# Lifestories Across the Lifespan:

# Meaning, Well-being, and Methodological Issues

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**Abstract**

*Comprehensive Overview*

This dissertation starts with a theoretical section that is composed of general foundations and reflections about the fundamental concepts and analytical models. The second chapter presents own but attended research which is framed by these essential thoughts. The general discussion reconsiders seminal conclusions, critically disputes the overall outcomes, and elaborates on research questions that emerged from the findings in view of posterior knowledge of this work.

*Research Activity and Empirical Studies with Reference to this Dissertation*

(1) A review article presents comprehensive reflections about age-graded interventions that are evident from research on reminiscence and aging, the results are reflected within their respective conceptual and empirical context. Presentation of meta-analytical findings and evidence from a random controlled trial (RCT).

(2) Experimental RCT in trauma analogue paradigm explores three brief interventions in a psychopathology model with zero result. Evidence of optimal model complexity on: measurements, choice of outcomes, external validity. Statistical analyses use (a) General Linear Model (GLM) and (b) Latent Growth Curve Modeling (LGCM) within Generalized Equation Estimations (GEE).

(3) Temporal framing is studied in a cross-sectional correlational design. The analytical model evaluates measures of well-being and life quality whether they are predictive of a balanced time perspective. Accuracy is externally assessed by cross-validation and ranges in the upper percentile of correct predictions of balancedness. Adding the present time to the model raises the quota of explained variance, showing that time perspective (TP) has a three-dimensional structure. The usage of compound indices incrementally increases fit, suggesting that the metric indicators outperform the originating scales. Furthermore, the results propose a differentiated indication of their usage, depending on whether measuring absence or proximity is the objective. Methodological considerations ought to prioritize establishing a vague prior on even baserates which is precedent in classification tasks. Subjective well-being varies between balanced and unbalanced observations. Linear Discriminant Analysis (LDA) applies.

*Conclusion*

The recognition of self-reflective sameness creates a lifestory of purpose, coherence and meaning. Autobiographical reasoning operates a variety of cognitive-emotional processes, whereby reminiscence and time perception are important.

## Zusammenfassung

*Überblick*

Die Dissertation beginnt einleitend mit einem Überblick und erarbeitet die konzeptionellen und methodischen Grundlagen, die im Weiteren grundlegend sind. Der zweite Abschnitt präsentiert die eigenen empirischen Forschungsarbeiten, diskutiert sie im jeweiligen Kontext und vertieft spezifische inhaltliche oder methodische Details. Die allgemeine Diskussion erörtert übergeordnete Schlussfolgerungen, setzt sich mit den Inhalten kritisch auseinander und stellt Forschungsfragen vor, die sich aus den Erkenntnissen dieser Arbeit posthoc ergeben.

*Eigene Forschung in dieser Dissertation*

(1) Der Überblicksartikel diskutiert Interventionen aus dem Anwendungsbereich der Reminiszenzforschung und berichtet zu empirischen Befunden, u.a. Ergebnisse aus einer Metaanalyse und einem randomisiert kontrollierten Trial (RCT). Erörterung altersgerechter Rahmenbedingungen von Psychotherapie und ihr differenzieller Bedarf entlang der Lebensspanne.

(2) Experimentelles RCT im Trauma-Analog Paradigma. Vergleich von drei Kurzinterventionen in einem Psychotherapiemodell berichtet ein Nullresultat. Evidenzbasierte Empfehlungen zu: Anzahl der Messungen, Auswahl der empirischen Kriterien, externe Validität. Die statistischen Analysen verwenden (a) das Allgemeine Linear Modell (GLM) und (b) das Latente Wachstumskurvenmodell (LGCM) innerhalb der Verallgemeinerten Schätzgleichungen (GEE).

(3) Querschnittsstudie in einem korrelativen, quasi-experimentellen Design zum Wohlbefinden und Zeiterleben. Eine balancierte Zeitperspektive ist ein robuster Prädiktor von subjektivem Wohlbefinden und Lebensqualität. Die Modellgüte ist exzellent und liegt im oberen Perzentil korrekter Vorhersagen. Die Ergänzung der Gegenwart erhöht den Anteil aufgeklärter Modellvarianz, was eine drei-dimensionale Struktur der Zeitperspektive aufzeigt. Verdichtete, zusammengefasste Indikatoren verbessern die Modellgüte inkrementell; außerdem unterscheidet sich ihr Anwendungsbereich zur Vorhersage von Balanciertheit. Klassifikationsaufgaben erfordern eine ausgewogene Basisrate. Subjektives Wohlbefinden unterscheidet sich zwischen (un-)balancierten Beobachtungen. Verwendung der Linearen Diskriminanzanalyse (LDA).

*Schlussfolgerung*

Autobiografisches Schlussfolgern, das selbstreflexive Erkennen von Absicht, Bedeutung und Kohärenz erschafft eine stimmige Lebensgeschichte; es moduliert eine Vielzahl kognitiv-emotionaler Prozesse, die in der Reminiszenz und für die Zeitwahrnehmung grundlegend sind.

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# 1 Introduction

Lifespan development unfolds through transitions in a biopsychosocial space. The trajectory pictures lifelong choice or adaptation and emerges in the service of intentional self-development. The underlying psychological processes are motivated and have direction, although outcomes may differ from the originating intent. From lifespan perspective, a distinction is drawn between normative transitions and life events of more or less (un-)systematic occurrence. Developmental tasks show age-graded variance is specific in a certain culture or population, while life events in general correspond to either cohort-graded incidents or relate to incidents in an individual biography. As future events are uncertain, so is human behavior undetermined, but knowledge of both the past and the current state allows to reasonably predict future connecting directions. Maintaining or to recover plasticity is fundamental in functional development, as opposed to constrictive and maladaptive adjustment. Failing mastery in developmental tasks or lack of coping with life events increases the odds of mental distress and disorders.

The conceptualization of a self is closely related to motivation, volition and intent. Self-formation arises in autobiographical reasoning from the experience of sameness and coherence. Indicators and models vary, depending on the respective theoretical foundation. A nomological network of identity deployment builds on exploration and commitment to measure consistent engagement across life domains. As both can be either high or low, identity can be decomposed into four maturity states: achievement, moratorium, foreclosure, and diffusion (Maehler & Hernández-Torrano, 2025; McLean & Pratt, 2006). The lifescript account uses the rate of spontaneous recall in order to allocate life episodes that are of particular relevance in a biography. It is hypothesized that elevated recall maps phases of self-formation (Berntsen & Rubin, 2002, 2004; Rubin & Berntsen, 2003; Rathbone et al., 2008). Free recall of any past event highlights individual relevance whereby systematic pattern indicate normative change, resulting in age-graded transitions. The lifestory account adds the concept of a reflective self and centers on autobiographical reasoning. Neither frequency nor a scripted recall guide the recollection of memory, but the recognition of a coherent biography (McAdams et al., 2001, 2004; McAdams, 2024; McLean et al., 2020). It is argued that attention and reminiscence are inherently selective in the service to create coherence and meaning.

In developmental lifespan psychology, life meaning is currently receiving scientific attention. The corresponding models postulate that *reasoning* is central to psychological functioning. In consequence, purpose and valued goals are essential to intentional self-development (McLean & Fournier, 2008; McAdams, 1995). Accordingly, it is important to *comprehend* the

course of biographical transitions and changes. To socially reminisce and to share memories supports self-regulatory competence. Coherence has recently also been linked to well-being and life quality, proposing a salutogenetic effect (Kapoor et al., 2023; McLean et al., 2020). Moreover, the concept of life meaning provides promising applications in treatment of mental disorders, supplementing existing guideline therapy. For instance reminiscence interventions, Life Review Therapy (LRT) and Narrative Exposure Therapy (NET), in both of them the recovery of coherence and meaning is fundamental. This approach perfectly adds to evidence-based interventions such as cognitive restructuring or exposition and habituation in Cognitive Behavioral Therapy (CBT). A narrative treatment can be tailored to the needs and even offered to the most vulnerable individuals, e.g. the elderly, especially in concern of psychotrauma or lasting grievance.

## 2 Theoretical Background and Methodological Considerations

### *2.1 Lifespan Perspective in Developmental Psychology*

A theory-driven account has to provide a classification system to clarify the causes that carry on change. Although individuals develop in time, just life age lacks explanatory power and rather is a covariate of methodological relevance. (a) The life*script* approach takes the view of normative trajectories that correspond to highly expectable life events that are given in a cultural context (Berntsen & Rubin, 2004). (b) The life*story* account centers on autobiographical reasoning in the service of narrative inference whereby coherence and meaning are being construed (Glück & Bluck, 2007). In agree with either understanding, elevated recollection attributes to self-defining memories during particular life episodes. Models have to specify, which processes are psychologically essential to account for lifelong development and adaptivity. Systematic sources of change can be classified as follows:

(a) Normative development describes age-graded transitions that can be observed in the majority of persons in a certain population. Biological maturation applies next to sociocultural space as well. (b) Cohort effects result in history-graded trajectories so that experience differentiates by life conditions that have been commonly shared. Individuals of approximately the same age will be similar, reasoned by cohort-specific adaptations. Examples are catastrophes, war, severe economic conditions, pandemic, climate change. (c) Life events of unsystematic expectancy may be conceivable, but none of them is age-graded or normative. (c.1) An incident is unprepared, comes by (bad) surprise or is a threat in case of critical life events. (c.2) Outcomes or current living conditions may not have been intended, but previous decisions have influenced life, although. Living conditions or individual states conflicting with intentional self-development are likely to

raise cognitive effort to adjust for the experience of dissonance. To give comprehensive examples: Indeterminacy of life and multidirectionality of causes, such as loss, alienation, crime and victimization, severe diseases, accidents, settlement, acculturation.

