized protocol (https://osf.io/42mvp/). The study protocol was registered (Scholten & Glombiewski, 2019) and approved by the institutional review board of the psychology department at the University of Landau, Germany. Informed consent was obtained prior to conducting the assessment strategy.

Evaluation of Feasibility and Acceptance

We evaluated the assessment using a mixed-method approach considering the perspective of the participants as well as the feedback of practitioners. Following Larsen et al. (1979), we constructed a feedback questionnaire for participants (https://osf.io/3p7dg/); it targeted feasibility, effects, and general evaluation and comprised 28 statements (e.g., “Time and effort were adequate.”; “The assessment interfered with my everyday life.”) rated on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Additionally, we conducted a semi-structured interview in the final session asking for expectations, positive and negative effects of the study, feasibility, and general feedback (https://osf.io/g7f4z/). To bridge the gap between science and practice, we conducted a focus group with practicing psychotherapists and supervisors to identify potential obstacles for the implementation of the assessment in practice and to receive a general practitioner feedback (https://osf.io/gxh6j/). The documentation of the semi-structured interviews as well as the minutes of the focus group were analyzed with qualitative content analysis according to Mayring (2015). We used inductive category building to identify the most relevant aspects of the participant and practitioner feedback.

Results

For brevity reasons, we will present the detailed results only for participant 1, while the results of participant 2 and 3 are described in the Supplemental Material 4. Because the study was designed as an N-of-1 assessment, these results may allow the reader to get the picture of the assessment strategy's potential.

Participants

Participant 1 ("Bill")—diagnosed with social anxiety disorder, specific phobia (of driving), and persistent depressive disorder—was male, 30 years old, held a university degree and was currently employed. In the pre-assessment, the BSI total score was above average (M = 1.32, T-value = 77) with a maximum symptom score for depression (M = 3, T-value = 80), while the PMH also indicated some experiences of positive mental health (M = 1.33). The post-assessment showed a slightly higher BSI total score (M = 1.36, T-value = 80) with the highest symptom scores for depression (M = 2.83, T-value = 80) and psychoticism (M = 1.4, T-value = 80), but also a slightly higher PMH (M = 1.44). Emotional deprivation (pre: M = 6; post: M = 6) and defectiveness/shame (pre: M = 6; post: M = 5.6) were the most prominent maladaptive schemata in the YSQ-SF3 in the pre- and post-assessment. His reminders for the daily assessments were sent at 12 a.m., 4 p.m., and 8 p.m. His response to the reminder had a maximum delay of 16 minutes. The average processing time was 1 minute per assessment. Overall, 3.33% of the variables were missing at random.

Descriptive Analysis, Inter-Item Correlations, and Principal Component Analysis

For Bill, 31 variables were included in the individualized daily assessment. All variables had standard deviations > 0.10 and responses varied across response options so that

no response category had more than 80% of the responses. Inter-item correlations varied between $r = .00$ and $r = .99$ (SI07 & BR03). Due to the large correlation and its lower SD, we excluded variable SI07 from further analysis. Parallel analysis suggested four components, labeled "hopelessness," "procrastination," "coping," and "avoidance." Descriptive results and the results of the principal component analyses are depicted in Table S1 in the Supplemental Material available online. Inter-item correlations can be found in Table S2.1-S2.3.