A theory-based lifespan account spans a broad nomological network. In general, events that are relevant to the individual are likely to be processed, especially if the consequences have changed life and are still holding on. The reminiscence bump refers to elevated recall that peaks during certain life episodes (Rathbone et al., 2008). Normativity is conceptualized by the use of a *lifescript* that serves as a retrieval strategy, resulting in episodically concordant reminiscence among individuals (Berntsen & Rubin, 2002, 2004; Rubin & Berntsen, 2003). But to explain selective recall has to be taken into account that these phenomena can also be attributed to memory effects and is therefore related to neuronal processes in the brain. Memory of age tends to fade out, similar to events that are irrelevant or bear negative connotations, while recent events or those of positive valence are more likely to be remembered. Anyhow, recall frequency may differ from actual occurrence, but reminiscence still is linked to the normativity of a lifescript (Berntsen & Rubin, 2004; Rubin & Berntsen, 2003).

Identity formation originates in the experience of sameness and builds on the accumulation of self-reflective memories that are in line with goal preference across the lifespan, appearing as trajectories of choice. Related mental processes are exploration and commitment, establishing chronological consistency and semantic coherence, and joining contexts across time (McLean & Pratt, 2006). *Reasoning* about life introduces the concept of a narrative self. The intent of reminiscence, why to remember, is explained by memory relevance and salience. Exhaustive cognitive processing indicates matter, either corresponding to engagement in life topics or while experiencing dissonance (*see chapter on Connecting Research Questions in Future Directions*). Accordingly, life episodes and events of individual significance are likely to be recaptured, because they have intent (McAdams, 1995; McAdams et al., 2004; McLean & Pratt, 2006; McLean et al., 2020). From this point of view the self *is* a story in essence.

Autobiographical reasoning operates on cognitive-emotional processes that serve as the functional building block to construe coherence and to create meaning. In this approach, self-reflective cognitions are of communality in order to compose memory (ibid.). The psychosocial construction of a narrative self accomplishes a *lifestory* that is about the evaluation of past events by joining experiences of salience to a coherent and meaningful tale.

## *2.2 Narrative Identity*

The identity (status) is described by mastery and maturity in the procedural context of engagement, exploration and commitment. During self formation and in the service of intentional self-development, purpose, meaning, and valued goals establish on the most advanced level of cognitive-emotional functioning (McLean & Fournier, 2008; McAdams, 1995). On level one, traits and dispositions impose behavioral consistency across situations and over time. Level two comprises motivation and volition, placing individual needs into relation with situational demands, striving for adaption. Level three contains self-defining memories of a reflective self. The reminiscing person uses thematic or chronological clues from remembered life events, on purpose to compose coherent and meaningful episodes. Reasoning about relevant or negatively evaluated life events imposes extra effort (Amlashi & Forstmeier, 2025; McLean & Pratt, 2006; McLean & Thorne, 2003; Thorne et al., 2004). The concept of self-reflective reasoning is in accord with the lifestory approach, because a meaningful insight has to be narrated, inferred and construed.

Attribution theory explains the formal principles of causal inference. Accordingly, perception is continuously monitored for contingency of place and time between incidents, postulating that causes precede the outcome. Specifically, it is the *systematic* variation in changing conditions (i.e. their covariation) that provides reason. To draw comprehension, the dimensions of consensus, consistency and distinctiveness are relevant in order to differentiate between internal and external causes, separating actorship from contextual agency. However, selective or biased perception may impose false or distorted conclusions. Expanding upon these formal assumptions, attributional theories explain how causal inference affects experience, motivation, and volition. The respective domain of practice determines what is important, distinctive or salient, for instance: (a) depression can be explained by cognitions that link internal causes with assumptions about temporal or contextual persistence, (b) motivation associates with the recognized stability of an outcome, (c) affect quality and quantity are modulated by the locus of reason, (d) social cognition and interpersonal ratings are influenced by perception of controllability (Stiensmeier-Pelster & Heckhausen, 2018). To sum up, the recognition of chronological order and thematic contingency creates purpose, coherence and meaning (Kapoor et al., 2023).

Outcomes may differ from the initial intent, so that the reasoning about own actorship is challenged. Evidence in literature points to creativity and wisdom to be predictive of narrative coherence, sustaining the individual either to restore or maintain a meaningful lifestory (Fournier et al., 2018). Of note is that autobiographical reasoning is not constricted by intelligence per se but rather associates with cognitive flexibility and mental positivity (Chuderski et al., 2012;

Kapoor et al., 2023). This is insofar conclusive, since positive attitudes establish open-minded and optimistic states which broadens the view and are supposed to build adaptive habits (Fredrickson, 2002; Ostafin & Proulx, 2020). In case of depression, the empirical evidence is contradictory and does not show a clear connection with coherence (Kapoor et al., 2023; Westerhof et al., 2014). Literature explains inconsistent findings by rumination, which can be coherent, yet negative and propagating overgeneralized memory or affect, and therefore is dysfunctional (McAdams et al., 2001; McLean et al., 2020).

### *2.3 Reminiscence*

The recollection of past life events is quite ubiquitous and serves various purposes in autobiographical reasoning, it has direction, is based on intent and motivation. Reminiscence is the process whereby memories about the past and present self are voluntarily recollected and recalled, to be distinguished from intrusive and non-volitional memory.

The Reminiscence Function Scale (RFS) is a quantitative measure that differentiates among various uses of reminiscence. Its factorial structure is oblique, which is consistent to an often varying intent why to remember. However, crossloadings have contributed to a discourse about the dimensionality of the construct (Robitaille et al., 2010). The original version of the RFS (Webster, 1993, 1997) contains eight factors measuring various types of reminiscence (Identity, Problem Solving, Death Preparation, Teach and Inform, Conversation, Bitterness Revival, Boredom Reduction, and Intimacy Maintenance). Joining the first two scales to one dimension (Identity/ Problem Solving) establishes a factorial structure of seven subscales (Robitaille et al., 2010; Webster, 1997). An alternate circumplex model was intended to to consolidate the various solutions, as it by method favors four higher-order factors on eight items, but never was broadly advocated (Webster, 2003). Broadly acknowledged evidence suggests a model of eight functions, clustering into three latent second-order factors on prosocial, self-positive and self-negative reminiscence (Cappeliez & O’Rourke, 2006; O’Rourke et al., 2016). Local adaptations of the Reminiscence Function Scale (RFS) coexist, since the items appear to bear cultural sensitivity (Ros et al, 2016).

Reminiscence functions delineate the cognitive means by which memory recall maps to (mental) health and other psychological outcomes. Self-positive functions promote well-being and self-negative increase distress, whereas no direct health correlates have been found for prosocial reminiscence. This finding is likely explained by its usage, since primary intent of the latter is a pleasant interpersonal experience, but not to evaluate on past events (Westerhof et al., 2014). Self-negative reminiscence is predominantly characterized by boredom reduction and reinforces

avoidance, whereas self-positive functions link to identity formation and adaptive habits. Even though having only a momentary impact, socializing reinforces functional habits and builds resources because it accumulates over time and across different contexts. Thus, the influence of prosocial reminiscence on well-being is indirect, being mediated by self-positive and self-negative reminiscence (Cappeliez & O'Rourke, 2006; King et al., 2019; O'Rourke et al., 2010).

### *2.4 Autobiographical Reasoning*

The narrative self has recently become focus of interest in developmental psychology, rooting in lifespan perspective. Adjusting for biographical turning points, the functional compensation of deficits, health related impairments, and aging are examples of cognitive-emotional processes that contribute to lifelong adaptation in the service of restoring, maintaining, or broadening plasticity (Baltes & Baltes, 1990; Brandstädter & Renner, 1990). Persons differ in age-graded goals, reflecting which aspects in life are salient and valuable in the course of time (Carstensen, 1995; Carstensen et al., 1999; McAdams, 1995; McAdams et al., 2004; McLean & Pratt, 2006). It is postulated that the experience of coherence, meaning and purpose exerts influence on functional performance and, in consequence, fosters adaptive cognitions, traits and habits (Hallford & Mellor, 2017; Kapoor et al., 2023; Westerhof et al., 2014).

Reminiscing about past events often occurs as a spontaneous need in everyday life. It also offers a scientific means to measure latent constructs (McLean & Fournier, 2008). Elevated reminiscence is intentionally motivated, and it the lifescript account hypothesizes that it associates with life episodes in which the self emerges (Rubin et al., 1986). In line with the conceptualization of normativity will self-formation be salient during adolescence. Turning points, life tasks and developmental transitions raise the urge to adjust for the experience of misfit. Thus, peaking memory recall does not necessarily suggest a normative lifescript, but rather relates to *any* significant episode in life possible that has influenced development or will conceivably do this.

Autobiographical reasoning operates a variety of cognitive-emotional processes, whereby reminiscence and time perception are important. Centering on purpose and coherence turns loose events into a meaningful lifestory. Evidence proofs that the effort spent on memory recall differs with regard to the evaluative significance of the respective life event (Amlashi & Forstmeier, 2025; Kapoor et al., 2023; McLean & Fournier, 2008). A loss in coherence rushes adaptivity for which self-regulatory competence is essential to restore meaning in response to this experience. Emotional coping is likely to intrude when factual adjustment fails to ease the dissonance, also in cases when the self-regulatory capacity is either constrained or somehow impaired (*see chapter on Connecting*

*Research Questions in Future Directions*). By reason of the latter has been shown that the persistent strive for coherence and meaning is likely to occur aside from deficits in self-regulatory competences and will propagate a damaged self-experience (Amlashi & Forstmeier, 2025; Lazarus & Folkman, 1987).

Notably, the concepts mentioned before can be combined together in a comprehensive nomological network, encompassing coherence in lifestories (narrative self) as well as commitment and exploration (narrative identity), where maturity serves as the moderating link (Maehler & Hernández-Torrano, 2025; McLean & Pratt, 2006). Engagement in life topics and autobiographical reasoning about self-defining memories, both frameworks supply complementary conceptualizations of self-defining cognitions. From a structural perspective, the narrative self can be decomposed into three latent factors: (a) autobiographical reasoning; (b) structure; (c) motivational and emotional themes (McLean et al., 2020). This model is in line with robust evidence that coherence and meaning are predictive of well-being and life satisfaction, for instance: composing live events to a contaminative or a redemptive lifestory will yield different outcomes, whereby the respective meaning is either supportive or constrictive to well-being and (mental) health (McAdams et al., 2001, 2004; McAdams, 2024).

To sum up, the aptitude to adjust for decisions that have altered the course of life, along with the ability to retain plasticity aside from critical life events, stands in contradiction to the model of a lifescript as the unique pace setter for identity maturation and self-development. These outcomes rather suggest intent and motivation, on purpose to construe coherence and to create meaning, hence to elaborate on a lifestory in service of a *reflective self* (Fournier et al., 2018; Glück & Bluck, 2007; McAdams, 1993, 2024; McAdams et al., 2001; McLean & Fournier, 2008). Autobiographical reasoning is a vital approach in lifespan developmental psychology, open to various paradigms, and introduces the narrative self as a seminal model of lifelong adaptivity, exerting influence on well-being and (mental) health outcomes. The respective cognitive-emotional processes cover a broad range of psychological phenomena related to aging and plasticity.

### 2.4.1 Life Meaning

Currently, lifespan developmental psychology has opened up the topic of life meaning as an agile research goal. The concept originates in early work on a salutogenetic approach to (mental) health. In a narrative approach to the self, purpose and the recognition of coherence are fundamental. For instance, to acculturate in a foreign culture touches self-defining memory. As the issue is highly significant for the individual, cognitive processing will spent attention on this life

topic (Amlashi & Forstmeier, 2025; Hooker & McAdams, 2003; McAdams, 1995; McAdams et al., 2004). Regardless of the specific sources of the psychological correlates, elevated recall obviously indicates matter. The recognition of chronological and contextual consistency increases the impression of self-sameness, consistency and coherence, similar to a trait (Glück & Bluck, 2007). Most recently, life meaning has been linked to mental health, distress and rumination as well (Ostafin & Proulx, 2020, 2022; Ostafin et al., 2022): findings report that both uncertainty fear and the degree of experienced discomfort modulate the influence of life meaning on cognitive and emotional outcomes (ibid; Ostafin & Proulx, 2020, 2022). In addition, brief meaning centered interventions add feasible applications for trauma-focused therapy (Seidel-Koulaxis et al., 2024). In general, the experience of meaning and coherence is supposed to have a salutogenetic effect, it reduces distress and enhances the odds of adaptation. Lifestories differ in meaning, separating compositions of contaminative from redemptive conclusions (Kapoor et al., 2023; McLean, 2006; O'Rourke et al., 2016). Empirical findings underscore the importance of self-regulatory competencies. A low aptitude proves to be a risk factor for maladaptation, for instance in cases when emotional-focused coping cannot sufficiently ease the discomfort so that the search for meaning will likely exert an exacerbative influence and yield a damaged self-experience (Amlashi & Forstmeier, 2025; McLean & Fournier, 2008).

To measure life meaning uses methods that originate in qualitative research, such as talking about turning points or free recall tasks. Meanwhile, quantitative approaches measuring life meaning have been established, starting with one-dimensional instruments in the beginning and supplementing multi-factorial models most recently. In line with this conceptualization does life meaning cover the facets of comprehension, purpose and matter (i.e. salience) (Ostafin et al., 2022). The Awareness of Narrative Identity Questionnaire (ANIQ) is a quantitative measure, assessing life meaning based on four scales. Awareness addresses the meta-cognitive knowledge of having a lifestory, and the other three scales capture facets of biographical consistency, containing chronological, contextual and thematic coherence (Hallford & Mellor, 2017; Kapoor et al., 2023) .

To sum up, life meaning has been confirmed to be a health promoting factor, operating on a high cognitive level. To *attribute* meaning implies to recognize a chronological and semantic order across life events, also to interpret the outcomes in the shade of valued goals. Nevertheless, life meaning is a creation, a fiction of mind that arises from the composition of loose events into a comprehensive lifestory (McLean & Fournier, 2008; Fournier et al., 2018).

### 2.4.2 Storytelling, Life Review Intervention and Life Review Therapy

The increasing proportion of older persons in an aging society poses a challenging demand for services that meet the particular needs and confinements. Life quality of older people is often compromised, due to the health status or with regard to the socioeconomic conditions in daily living. In case when problem-focused coping is not an option, debilitating processes are likely to arise. Persisting problems promote feelings of inadequacy and insufficiency. Affective or anxiety disorders, dementia and manifest physical diseases are of distinct prevalence in this population. Viciously, comorbidity exacerbates vulnerability.

To offer easily accessible support, reminiscence can be a promising candidate to look at, because it is ubiquitously used and shared in storytelling. Simple reminiscence occurs spontaneously and complies with prosocial reminiscence functions (Cappeliez & O'Rourke, 2006; King et al., 2019; O'Rourke et al., 2010, 2016). In care giving and in nursing, both applications are of approved practice. To share memories accomplishes understanding, promotes interrelational validation and enhances a positive mood, at least momentary. Prosocial reminiscence is not necessarily restricted to persons of age, because its usage offers a self-regulatory experience to the practitioner. But it is particularly useful to cope with developmental tasks, such as balancing life. In the elderly, prosocial reminiscence adds to selective goal attention, preferring pleasant experiences and engaging in enjoyable times (Carstensen, 1995; Carstensen et al., 1999). A decrease in trait-openness can reinforce this trend as well (Donnellan & Lucas, 2008; Lehmann et al., 2013). Selectivity is supposed to be adaptive because it corresponds to the ability to actively disamplify arousal caused by negative stimuli (Reed & Carstensen, 2012).

Structured interventions, such as Life Review Therapy (LRT) or Life Review Intervention (LRI), usually yield higher effects on both psychological and health outcomes, compared to simple reminiscence. In therapy, etiological considerations and a psychopathology model provide guidance to administer a treatment that has proven effective for a certain disorder. Reminisce interventions strive to modify any dissonance experience or discomfort and integrate new comprehension into a coherent lifestory, targeting as well to lower vulnerability as to recover life meaning (McLean et al. 2020; Ostafin & Proulx, 2020; Ostafin et al., 2022).

Evidence for the efficacy of reminiscence therapy and narrative interventions point towards larger effects in depressed individuals and in those with a physical illness(es), compared to anxiety or other mental disorders. In contrast, the effect on well-being is rather low and indirect, seemingly mediated by functional habits and self-regulation (Fredrickson et al., 2002; O'Rourke et al., 2010, 2016; Ros et al., 2016). Cognitive improvements in persons with dementia are either absent or have

a short aftermath. However, the momentary ease of depressive or anxious symptoms is protective in subsyndromal states and reduces the risks of disease progression (Gonzalez et al., 2015). Meta-analytical findings on Life Review Therapy (LRT) are by and large in accord to overall epidemiological evidence. A meta-analytic study has been conducted on the effects of reminiscence interventions, evaluating health related outcomes and indicators of life quality. Findings report certain recommendations (Pinquart & Forstmeier, 2012), among others:

(a) Life Review Therapy (LRT) requires a clinical context, (b) the impact of Life Review Therapy (LRT) on clinical outcomes outperforms those in Life Review Intervention (LRI) and simple reminiscence, (c) depressed individuals or persons with a physical illness profit most from reminiscence interventions, compared to other clinical populations, (d) presence of an active control condition lowers the effect on well-being, (e) the effect persists at 6 - 9 month follow-up, (f) the initial health status is predictive for possible gains.

Notably, improvements in well-being are more distinct if the design uses a waiting control group, as opposed to a placebo arm. By reason of the latter do study conditions alike prosocial reminiscence offer a self-regulatory source that improves momentary benefits in health (O'Rourke et al., 2010, 2016). A larger effect size, particularly in mentally or physically ill individuals, can be reasoned by a restriction of value range under selective conditions. Therefore, evidence has to be collected in a random controlled trial (RCT), preferably in a longitudinal design. Study requirements advice the usage of a waiting control to investigate the effect of reminiscence interventions on well-being.

### 2.4.3 Empirical Application and Validity: RCT on Life Review Therapy in Holocaust Survivors

A recent study on aged holocaust survivors presented prove of treatment possible, even in this delicate context. But some basic conditions have to be considered in regard to adjust the setting for the needs of this population and the elderly. Although highly effective in general, cognitive behavioral interventions and exposure therapy are reported to have reduced impact on persons of age (Forstmeier & Ochel, 2022). Health impairments, chronicity, aversion to exertion and selective goal attention, and a lowered trait-openness are likely reasons for their diminished efficacy. As stated by the positivity effect, the competence to actively downsize negative arousal is adaptive (Carstensen, 2006; Reed & Carstensen, 2012), mostly motivated by a prolonged recovery time succeeding an aversive stimulation in the elderly. However, the perseverance to adhere to an ambitious protocol soon becomes fragile, if the outcomes do not compensate for the burden that has been imposed by the treatment. Therefore, Life Review Therapy (LRT) is a promising option for the

aged to get access to psychotherapy. Of note is that evidence-based Narrative Exposure Therapy (NET) resembles interventions in structured reminiscence. For instance, to reflect upon past events across the lifespan encourages not only to talk about critical life events, the narrative intervention exercises exposure in sensu as well. Restoring life meaning requires the recall of critical life events by placing memories in their proper order of place, time and context (Schauer et al., 2011).

Although the efficacy of reminiscence interventions is apparent, their acknowledgment in evidence-based guidelines still is lacking. To push this issue raises demand on random controlled trials in order to thoroughly study the effect. In accord to this purpose, Life Review Therapy (LRT) had been offered to holocaust survivors, a population with considerably elevated prevalence in Post-traumatic Stress Disorder (PTSD). Comorbide mental disorders add to the primary disease. The design was composed of two study arms, i.e. an adapted protocol of Life Review Therapy (LRT) versus supportive services in the active control group. Study results were reported promising.