Network Analysis

Eight networks were modeled for Bill (Figure 2). The *temporal networks* indicated that "difficulty to concentrate" (PR03; $r = .41$) predicted concentration problems in the following assessment. The variables "I will never come to terms" (CR02; $r = .15$), "I'd like to chuck it all" (CR06; $r = .17$), and "loss of energy" (PR02; $r = .17$) also predict themselves in the following assessment. Furthermore, "burning chest" (PR01; $r = .16$) and "I shouldn't feel this way" (CR04; $r = .13$) predicted "I had financial restrictions" (SI03) and CR04 predicted CR06 ($r = .11$) in the following assessment. All other relations were < .10. In the *contemporaneous network* of the *"hopelessness"* component, the strongest relations were between the physiological response "burning chest" (PR01) and the emotional response "anxiety" (ER02; $r = .19$), followed by the relation between the situation "I had financial restrictions" (SI03) and the physiological reaction "burning chest" (PR01; $r = .11$), emotional reaction "anxiety" (ER02; $r = .11$), and the cognition "I'd like to chuck it all" (CR06; $r = .07$). "Anxiety," "burning chest," and "I had financial restrictions" had the largest centrality values. The contemporaneous network of the *"procrastination"* component indicated the strongest relation between the cognitive response "I can't bring myself to begin with something" (CR01) and the behavioral response "I didn't take over a task" (BR01; $r = .37$). The cognition

CR01 had the largest centrality value. The strongest relation in the contemporaneous *"Coping"* network was the emotional response "relief" (ER01) and the physiological response "relaxed chest" (PR04; r = .47). The latter also had the greatest centrality in the network. Finally, the relation between the consequences "I didn't give others the opportunity to offend me" (CO03) and "I isolated myself from my social contacts" (CO04; r = .09) and the situation "I wasted time" (SI02) with the behavioral response "I put off an overdue task" (BR04; r = .11) were the strongest relations in the network of the contemporaneous *"avoidance"* component and BR04 had the largest centrality.

In sum, Bill's main problematic behavior concerns procrastination and avoidance of relevant tasks in combination with physically noticeable symptoms of anxiety while worrying about his financial restrictions. Nevertheless, the results also showed that he can relax when he exercises, which is an important resource. Building on this resource, behavioral activation might be the psychotherapeutic intervention of choice.

Evaluation of Feasibility and Acceptance

In the participant feedback questionnaire, all three participants agreed that the instruction was easy to understand (M = 4.7), the implementation easy to administer (M = 5), the handling effort was adequate (M = 5), and participation did not impair everyday life (M = 1.7). We successfully personalized the daily assessment: All three participants rated that all their items appropriately represented their personal state (M = 5) and were neither too specific (M = 1) nor too general (M = 1). Overall, they indicated that they had benefitted from the assessment (M = 4.3), would participate again (M = 5), and would recommend it to other participants (M = 5).

In the semi-structured interview, participants reported high *acceptance* (21 statements), personal *benefit* (17 statements), and some factors that facilitated or impeded *practicability* (12 statements). For example, regarding *acceptance* Bill and Bob reported that they were satisfied and comfortable with the assessment. Susan stated that it was especially positive at the beginning. All participants reported that duration and frequency of the assessment felt appropriate. Bill and Bob requested that the results should be given to their future psychotherapist because they wanted to use them in their psychotherapy. Concerning *benefit,* all participants indicated that the assessment was useful during the waiting time. Bill reported that essential problems were identified, and self-reflection was enhanced. In addition, Susan stated that the assessment uncovered positive experiences in her everyday life. Bob mentioned that the structure of FA helped to clarify his problems, a phenomenon that he perceived as a good preparation for psychotherapy. With respect to *practicability,* Bob reported that the assessment was feasible in everyday life as the questionnaires were at hand and easy to administer via mobile phone. On the other hand, Bill and Bob raised the possibility that participants could get used to the questions and respond to them without consideration. Susan remarked that she sometimes had trouble completing the daily assessment when she was doing especially badly.

The focus groups comprised six psychotherapists (33% female; M_{age} = 33 years; $M_{\text{professional experience}}$ = 6 years; minimum = 1 year, maximum = 19 years). In addition, we asked 21 well-advanced psychotherapists (52% female) the key and ending questions of the questioning route during a cooperation meeting after presenting the results. The focus group mentioned the following positive aspects: efficient profit of the waiting time; helpful (diagnostic) information for psychotherapy such as an overview about relevant situations and responses; additional focus on positive aspects; and self-monitoring and structure of FA that