Target outcomes focused on the remittance rate in PTSD aftermath and on the remaining prevalence of affective disorders. Findings revealed some insights. Life Review Therapy (LRT) outperformed controls with large effects on PTSD and had moderate outcomes on depression. The interaction of time and treatment was moderate at post-treatment and prospered with delayed effect on PTSD at 6-month follow up. The impact on affective states leveled out at post-measurement and reclined afterwards for participants in the control group, before returning to baseline again. The overall effect of Life Review Therapy (LRT) resembles gains possible in Narrative Exposure Therapy (NET), but levels slightly higher than Integrative Testimonial Therapy (ITT) regarding PTSD. In case of depression, Life Review Therapy (LRT) is equally efficient to Narrative Exposure Therapy (NET), but considerably ranges over those achievements in Integrative Testimonial Therapy (ITT). Overall, more participants recovered or at least improved in Life Review Therapy (LRT), as opposed to supportive services in the active control group (Forstmeier et al., 2023).

### *2.5 Balanced Time Perspective*

Temporal framing is essential in psychosocial and cognitive-emotional processing. Human mental functioning in daily living is inseparably bound to the perception of time (Carstensen, 2006; McAdams, 1995; McAdams et al., 2001). By definition, the narrative self is based on coherence (Hallford & Mellor, 2017; McLean et al., 2020), and autobiographical reasoning is unthinkable without putting events into chronological order. However, the cognitive processing associated with temporal framing, which also includes the meta-cognitive knowledge of having a time perspective, mostly is not in focus of attention.

In current research, time perspective theory offers a seminal approach to investigate well-being, life satisfaction and adaptation across the lifespan. Balancedness is assumed to be functional, since "[…] an optimal blend of temporal orientations would be adaptive, depending on external circumstances and optimal in terms of psychological and physiological health" (Boniwell & Zimbardo, 2004, p. 171). Individuals in favor of a certain time perspective differ in preference, hence temporal orientation varies akin to a trait and can be measured in individuals (ibid.). It seems to be intuitive and plausible that the exhaustiveness of a mental representation depends on the extend by which attention and focus expand in different temporal directions. Robust findings underscore the relevance of time perception in psychological functioning, but a plurality of operationalizations coexist, alongside various approaches to measure it. However, time perspective theory is conceptually and empirically convergent in lifespan developmental psychology. Applications are widely spread, encompassing reminiscence in a reflective self and autobiographical reasoning in the service of the composition of coherent lifestories.

Time perspective theory postulates that a skewed time perspective raises the risks of mental disorders, while a balanced temporal framing is a robust predictor of mental well-being. This effect proves not to be associated with age or sex (Stolarski et al., 2020; Stolarski & Cyniak-Cieciura, 2016). Autobiographical reasoning is profoundly interrelated with balancedness, because the outcomes of behavioral responses accumulate over time and generalize across contexts towards (mal-)adaptivity (McAdams et al., 2001; McLean & Pratt, 2006). Self-regulatory competence, uncertainty intolerance, and fear of the unknown modulate the salutogenetic effect of life meaning on various well-being indicators and life quality. Experiencing distress apart from deficiencies in self-regulatory competence reinforces maladaptation (Amlashi & Forstmeier, 2025; Ostafin & Proulx, 2020, 2022) which adds to the problems and favors an exacerbating dynamic.

To summarize, models in lifespan developmental psychology span a broad conceptual framework, containing prosocial reminiscence in autobiographical reasoning, positivity, aging and socioemotional selectivity. Prosocial reminiscence is hypothesized to build resources; selective goal attention is supposed to be adaptive for well-being and life satisfaction (Cappeliez & O'Rourke, 2006; King et al., 2019; O'Rourke et al., 2010, 2016; McAdams et al., 2001; Reed & Carstensen, 2012). A most recent study, being part of this dissertation, places well-being and life quality in the conceptual space of time perspective theory and the cognitive-emotional processes that associate with temporal orientation (Lenz et al., 2025b).

## *2.6 Analytical Models*

Methodological considerations are briefly outlined to supply the inferential background of some analytical models used in this dissertation. The ongoing discourse about an adequate operationalization of balancedness is referenced from a Bayesian perspective to show that a prevalence of even baserates is precedent in order to get accurate estimates and precise predictions in classification tasks. Some fundamental considerations regarding the Linear Discriminant Analysis (LDA) will be present as well.

### 2.6.1 Bayesian Inference

Unlike in frequentist application does Bayesian inference explicitly formalize assumptions about prior information, proposing a proportional equivalence between prior and posterior probability distribution. Likelihood is a concept of posterior knowledge and describes the expectancy of data, which has already been collected. It is defined by $L = p(H) \times p(data|H)$, i.e. the odds to observe the data conditioned by the hypothesized model, multiplied by the prior probability of the model. The latter part of the term relates to initial assumptions about the hypothesized model *H*, in classification tasks referred as prevalence or baserate. To update prior expectancy to posterior knowledge, the data likelihood is weighted by the total probability, thus the superset over all possible hypotheses $H_n$. Formally, total probability corresponds to the marginal in cross-tabulation, given by $p(data) = p(data|H) \times p(H) + p(data|\neg H) \times p(\neg H)$. In particular, Bayesian inference requires to specify *any* complementary model that can explain the data as well. Evidence is being collected in favor of the hypothesis in question and the equation is solved by conditioning the likelihood with the marginal. Thus, the nominator specifies the likelihood, which is divided by the denominator of the formula, containing the total probability:

*Lemma*: Posterior and Prior Probability are Proportional
Bayesian Inference postulates $p(H|data) \propto L/$ total probability, i.e. the prior is updated to the posterior distribution by empirical evidence.

Accordingly, Bayesian inference formalizes the accumulation of knowledge, while assuming that the posterior probability $p(H|data)$ is proportional to the likelihood *L*. The way in which the formula is solved may differ, depending on the type of the underlying random process that describes the model parameters. To estimate a discrete random variable, the summation operator applies to

quantify the denominator, whereas continuous outcomes require integration in order to gain the total probability. In either use case, both prior and total distribution have to be known.

For discrete variables, the family of Probability Mass Function (PMF) is adequate, which returns the exact probability estimate for a *discrete value* of a random variable, i.e. $p(x \in X)$. Values in set *X* belong to either $\mathbb{Z}$ or $\mathbb{N}$. A typical scenario is the number count of cases: Poisson distribution applies to observations of scarce occurrence, Binomial distribution describes the probability for more frequent outcomes. For continuous measures, a Probability Density Function (PDF) quantifies the probability for an *interval* of random values, i.e. $p(\delta x \in X)$. Thus, values in set *X* are in $\mathbb{Q}$ or in $\mathbb{R}$. Possible use cases include reaction time, physical units in general, also particular measurements in psychometrics, for instance: Gamma distribution supplies the parameters to estimate decreasing rates in continuous outcomes, Normal distribution operates on assumptions about centrality and spread to provide the estimates.

However, to solve the formula for continuous variables may be laborious, because PDF will return a probability density, implying that an infinite number of alternate models has to be considered. Hence, total probability has to be found by integration, i.e. $\int p(data|H) \times p(H) \delta H$. Conjugate shortcuts offer an analytical solution for particular problems whereby applicability depends on the type of the respective random process. If suited, the parameters can be taken over to update the prior to the posterior probability. To give an example, a gamma distributed prior can be used to to parameterize Gaussian data $N(\mu, \sigma)$, depending on whether population mean or spread is known: providing variation in *X*, the conjugate gamma takes the sample precision [precision; $1/\mathrm{Var}(X)$] and allows to estimate the prior mean. Simulation remains feasible when none relevant distribution is available to estimate any prior parameter (Döring, 2022; Everitt & Skrondal, 2010[337-341, 350]).

Although frequentist statistics and Bayesian inference differ in how explicit prior knowledge is formally specified, both approaches provide a sampling distribution in which the respective estimates converge empirically (Everitt & Skrondal, 2010[1389]). Use case in this dissertation is a binary criterion, which means that inference is based on a PDF. The following chapter gives a snapshot of how to translate these general reflections into a statistical model.

### 2.6.2 Linear Discriminant Analysis

The concern of Linear Discriminant Analysis (LDA) is twofold, first to classify observations and second to predict an either binary or multinominal outcome. LDA expects that the multivariate feature variables are Gaussian. Depending on the respective purpose, the analytical model either

classifies cases, or predicts the posterior probability for a categorical criterion. A Linear Discriminant Function (LDF) denotes by $B_jX_i \rightarrow Y_{ig}$, where $Y_{ig}$ maps to individual discriminant values; *j* [1; k] predictors, *i* [1; n] observations, *g* [1, g] groups. The statistical model is capable of performing complex classifications.

LDA maximizes the explained model variation by a metric discriminant value, which emerges as the eigenvalue from LDF. The centered estimated value of this metric gives the cutoff used to classify cases. Values greater (less) zero of the threshold are allocated into distinctive and homogeneous groups. Of note is that multiple LDF apply in case of a multinominal criterion. To ensure estimates of good quality, the feature variables have to fulfill the subsequent requirements. However, for models of $k \leq 5$ predictors and $n \geq 20$ per group, LDA proves to be robust (Backhaus et al., 2023, p. 258; Rudolf & Buse, 2020[181]).

- normally distributed feature variables
- uniform prevalence of balancedness
- equal covariance-matrices between the groups
- no influential cases in the predictors
- no multicollinearity among the feature variables

LDA resembles Principal Components Analysis (PCA) in some aspects, as it decomposes multivariate variance and recursively maximizes eigenvalues in linear equations. Unlike PCA, in which covariation is an emergent property in the data, does LDA preserve group membership and propagates the classifier into the model. Thus, the solution vectors also capture psychometric properties (Dunn & Everitt, 2004[129-198]; Rudolf & Buse, 2020[182]; Wirtz, 2022a).