patients learn and that enables them to become active right away. The psychotherapists criticized that the chronological order of functional analyses guided the order of the questions in the assessment but was not represented in the assessment or NA. They also noted that because a lot of information is assessed, it is hard to prioritize and the results are difficult to interpret for practitioners. Important aspects such as suicidality might be overlooked. The additional value to current diagnostic procedures is not clear if the effort remains intensive and extra analysis by the psychotherapist is necessary. The panel proposed a more intuitive presentation of the results as well as support to understand and interpret results to enhance implementation in clinical practice. The focus group generated several ideas for future use: implementation in regions where there are shortages in psychotherapy supply to enhance the efficiency of this modality; therapeutic use, for example, to monitor warning signals or to add items with functional behavior (such as alternative thoughts or coping behavior) as an intervention to remind and monitor patients therapy successes; and further develop the assessment with machine learning.

Discussion

The present study set out to integrate FA as a well-established theoretical approach to case conceptualization with EMA and NA – both representing recent advances in data collection and modeling – by developing a novel assessment strategy. In our approach, we were first able to compile lists of items that allow a computer-assisted assessment of elements of FA. Second, personalized item subsets that reflected individually relevant contents of FA could be selected based on relevance and intensity ratings, frequency, and participant's feedback in a shared decision-making process with the respective participant. Individually developed and formulated consequences complemented the personal selection of the most

relevant items for each participant's daily assessment. Third, we assessed the personalized item subsets three times daily for thirty days. Three quarters of the patients responded to the daily assessment in at least 80% of the incidents; their compliance was good. Fourth, we found few temporal relations when we applied NA, but the networks showed clear contemporaneous relationships that allow conclusions about relevant functional and dysfunctional behavior patterns, which could be used for psychotherapy planning. Fifth, centrality measures indicated most relevant variables in the networks.

This assessment strategy was evaluated in terms of feasibility and acceptance in a proof-of-concept study with a final sample of three participants with the diagnosis of anxiety disorders and/or unipolar depression. Participants accepted the assessment strategy and found it feasible. They did not report any side effects. In addition, in a focus group, practitioners feedback indicated that the general idea of the assessment strategy was promising, but they also pointed to some challenges that need to be overcome.

Strengths

A major advantage of the assessment strategy is its potential to support and enhance (shared) clinical decision-making processes. Specifically, conducting a FA through EMA, the subjective report was taken out of the therapy room into the natural environment of the participants, thereby reducing retrospective bias. Moreover, our approach indicated more than just one trigger of different dysfunctional behavioral responses and allowed to examine their temporal and contemporaneous associations. Practicing psychotherapists highlighted that the collected individualized information complement current diagnostic procedures. NA allowed to model and visualize the relation of subsets of the included variables (Kroeze et al., 2017). Using elements of FA as variables enabled us to investigate psychological processes and

shifted the focus away from symptom descriptions and classification of disorders (Hayes et al., 2020). From a clinical perspective, the assessment strategy may facilitate the objectification of psychotherapists' heuristics of the patients' mental health problems and enhance treatment planning (Arean et al., 2016; Wright & Zimmermann, 2019). It may also hold the potential to balance current differences between novice, experienced and expert therapists in case formulation because it comprises a standardized, data-based approach to FA (Eells & Lombart, 2003). In addition, the presented assessment strategy also included personal resources broadening the scope of participants' foci to negative and *positive* dynamics. In line with previous findings, the assessment strategy also promoted patients' self-monitoring and added to their self-reflection (van Os et al., 2017).

Challenges, limitations, and future research

At almost every step in developing and conducting this assessment strategy, we took risky choices in the absence of specific prior work guiding us [1]. The empirical assessment of FA (steps 1-3 of the assessment strategy) brings about conceptual and practical obstacles: First, regarding the development of lists of items that allow to assess FA empirically, the use of the classic S-R-C variables might have limited the focus and potential of FA. From an evolutionary perspective, attentional, motivational, and social/cultural variables could be taken into account as well (Hayes et al., 2019). In addition, we decided to exclude the "organism" variable because we assumed that core beliefs or schemes do not vary daily. Future research should investigate how typical schemes could be assessed daily and whether