Use case of discriminant analysis is exploratory for most of the hypotheses, assuming an error level of α .05 and a Power of .80. Statistical inference is drawn by: $\chi 2$ to infer model's ability to correctly classify and predict observations, *F*-Test and Wilks Lambda to evaluate the eigenvalues of the model and to assess the significance of the discriminant coefficients, *z*-test to infer the significance of logistic estimates ($Y_{ig}$, group membership). A cross-validation procedure segments the sample into a training and a testing subset of *p* (0.80, 0.20).

### *2.7 Research Gaps Concerning Lifestory Account and Autobiographical Reasoning*

Unlike dysphoria and negative mood, positive affect does not prescribe a specific course of action, leaving behavioral responses more ambiguous (Fredrickson & Joiner, 2002). Notwithstanding, states of subjective well-being obviously associate with distinct outcomes in overall psychosocial functioning and life quality. Robust findings correlate coherence, life meaning

and adaptation with mental and contextual conditions that are reported to sustain plasticity. Though empirical evidence broadly supports the fundamental importance of autobiographical reasoning in a narrative self, it is intended to thoroughly explore the underlying psychological processes that are involved when a biography turns into a lifestory. Moreover, official guidelines do not yet recommend reminiscence interventions, despite the growing body of evidence pointing to tailored and efficacious therapy.

In time perspective theory, the metric of a balanced temporal framing is controversially discussed in scientific discourse on the optimal operationalization of a possible measure. Issues to be clarified include the factorial structure of the construct and its optimal scale level, concerning the usage of categorical versus metric indicators. These controversies not only originate in the usage of different instruments, but also relate to the assumption that temporal framing consists of both cognitive and emotional processes. The disparate drafts supply a heterogeneous picture: a five-factor profile for the ZTPI, and a two-factor structure for the BTPS with past and future direction; its modified version supplements the present, i.e. BTPS relative to mBTPS.

The trauma analogue paradigm offers a psychopathology model that is appropriate for experimental and prospective studies to safely study the effects of treatments on symptoms caused by analogue stressors. A greater number of design options hardens the comparison of empirical evidence. To differentiate symptoms from risk factors in subsyndromal state, longitudinal measurement is necessary, but literature is sparse on this topic.

## 3 Comprehensive Summary of Empirical Studies and Research Projects

### *3.1 Aims of this Dissertation*

The objective of the research program related to this dissertation is threefold. (a) The thesis reflects upon cognitive-emotional processes that contribute to adaptivity and maintenance of plasticitiy across the lifespan. Lifelong development unfolds in the service of intentional self-development. Adjustments for age-graded change are postulated to be functional, their empirical correlates will be referred to as well-being, life quality and selective goal attention. (b) Responses to losses, life events or adjustments for changes in individual performance across the lifespan may be dysfunctional and will likely exercise a debilitating dynamic when deficits pertain. In these cases, adaptive aging is impaired as well, for instance the mastery of developmental tasks. The research in this program elaborates on interventions that suit the specific demand that arises with aging. To elaborate on the experience of coherence and life meaning offers a transdiagnostic orientation.

(c) The overall results and empirical findings raise methodological considerations regarding the design parsimony and the appropriateness of statistical models. Findings in the second study supply recommendations for the selection of stressors and the number of measurements in trauma analogue paradigm. Evidence from the third study adds to the scientific discourse on how best to measure a balanced time perspective, it also suggests an adequate design.

Accordingly, the presented studies will focus on these key aspects:

*Study one, review article*: the conceptual work reflects on conditions that sustain lifelong plasticity, while adjusting for life events or developmental transitions, or as a response to aging. Autobiographical reasoning is supposed to be fundamental in self formation, separating contaminative from redemptive lifestories. The viewpoint of a late onset afterward lifelong complaints or grievance is taken as well.

*Study two, RCT in trauma analogue paradigm*: the longitudinal RCT in trauma analogue paradigm compares three acute interventions against a waiting control group, investigating treatment efficacy, also on purpose to distinguish between risk factors and symptoms. The study design is exploratory.

*Study three, online survey on balancedness in temporal orientation*: the empirical work deploys a cross-sectional study in a quasi-experimental correlational design. The analyses explore the influence of time perception in human functioning, in particular its impact on well-being and life quality. Methodological considerations focus on construct validity, elaborating on the dimensional structure of temporal framing whether two or three directions adequately describe time perspective, and supply empirical validity in concern of how best to measure balancedness.

## *3.2 Review: Recollective Growth and Recovery of Life Meaning [Theoretical Work]*

This chapter is based on the following publication:

Lenz, H.-J., Zimmermann, S. & Forstmeier, S. (2020). Der Lebensrückblick und Traumafolgestörungen aus der Perspektive der Lebensspanne. *Trauma & Gewalt*, *14* (4), 288 – 302. https://doi.org/10.21706/tg-14-4-288

The complete article can be found under supplementary materials to this dissertation.

### 3.2.1 Introduction and Purpose of the Review Article

The objective of this conceptual work is to unfold a broader picture on the particular needs and conditions that have to be considered in psychotherapy of aged persons. The considerations are

exemplified by LRT, a reminiscence intervention that had been offered to holocaust survivors. The effects were studied in a random control trial to collect evidence of treatment efficacy. Some reflections will clarify the conditions that exercise influence on the composition of lifestories, construing contaminative versus redemptive meaning into life events. Since either direction will influence the respective outcomes, the considerations address both responses to lifespan transitions and the recovery of life meaning alongside a mental disease. Options and conditions in late onset of a disorder and conditions of posttraumatic growth will be reflected as well.

### 3.2.2 Comprehensive Summary

Apart from inconceivable harm and sorrow in holocaust survivors, so is the urge of treatment and support also reasoned by age-graded developmental tasks. These adaptations are usually transitional and supportive in regard to maintain life balance, but are likely to be hindered in those participants who envision intruding memories. Though guideline psychotrauma-focused intervention is effective in general, evidence in the elderly is scant, contradicting a lifetime prevalence of about 2.5 to 3.9 percentage in PTSD (Böttche et al., 2012). Findings also report that guideline interventions are less efficacious in persons of age (Forstmeier & Ochel, 2022). Access to psychotherapy is strongly needed, but treatment has to be adapted when applied to the elderly. Among others, aversity avoidance and selective preference for pleasant experiences, erroneous assumptions about psychotherapy, and motivation have to be considered. In regard to the study sample, the application of psychotrauma-focused interventions requires first and foremost to prove affect tolerance before proceeding with treatment. The baserate of mental disorders in holocaust survivors is demanding, with a prevalence of distinctly greater than 25 percentage points, including syndromal aftermath and mental comorbidity (Forstmeier et al., 2020, 2023; Forstmeier & Ochel, 2022). Reminiscence interventions promise to be both supportive and curative, whereof Life Review Therapy (LRT) explicitly builds on etiology and uses a psychotherapy model, adjusting for the precarious challenge of narrating and balancing life even after lifelong suffering.

In concordance with the overall topic of this chapter, anxiety disorders and posttraumatic stress disorder will be discussed in more detail. The two-factor model provides a basic theoretical framework to understand the psychopathology and the principles whereby fear is acquainted and maintained. Initially, exposure to an aversive stimulus primes future alertness toward the stressor, which later on will be maintained by avoidance. Accordingly, respondent conditioning and behavioral reinforcement apply and are essential to explain the etiology of anxiety disorders (Kandale & Rugenstein, 2022). In regard to PTSD, the fundamental mechanisms of fear conditioning hold in addition to the psychopathology of a memory disorder, originating in

dissociative processes during exposure. The model suggests that a dominance of sensory processing and low conceptual processing increases the risk that the highly sensory-based traumatic experience will be poorly elaborated. The affected memory appears to be fragmented, because of physiological arousal that had interfered with cortical brain integration while the event was taking place (Ehlers & Clark, 2000; Schauer et al., 2011; Schauer, 2015).

In Narrative Exposure Therapy (NET) and Life Review Therapy (LRT), the narration of critical life events employs exposure in sensu. Narrative Exposure Therapy (NET) encourages to story recalled memory by means of a line line, elaborating on critical events and placing them into context. LRT offers a manualized protocol that spans the entire life until present, while spending extra attention on the recollection of problematic episodes, so as to adequately contextualize the narration before proceeding further. The framing of experiences and the composition of life events into lifestories creates coherence and construes meaning. Mental growth always is an option when meaning is adaptive, sustaining and contributing to plasticity.

### 3.2.3 Conclusions

Redemptive sequences typically comprise benefit-finding attributions in order to elaborate on a meaningful and adaptive conclusion, contamination stories focus on deficit and bereavement by which plasticity is impaired and adaptivity becomes constrained (McAdams et al., 2001; McAdams, 2024). Autobiographical reasoning provides a comprehensive understanding of the cognitive-emotional means through which Life Review Therapy (LRT) eases symptoms and complaints, including the recovery of life meaning as well. Narrative interventions offer seminal applications in the context of the lifestory account:

(1) Simple reminiscence is ubiquitous, it occurs spontaneously, and complies with prosocial reminiscence functions. In care giving and nursing, both applications are approved practice. In the 3-factor model, reminiscence functions are grouped into three latent factors of higher order. Self-positive functions are connected to well-being, whereas self-negative functions propagate distress; prosocial reminiscence, the third latent factor, is primarily exerted in favor of a pleasant interpersonal experience, but does not serve to evaluate on past events (Westerhof et al., 2014). Even if the effect is only momentary, the re-experience accumulates over time and builds resources (Cappeliez & O’Rourke, 2006; King et al., 2019; O’Rourke et al., 2010, 2016).

(2) The latent factor model of the narrative self provides detailed insights into the interplay of cognitive processes and various psychological outcomes. A structural view on the model discloses the following components (McLean et al., 2020): (a) autobiographical reasoning,

(b) structure, (c) motivational and emotional themes. Whereby coherence is part of structure; and meaning, well-being, and life quality are related to motivation and emotional issues.

(3) Psychotherapy in persons of age has to be adjusted for the specific needs of this population. A late onset of mental disorders often evolves aside debilitating socioeconomic conditions and interrelates with age-graded changes, whereof reduced cognitive fluidity, a prolonged recovery time and selective goal attention are most reasonable (Carstensen, 1995; Reed & Carstensen, 2012). Of note is that these responses to age-graded change in performance are assumed to be adaptive, as long as the condition is not linked to a kind of syndromal status (ibid.). While cognitive mechanics tend to decline while aging, cognitive pragmatics remain stable in healthy individuals. However, due to impaired sensory perception, persons of age often are prone to a quality loss in source monitoring. Treatment setting and application have to be adapted to the specific needs in order to be adequate. Furthermore, treating anxiety disorders is usually wearing, as it involves exposure, either in sensu or in vivo. The integration of dissonant experiences into a coherent lifestory should both reduce vulnerability and provide life meaning again (McLean et al. 2020; Ostafin & Proulx, 2020; Ostafin et al., 2022).

## *3.3 Longitudinal RCT: Trauma Analogue Paradigm on Brief Interventions [Experiment]*

The research project is preregistered (Lenz et al., 2025a) and has currently been submitted for peer review.

The complete article can be found under supplementary materials to this dissertation.

### 3.3.1 Introduction and Purpose of the Submitted Study

Traumatic experiences are common worldwide and can lead to severe psychological distress and mental health problems. PTSD is a mental disorder that may develop succeeding a traumatic exposure and is associated with significant personal and societal costs. The empirical work of this research project will be discussed in line with these considerations: (a) Mental disorders exercise limiting effect on plasticity and thus limit the alternatives of adjustment to life, as well in manifest as in subsyndromal states. Throughout lifespan, need of adaptation is a matter of fact, either in conjunction with identity deployment or due to daily struggles and responses to critical life events. Dysfunctional adjustment reinforces constrictive coping strategies and also hinders the mastery of developmental tasks. (b) Although evidence-based interventions are available to treat PTSD, options that can be administered immediately after a traumatic event remain lacking. (c) Persons of age do have specific demand for support that arises from both age-graded needs and vulnerability.

Lifetime prevalence estimates of PTSD varies greatly between countries. Notably, despite the large number of individuals who experience potentially traumatic events over the course of their lives, only a fraction develops a PTSD after exposure (Knipscheer et al., 2020; Koenen et al., 2017). Several models have been proposed to explain the etiology of PTSD (Brewin & Holmes, 2003). The most prominent theories today primarily conceptualize PTSD as a memory disorder, resulting from maladaptive encoding and consolidation of the traumatic memory. A broadly acknowledged cognitive model places a strong emphasis on the processing style employed during and after the traumatic event to provide a psychopathological explanation for PTSD (Ehlers & Clark, 2000). Accordingly does peritraumatic stress hinder cortical processing, so that highly emotional material cannot be adequately recognized in higher brain regions. Instead, the decontextualized perception will be processed in the hippocampic brain. From the perspective of the reminiscing person, the originating threat is re-lived as if it were still ongoing. The mental disorder is characterized by either of the following symptoms: intrusions, hypervigilance, hyperarousal, and the avoidance of trauma-related stimuli.

Guideline psychotrauma-focused therapy aims first to strengthen affect tolerance toward the critical memory in order to then enable the contextualization of the aversive experience, in addition to recover a sense of coherence and meaning (AWMF, 2025; Lely et al., 2019). The majority of affected individuals remit within four weeks following the exposure. However, the disposability of acute interventions is essential to better reduce the risk of progression.

The clinical system that has been employed in this study is in accord to the International Classification of Diseases, version 10 (World Health Organization, 2016). Its successor edition will deliver some adjustments that particularly affect the recognition of complex psychotrauma and thus resembles the Diagnostic and Statistical Manual of Mental Disorders (DSM V) in its current version.

### 3.3.2 Methods and Design

A longitudinal RCT over a two-week period of ten measurement points compares the effect across four study arms. The design allows for causal inference and is capable to separate risk factors from subsyndromal PTSD symptoms, assessed in a non-clinical sample of German university students. The experiment ruled out in Trauma Analogue Paradigm (TAP) that in current research has been acknowledged as a valid experimental psychopathology model (James et al., 2016). In this approach, the stressor is assumed to impose complaints that are similar to symptoms of real-life disorder. The study treatments compare three active conditions for superiority against a placebo

waiting group. The design contains the following interventions offered as immediate aid, i.e. an adapted version of Narrative Exposure Therapy (NET) protocol, Tetris game, and a combination of the aforementioned treatments.

Afterward an initial screening, 99 out of 145 participants were included in the experiment. The dropout rate was low over the course of the study (0.274) and the pattern of missing data was shown to be completely at random (MCAR). Cook's *D* identified influential cases, that were winsorized if they had large values above *p* (.50). Analyses were carried out with listwise deletion of missing data. Dropouts were handled as intention-to-treat (ITT), a protocol especially suited for conservative inference in superiority comparisons.

Power analysis is based on reported effect sizes of psychotrauma-focused interventions (James et al., 2016, Lely et al., 2019), of which moderate estimates were taken ($d$ = .80, one-sided $\alpha$ = .05, power = .80). Primary analyses conducted in GLM 4 x 4 repeated measurements design, resulting in a sample size of $N$ = 84, equally distributed across the four treatments. Secondary analyses performed in General Estimation Equations (GEE) of which Latent Growth Curve Modeling (LGCM) served as the analytical model. This statistical approach allows for the adequate handling of autocorrelated error terms and in particular is suitable for modeling changes over time. Analyses started with full model complexity on 10 measurement points and fixed effects, adjusted for random effects, and decrementally reduced measurings until model fit was optimized.

This study reports results from a two-step data analysis process. In a first step, the efficacy of the different treatment interventions was assessed using a General Linear Model (GLM) for repeated measures, with time and treatment as independent variables. In the model, time specifies the error term and was the within-subject factor of the design, the four treatments constituted the between-subject factor and the interaction term was defined by the covariation of both. Study conditions were compared for outcomes that related to symptoms of clinical relevance, i.e. mood and intrusion.

Secondary data analyses were conducted after evaluating the results of the primary data analysis. Specifically, research questions addressed future methodological considerations. One aim was to determine whether the primary results were influenced by the way the General Linear Model (GLM) handles data and whether a different approach to statistical modeling would affect the results. Secondary analyses also explored if the consideration of random effects improved model fit and what number of measurement points was most suitable from a perspective of model fit and

parsimony. Additionally, to expand upon previous findings, the predictive effects of treatment, sex and emotional reactivity were examined in conditional models.

### 3.3.3 Results

The results can be summarized akin to methodological considerations: Analogue stressors lack ecological validity as they differ from real symptoms and are studied in healthy persons. Therefore, effect size may be less than initially assumed. If the study was in fact underpowered, it was impossible to determine treatments efficacy. Yet, valuable findings can be referred.

A visual interference task (Tetris), an adapted version of Narrative Exposure Therapy (NET), and a combination of both, in the General Liner Model (GLM) analyses all of them proved to be ineffective in reducing PTSD symptoms in comparison to a placebo control group. In secondary data analyses, Latent Growth Curve Modeling (LGCM) examined these treatments as covariates in conditional models. Again, treatment comparison reported null-findings concerning the superiority of any intervention. But a moderating effect was shown for some covariates, such as emotional reactivity to the film clip and female sex significantly predicted a higher number of intrusions. Emotional reactivity was associated with negative trends across various aspects of mood.

Latent Growth Curve Models (LGCM) with varying numbers of measurement points were successively compared to provide methodological recommendations for an efficient experimental design. Model fit indices suggest that four measurement points are sufficient, pointing to future research utilizing the trauma film paradigm.

### 3.3.4 Conclusions

Considerations are drawn in accord to evidence: The analogue paradigm allows to safely study trauma related etiology under experimentally controlled conditions. While research in clinical trials is limited by practical and ethical issues, the paradigm opens ways to gain prospective insight in factors that raise vulnerability for the disorder. Results imply that psychopathology and stress differ as well in terms of etiology as in consequences for the experiencing person. Methodological implications address the considerable heterogeneity in the field of analogue trauma research. Four measurement points are sufficient for capturing the effects of an analogue design. Future study protocols and designs have to consider the choice of stressor and should carefully account for ecological validity.

## *3.4 Cross-sectional Survey: Temporal Framing and Well-being [Quasi-experimental Design]*

The research project is preregistered (Lenz et al., 2025b) and has currently been submitted for peer review.

The complete article can be found under supplementary materials to this dissertation.

### 3.4.1 Introduction and Purpose of the Submitted Study

Motivation and purpose of this study: This study aims for evidence of how best to capture balancedness in temporal framing. Various proposals coexist in scientific literature, concerning as well the factorial structure of the construct as the optimal operationalization of the measure. In scientific literature, benefits and shortcomings of different scale levels have been disparately discussed, with categorical classifiers being compared to metric indicators, which also includes differences in the factorial structure of the measure. The analyses in this study aim to find some answers on these open questions. Results are presented in the broader context of well-being and life quality with intent to deduce practical implications for lifespan psychology.

The Zimbardo Time Perspective Index (ZTPI; Zimbardo & Boyd, 1999) distinguishes a profile of five temporal qualities, as opposed to Balanced Time Perspective Scale (BTPS; Webster, 2011) that differentiates between past and future direction. The recently introduced modified version of the instrument (mBTPS; Vowinckel et al., 2017) extends the two originating scales by the present time. Balancedness in time perspective (TP) is conceptualized either by profile-fit in case of ZTPI or through the expansiveness in the temporal orientation in line with (m)BTPS.

Balancedness matters psychologically in many respects, since temporal plasticity is assumed be adaptive, reasoned by the ability to flexibly switch between different perspectives in response to contextual and situational demands (Zimbardo & Boyd, 1999). Accordingly, a temporally broad and expansive orientation is prerequisite.