[1] Minor challenges, limitations, and perspectives on future research are outlined in the Supplemental Material 5.

responses vary depending on the presence of particular schemes and the intensity of their presence. Second, the selection of items for the daily assessment holds the risk that identified components and networks are man-made. The limited number of variables might allow only a few meaningful combinations. Hence, components and networks might only represent optimal fit of reasonable variable combinations. It would be interesting to analyze whether FA assessed in a one-by-one in-session setting corresponds to - or differs from - the findings with EMA. We expect that despite the experts' impact on the item selection, more information can be generated assessing FA with EMA. Third, while three out of four participants completed the assessment with a sufficient response rate, one did not. Unfortunately, this participant was not available for a final session to find out the reason for the limited responses. We assume that the participant did not have the steadiness and motivation necessary for EMA. It is important to think about strategies that could enhance compliance and motivation such as little "cheer-ups" (Ebner-Priemer & Trull, 2009). On the other hand, a lack of motivation for the EMA might indicate a general lack of motivation for therapeutic change; this eventuality might be an important indicator for psychotherapy planning (van Os et al., 2017). The focus group remarked that EMA was not event-related. Instead, participants still retrospectively reported how relevant the preselected situations had been prior to the current sampling occasion. The optimal solution to this problem would be event-related sampling, ideally based on physiological parameters as well, e.g., using movement or additional heart rate (the heart rate accelerates even though there is no change in activity; (Ebner-Priemer et al., 2013).

Analyzing the data with NA and evaluating centrality indices for therapy decisions (step 4 and 5 of the assessment strategy) comes with several challenges and limitations that are prone to NA in general, but limit the interpretation of our personalized FA networks, too: We decided to conduct EMA for 30 days three times per day as a balance between enough

sampling occasions and reasonable demand for the participants. However, the statistical power of the collected data was not sufficient to calculate a network with all variables, an approach that would have been interesting (Epskamp, Waldorp, et al., 2018). Van Os and colleagues (2017) claim that a sampling scheme with eight random signals per day and no more than 30 items is generally feasible for use in routine clinical practice. It might be necessary to test different sampling schemes to derive an optimal balance between the maximum number of sampling occasions while sustaining a reasonable demand for participants and ultimately to improve power. An unexpected finding were the few temporal relations we found in the networks because we would expect that at least consequences impact future situations and responses. However, this outcome does not indicate that temporal relations do not exist. There is a possibility that the time periods between the sampling occasions were too large to assess temporal relations. Instead, such temporal relations show up in the contemporaneous networks as partial correlations of the correlated residuals of the temporal network (Epskamp, van Borkulo, et al., 2018). More sampling occasions per day and thus smaller time frames might be able to capture better the punctuation of FA and amend modeling the functional relations with networks.

Another question is whether reasonable therapeutic conclusions can be drawn for the selection of process-based interventions based on, e.g., centrality indices (Fisher et al., 2019; Kaiser & Laireiter, 2017; Rubel et al., 2018), expected influence (Fisher et al., 2019; Kaiser & Laireiter, 2017; Rubel et al., 2018), or other statistical analysis such as automated impulse response analysis (Robinaugh et al., 2016). Such a straightforward conclusion might not be viable because the same multifunction intervention may work for different problems, while different interventions may situationally work for the same ones (Blaauw et al., 2017). Also, different choices might be made depending on the person who is identifying and selecting the

variables with the participant. Furthermore, additional decisions are made throughout data analysis. The results are still a matter of professional experience and procedure, a factor that may also result in different treatment plans. Bastiaansen and colleagues (2019) gave the same individual patient's EMA dataset to 12 research teams with the question "What symptom(s) they would advise the treating clinician to target in subsequent treatment?" The data analysis, statistics, and the number and nature of the selected targets varied widely. Future research should answer the question how we could move from FA to intervention (Hayes et al., 2020). At this point, it is important to note that the aim of the assessment is not a technical replacement of professional case conceptualization, but to support psychotherapist decisions by an objectification and expansion of the data assessment, which is the foundation of the decision. The actual clinical impact of the assessment strategy still needs to be determined in future studies.