Indicators of balancedness use either a distance or a proximity semantic, for which cutoff-points and metrics have been compared (Zhang et al., 2013), for instance Hierarchical Cluster Analysis (HCA) and median-split, or Deviation from Balanced Time Perspective (DBTP). In addition, a Structural Equation Modeling coefficient (SEM) will be evaluated as well, which was introduced by this research project. Evidence reports findings from a Bayesian vantage point that prevalence and baserates are fundamental in classification tasks, since prior information will be updated to the posterior probability of the outcome. Therefore, feature engineering must prevail even odds between samples, and the subsets have to be sufficiently large. This study uses median-split to classify observations for balancedness.

### 3.4.2 Methods and Design

Methods and Design: observational cross-sectional study in a quasi-experimental design, conducted as an online survey throughout 16.03.2022 to 28.03.2022 by assistance of a panel provider. Neither blinding nor random assignment of the subjects applied. Observations are uniformly distributed across 6 groups [18; 71+] for age and sex in accord to favor comparable results. Though not stratified for representativity, so does the wide age span relate to a distinct variation in socioeconomic statuses in this sample. Neither age nor sex covaries with balancedness.

The pattern of missing data is in line with MCAR. Missing quota: 80 participants failed in the quality check, ensuring the carefulness of the answers, and was administered by three items spread over the survey that had to be filled out according the instruction, resulting in a sample size of $N = 302$. For Subjective Well-being (SWB) a binomial logistic regression is non-significant [ $\chi^2(1) = 0.122$, $p = .727$] which indicates randomness. Missings on that measure are substituted by the mean. Outlier: Cook's *D* detected 14 influential cases, all of them are evenly distributed for balancedness. Exclusion of outliers established normality in all predictors. Linear Discriminant Analysis (LDA) applied to inferential models (R package MASS4 v7.6-65: Venables & Ripley, 2002), logistic regression estimated by glm-function using R package stats v3.6.2.

The choice of measures follows theoretical considerations and is driven by empirical conclusions during the predictor selection process. Model accuracy is 5-fold cross-validated, subsetting observations into training and test cases. The prevalence of balancedness is uniformly distributed in the sample and holds even odds in both subsets, having 80:20 proportion in the data. The explained model variance is maximized; lower values on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) indicate a better fit.

Feature engineering process assured compliance to the presumptions of the analytical models which applies to: multicollinearity, absence of influential cases, Gaussian feature variables, homogeneous variances between the classes, a vague prior of even probability. Linear Discriminant Analyses (LDA) conducted to infer evidence at 5 percentage significance. Rank correlations illustrate the bivariate associations between the feature variables. Their effect size is rated according individual differences guidelines: low, $|r| \leq .1$; moderate, $|r| \leq .2$, strong $|r|, \geq .3$ (Cohen, 1992; Gignac & Szodorai, 2016; Leonhart, 2022).

### 3.4.3 Results

The results can be summarized akin to methodological considerations: balancedness in temporal framing covaries with well-being and is associated with life quality. The amount of

explained variance that is captured by mBTPS exceeds BTPS with 8 percentage, hence three time perspectives are better than two. DBTP and SEM, two comprehensive indicators of alternate application, incrementally supplement with 2 percentage explanational power to the model, indicating that the originating scales ought to be replaced by one of the compound measures. Though all feature variables significantly account to overall modelfit, parsimony proposes a two predictor solution to sufficiently estimate balancedness, i.e. well-being aside from either DBTP or SEM. The predictive ability of the model is excellent and ranges in the uppermost percentile of correct estimations. Specifically, evidence suggests that DBTP is more predictive towards the absence of balancedness, whereas SEM better captures its closeness.

Evidence advises to take note of model parsimony, suggesting the usage of one of the two compound indicators in addition to a well-being measure. Of note is that DBTP is better suitable to capture the distance from balancedness, and SEM is adequate to assess its closeness. In balanced observations, the mean average in subjective well-being is above the upper quartile, which is considered to be a cutoff marker of clinical relevance (Cummins et al., 2019). Well-being does not predict age-graded differences, since balancedness does neither interact with age nor sex. Anyhow, future time perspective (TP) is skewed in the elderly, but without significant effect on balancedness across all age classes. Therefore, the experience of subjective well-being proofs to be a robust predictor of balancedness.

### 3.4.4 Conclusions

Conclusions can be drawn in accord to evidence: prevalence is essential in classification scenarios, because the predictive validity of a model is strongly determined by the baserate. Presuming that measures on a metric scale level in general outperform categorical or ordinal estimates, evidence of this study argues from a Bayesian account. In classification scenarios, uneven baserates induce a bias because a strong prior dominates prediction and prior information will be updated to the posterior. Accordingly, a non-informative prior is ideal to evaluate accuracy (Döring, 2022; Kuhn & Johnson, 2020). Assessing either sensitivity and specificity, or a compound measure of both (AUC; Area Under the Curve) retents consistent results (Goldhammer & Hartig, 2020, pp. 179 - 183).

Notably, a clustered criterion had yielded a higher quota in explained variance, as compared to median-split, but the risk of model overfit would have been consequence, small subset sizes as well. The former had limited the generalizability of the findings, while the latter had flawed the statistical power of the analytical model. In response to the various proposals on how best to

measure balancedness, the results indicate that measuring precision has to be evaluated under the restriction of prevalence.

# 4 General Discussion

## *4.1 Results of the Research Program*

The findings in the research projects contributed to posterior knowledge and provide insight in the mechanism by which (life) meaning translates into lifestories and how attributional inference relates to outcomes in both mental health and life quality. Though causality cannot be assigned in either direction, robust findings converge on the conclusion that autobiographical reasoning is essential in these domains. Even in cases of high vulnerability and increased need for support, such as the elderly and individuals who have suffered from lifelong complaints and disorders, tailored treatment is disposable. Furthermore, narration complies to various psychotherapy models and offers a transdiagnostic approach to supply assistance and aid. Recognizing coherence is fundamental to create life meaning and to also alter dysfunctional beliefs into a growth sequence. Any type of intervention should encourage individuals to frame life episodes in terms of matter, agency, and self-determination.

Although the experimental evaluation of three psychotrauma-focused interventions failed with null results in first hand, it provided valuable insights and methodological considerations. To begin with, findings underscore the importance of adequate statistical modeling in longitudinal data. Required are analyses that can straight handle autocorrelative variance, rather than to compensate with adjustments for violations of sphericity, like corrections on degrees of freedom for the *F*-statistic in the mean structure on fixed effects. In this line of thought, Linear Growth Curve Models (LGCM) applied in secondary analyses, for which findings suggest that four measurement points are sufficient to capture an effect in trauma analogue paradigm. Furthermore, model parsimony commands to align the type of analogue stimulus with the outcome(s), concluding that pictural stressors are best captured by intrusions, so that additional mood assessment is obsolete. This issue is of primary importance in exploratory designs, which should nevertheless focus on distinct outcomes, because analogue symptoms differ in burden and aftermath from real psychopathology.

Robust findings, both in literature and in this dissertation, underscore the importance of coherence and life meaning to be predictive of well-being and life quality. It is reasonable that the amount of effort spent on mental adjustment directly relates to topic relevance in autobiographical reasoning. According to time perspective theory, balancedness is based on temporal expansivity. A

balanced temporal framing is considered to be adaptive because appropriate resources can be utilized in line with situational demand. As a result of the overall analyses on well-being and temporal balancedness, adding the present to a comprehensive model consisting of three time perspectives improves the explained variance by 8 percentage above models that operate solely on past and future directions. Thus, temporal orientation is likely to be a three-dimensional construct, respectively mBTPS outperforms BTPS. Replacing the originating scales with a compound metric offers an incremental surplus of 2 percentage points. The overall explanatory power accounts for 60 percentage in explained model variation, and the cross-validated accuracy ranges in the uppermost percentile of correct predictions.

Findings also indicate that prevalence is a precedent property in classification tasks, while scale levels have minor relevance to evaluate how to best measure balancedness. Prior baserates exert rather high impact on model accuracy and predictive ability on the criterion. This dissertation adds a Bayesian vantage point to the pending discourse upon benefits and shortcomings of different approaches measuring balancedness. Furthermore, the upper quartile of average ratings on subjective well-being has been confirmed to distinguish between (un-)balanced cases. The findings confirm this threshold to have clinical significance in function of a screening cutoff. Lastly, and supporting socioemotional selectivity theory, well-being does not interact with age in predicting balancedness.

### *4.2 General Interpretation of the Findings*

In developmental lifespan psychology, this dissertation most notably contributes to research methodology and applications. Of fundamental importance is the concept of autobiographical reasoning, for which this thesis argues that the reflective self and the narrative identity are in function of intentional self-development, which arises from cognitive-emotional processes (McAdams et al., 2001; McLean et al., 2020). Across the lifespan, identity formation is conceptualized by commitment and exploration, on the observational level being measured by engagement in various life domains. Sophistication in these topics points to identity status and maturation. Coherence and life meaning are fundamental to constitute a narrative self in line with the lifestory account. The thesis elaborates on autobiographical reasoning to be a concept of high explanatory power that is open to any paradigm in this research area (McLean & Fournier, 2008).

Attribution theory supplies a formal view on cognitive functioning whereby a sense of coherence turns up from the recognition of self-sameness. In particular, consistency across life events settles *how* incidents had evolved, chronology and causality answer *why* they did occur.

Whereas contingency between incidents is a matter of fact, coherence and meaning are construed and emerge from inference. Consequently, the self is a fiction and is interrelated with reflective cognitions about the own person in time and place (McAdams, 1995; McLean & Pratt, 2006). Autobiographical reasoning offers a seminal approach to health-related outcomes in lifespan developmental psychology.