A basic limitation of idiographic research is that results cannot be generalized. Instead, participants need to be characterized precisely so that they can be pictured clearly. It is a limitation of our study that we did not assess ethnicity and culture, nor income and socioeconomic status. We only used existing sociodemographic data as assessed by the university psychotherapy outpatient clinic. In addition, generalizability of our results regarding feasibility and acceptance is questionable because the sample might have been selective. Five of the ten persons that were screened for participation did not enroll in the first place and one discontinued participation after the first introductory session. We could have received a more critical feedback with more numerous and diverse participants. However, the study may serve as a proof-of-principle to inspire future research (Leung, 2019).

Conclusion

Up till now, we lack empirical strategies to support and enhance clinical decision-making that take into account well-established theoretical approaches to case conceptualization. The presented assessment strategy[2] is a concrete demonstration that it might be possible to revitalize FA by moving it into a more idiographic EMA direction. At the same time, it is a concrete demonstration of the difficulties that arise on the way and need to be addressed in future research. If we follow this path, we strengthen practicing psychotherapists scientifically and may contribute to the improvement of the effectiveness of psychotherapy in routine clinical practice.

[2]We call it "POINT-Assessment" with POINT standing for Process-Oriented Individualized Network-based Therapy because the assessment strategy aims to support clinical decision-making in psychotherapy that is personalized and focused on psychological processes.

538 **Figure 1**

539 CONSORT participant flow chart

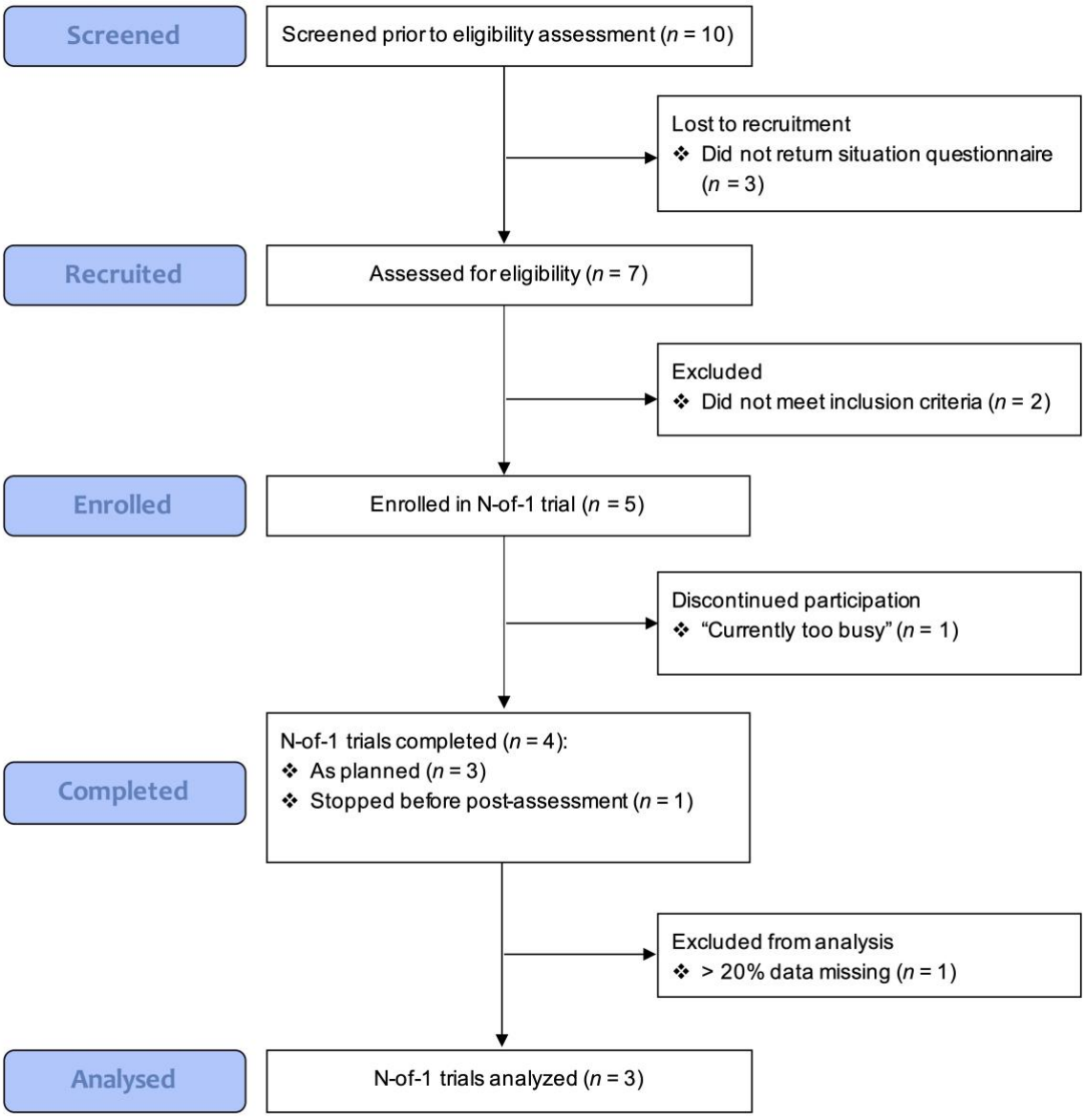

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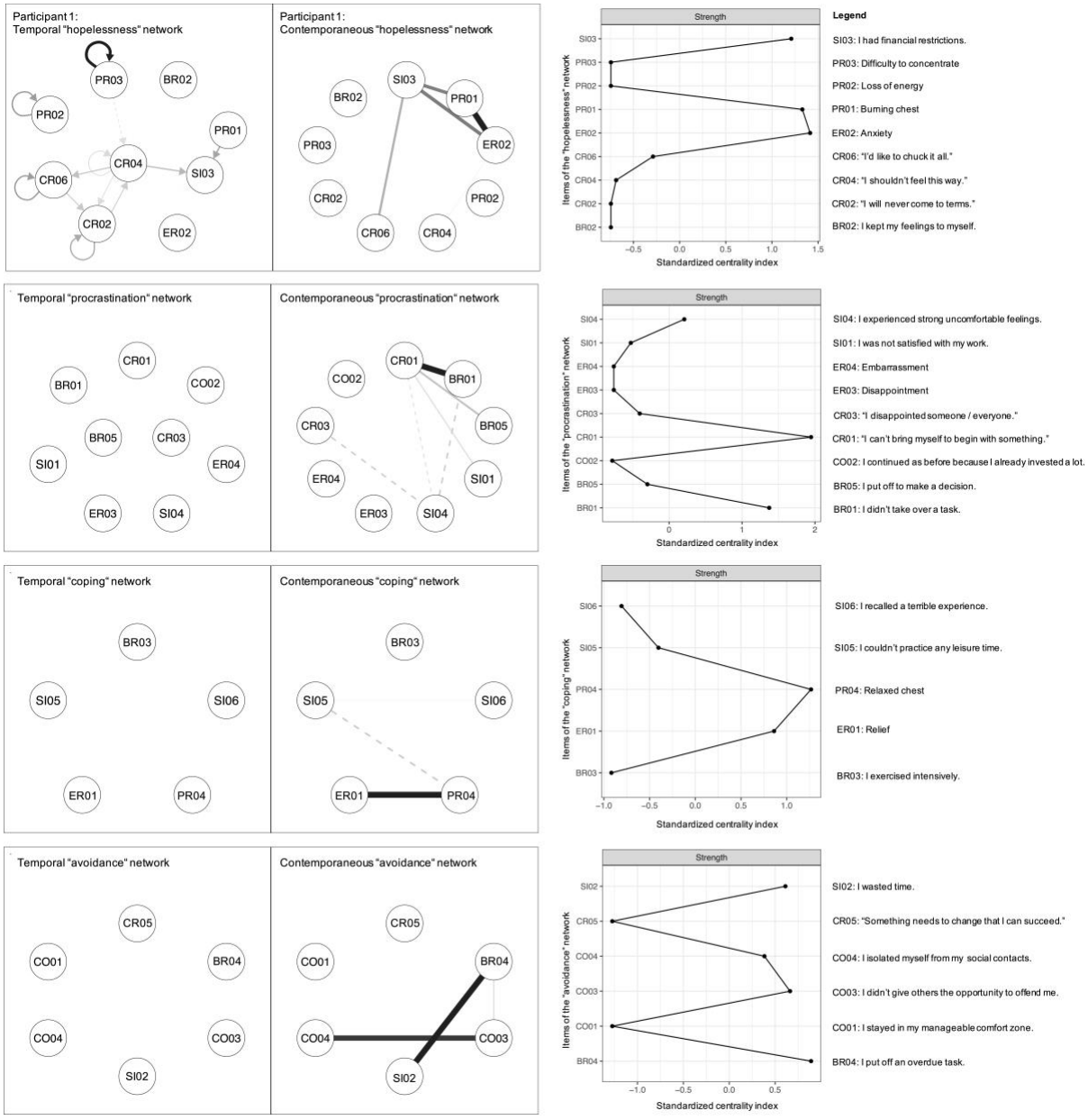
Figure 2

Temporal and Contemporaneous Networks and Node Strength for “Bill”



Note. The figure shows temporal and contemporaneous networks for participant 1 as well as the standardized outstrength as the centrality index. The network structures were estimated using the graphicalVAR package for R based on behavioral clusters identified with principal component analysis. Circles (nodes) represent variables of the individualized functional analysis and connections indicate predictive relationships. Undirected relationships are drawn as simple lines and directed relationships are drawn as arrows. Solid lines indicate positive relationships, while dashed lines indicate negative relationships. Width and saturation of a link indicate the strength (absolute value) of the relationship. The networks on the left show

the temporal networks for the separate behavioral clusters. The link indicates that one variable predicts another variable in the next window of measurement. The contemporaneous networks of all behavioral clusters are presented in the middle part of the figure. Links denote partial correlations between variables in the same window of measurement after controlling for all other variables in the same window of measurement and all variables of the previous window of measurement. Standardized outstrength is depicted as centrality index for all separate behavioral clusters on the right side.

Table 1

Overview of the Assessment Strategy in terms of Procedure and the Respective Assessment Instruments

Procedure	Assessment instruments
Screening	
Patients were screened for study suitability throughout the consultation at the university psychotherapy outpatient clinic	
Telephone call	
Suitable patients were contacted via telephone, informed about the study, and invited for a first session	First part of the assessment: Patients received a paper-pencil version of 119 internal and external situations by mail (https://osf.io/c7q8k/)
First session	
Participants were assessed for eligibility, informed consent for participation was obtained, and an individual set of relevant situations was selected.	Diagnostic Interview (Mini-DIPS; Margraf et al., 2017) Second part of the assessment: Participants filled out the list of responses online after the session. It comprises: 12 emotional, 80 cognitive, 46 physiological and 62 behavioral responses (https://osf.io/swbxz/)
Second session	
Eligible participants were introduced to functional analysis, an individual set of relevant responses was selected, individualized items to assess personal consequences were developed, and times for the daily assessment were chosen.	Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983; Franke, 2000) Positive Mental Health Scale (PMH; Lukat et al., 2016) Young Schema Questionnaire - Short Form 3 (YSQ-SF3; Kriston et al., 2013)
Daily assessment	
The individual set of items was presented for 30 days three times per day.	Individual set of items assessing situations and emotional, cognitive, physiological and behavioral responses, and consequences (~25–35 items)
Closing session	
The results were presented and discussed with the participants and participant feedback was assessed.	Feedback interview Online evaluation BSI, PMH, YSQ-SF3

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