*Review article*: This conceptual work discusses the effect of reminiscence (functions) on mental growth and adaptivity. The 3-factor model provides the conceptual framework to differentiate between prosocial, self-positive and self-negative reminiscence. Prosocial reminiscence happens to be a ubiquitous phenomenon and is exercised in the service of self-regulation. Although practiced in all ages, its is especially supportive in the elderly to master developmental tasks of age. With regard to self-positive and self-negative reminiscence, both styles add evaluative processes to reminiscence. The respective outcomes will differ in valence and suggest distinct meaning, composing lifestories of a redemptive or contaminative direction. Expanding upon the conceptual framework of reminiscence functions, both Life Review Intervention (LRI) and Life Review Therapy (LRT) are structured interventions for seminal applications. Whereas the latter operates on etiological assumptions and is intended to mitigate or *treat* mental disorders, the former rather grants guidance on purpose to ameliorate indisposition. The transition between both of them is smooth, since self-reflective and evaluative cognitions in autobiographical memory are involved in either approach. Life Review Therapy (LRT) encourages to talk about life and events targeting to contextualize the memory and to reinforce adaptive inference. On purpose to gain new insight, autobiographical reasoning focuses on benefit-finding to restructure beliefs whereby a contaminative lifestory is supposed to turn into a redemptive sequence (Forstmeier et al., 2023; Lenz et al., 2020; Pinquart & Forstmeier, 2012).

*Trauma Analogue Paradigm*: Experimental psychotherapy research in trauma analogue paradigm. The superiority of either treatment is compared across three interventions, contrasted to an active control group. Focus is laid on immediate interventions that can be administered during acute trauma states: (a) an adapted version of Narrative Exposure Therapy (NET) combining exposure in sensu with memory contextualization, (b) a visual interference task that competes with limited cognitive resources during imaginary reprocessing, and (c) a combination of both interventions. Initially conducting General Linear Model (GLM), null-results question the ecological validity of the stressor, proposing that the effect size is less than had been assumed at the start. In addition, sphericity in repeated measurements suggests to re-run the analyses in a different statistical model. Extending upon this reasoning, secondary analyses performed Latent Growth

Curves Model (LGCM) that better can handle autocorrelative errors in a longitudinal design. Fixed and random effects were examined for efficacy and the study design had been evaluated for efficiency across 10 measurements.

The experiment broadly contributes to methodological considerations and recommends 4 measurements to be sufficient in order to capture an effect in trauma analogue paradigm. Furthermore, model parsimony commands that the type of an analogue stimulus ought to be align with the outcome(s), concluding that pictural stressors are best captured by intrusions, so that additional mood assessment is obsolete (James et al., 2016). This issue is of primary importance in exploratory designs, which should nevertheless focus on distinct outcomes, because analogue symptoms differ in burden and aftermath from real psychopathology.

*Balanced Time Perspective*: Cross-sectional survey on temporal framing with conceptual and methodological implications (Stolarski et al., 2020). The results in this research project can be summarized as follows: (a) adding the present to a comprehensive model on three time perspectives (TP) yields an incremental gain in explained variance of 8 percentage, compared to a model based solely on the past and future, indicating that temporal orientation is a three-dimensional construct. (b) Replacing the originating TP scales by one of the two compound measures, DBTP or SEM, gives an additional rise in explanatory power of 2 percentage. Furthermore, (c) SEM coefficient is slightly more accurate toward the closeness to balancedness, whereas DBTP marginally better captures the distance from it. Lastly, (d) presuming that metric scales in general outperform categorical or ordinal measures, prevalence and baserates have proofed to be more important than scale levels in terms of accuracy. The results indicate that measuring precision has to be evaluated under the restriction of prevalence, which is in particular fundamental in classification scenarios.

### *4.3 Limitations*

Empirical evidence always is preliminary, subjected to falsification. Therefore, focus has been laid to elaborate on a nomological framework to establish a convergent theoretical foundation. Specific limitations have already been addressed in detail in the respective chapters of this cumulative dissertation. Overall considerations are briefly outlined here.

Limitations can be subsumed under the following topics: methodological considerations, generalizability and causality. In case of the experiment, the findings of this research project are constrained by a study sample that is composed of students, mostly female psychology participants. Referencing methodological issues, it is stated that repeated measurements can better be analyzed in models that are capable to handle autocorrelative errors in covariance structures (GEE; Generalized

Equations Estimations), as opposed to models that operate on mean structures, adjusting the degrees of freedom on purpose to compensate for sphericity (GLM; General Linear Model).

In the second study on temporal framing, the cross-sectional correlational design cannot distinguish between cohort effects and causal structures in the data, although the panel provides a wide range of socioeconomic information including age within [18; 71+]. The study also failed to assess whether temporal flexibility is a facet of executive control, because the design did not condition on cognitive ability, which in literature has been proved to be fundamental in the process of selective attention and goal tracking (Chuderski et al., 2012). However, it seems reasonable to assume that balancedness arises from self-regulatory competence, which is in line with its definition that postulates the flexible shift of temporal framing to be fundamental for a balanced time perspective. Feature engineering identified a trend result at .081 (.105) significance[1] between executive functioning and balancedness [1: metric according DBTP or SEM], proposing that there is indeed some association. Above all, an online-survey is not adequate to study the effect of executive control on temporal plasticity (*see chapter on Connecting Research Questions in Future Directions*).

Consequently, some research questions remain open, for instance the interrelatedness between flexibility, adaptivity and balancedness, similarly its salutogenetic effect on mental health and life meaning. The literature discusses further predictors influencing balancedness and life meaning, for instance: (a) cognitive mechanics in ability, flexibility and creativity, or (b) cognitive pragmatics in knowledge and wisdom (Chuderski et al., 2012; Fournier et al., 2018). Most of these issues require complex modeling, such as mediation analyses, cross lagged panels, or experimental (longitudinal) designs. Causal inference is fundamental to adequately handle these topics. Since experiments are time-consuming, in particular laborious in repeated measurement designs, analytical approaches will be explored for aptitude in connecting research to narrow down causality.

### *4.4 Conclusions for Prevention and Psychotherapy*

Memory is constructive towards perception, which in itself is selective. Motivation, sensory ability and cognitive capacity impose sources of bias. The mental construction of causality is a fiction, but fundamental for the creation of comprehension and coherence. Meaning emerges from attribution due to the recognition of contingency between life events (Kapoor et al., 2023; McLean & Fournier, 2008; McAdams, 1995).

Obviously, psychological outcomes will differ depending on how life events are understood and how they are framed. The composition of a lifestory can be either contaminative or redemptive.

The former focuses on losses and favors closed-mindedness within the constraints of dysfunctional beliefs. The latter discloses growth options, unfolding insight and choice (McAdams et al., 2001; McLean & Pratt, 2006). But in the past neither event is objective of change, only salience and meaning can be.

The transactional stress model describes the general context of adaptation and the associated mental processes. The model states that the demand for adjustment requires the perception of a relevant threat while evaluating the resources to be insufficient. Either problem-oriented or emotional coping is possible (Lazarus & Folkman, 1987). In general, adaptation is assumed to be functional, when behavioral, mental or affective plasticity can be recovered or has been maintained (Leipold, 2015).

Implications and conclusions for psychotherapy are outlined by these views:

(a) adaptation and plasticity, (b) motivation and volition, (c) etiological consideration on aging, (d) evidence based interventions and recommendations.

(a) Adaptation adjusts for contextual requirements and happens within a biospsychosocial space of development (Esser & Petermann, 2010), whereby lifespan trajectories of biographical transitions picture the course of intentional self-development (Leipold, 2015). Although demand for adjustment emerges in any age, the transactional stress model postulates that topic relevance and availability of resources are fundamental factors to cope with incidents. Critical life events are particularly challenging because they occur suddenly and the demand requires impromptu action.

(b) The rubicon model of action phases outlines a motivation-volition feedback loop and offers a general explanatory framework to explain cognitive-emotional processes in self-regulation. The motivational phase comprises preference and choice, whereas volition includes executive functioning and goal tracking (Achtziger & Gollwitzer, 2018).

- From a transdiagnostic perspective, interventions should focus on deficits in self-regulatory processes that contribute to vulnerability, aiming to enhance or to re-establish functional levels in psychosocial performance.
- Resilience factors offer a promising approach to build resources, including self-perception, self-efficiency, pragmatic and social skills (Fröhlich-Gildhoff & Rönnau-Böse, 2015; Leipold, 2015).

(c) From lifespan perspective, etiological considerations most notably address aging. Growing older happens in time and is both a process and a state, which often is accompanied by

quantitative and qualitative changes in psychosocial functioning. Most typical phenomena, among others, concern sensory competence and the cognitive reserve capacity. Shifts in cognitive fluidity are common while knowledge consolidation is more about experience and lifelong learning, provided the brain is healthy. Physiologically, a prolonged recovery time is usual in response to demanding tasks or following unpleasant experiences. Personality traits alter in line with typical trends, particularly in terms of less openness, accompanied by a reduced level of extraversion and a greater appreciation of conscientiousness (Chuderski et al., 2012; Donnellan & Lucas, 2008; Forstmeier & Ochel, 2022). Of note is that in subsyndromal state, adjustments for age-graded conditions are supposed to be adaptive. Accordingly, socioemotional selectivity and the positivity effect, both account for selective attention and distinct choice in the elderly (Carstensen et al., 1999; Reed & Carstensen, 2012).

- Assistance, support and treatment need to be shaped in order to meet the needs of aged persons. Insofar health or living conditions interfere with developmental tasks, mastery may be hindered: aging will be compromised which in consequence raises vulnerability for adjustment disorders.
- In case of anxiety disorders, affect-tolerance has to be considered, in particular apart from a prolonged recovery time following stressful activities in elderly persons.
- In psychotrauma-focused interventions, it is prerequisite to address life meaning as relevant therapy outcome, i.e. to recover a sense of purpose and coherence (Forstmeier et al., 2023; Lenz et al., 2020; McAdams et al., 2001; McLean & Pratt, 2006; Schauer & Elbert, 2011; Schauer, 2015).
- Depression and anxiety disorders are mental diseases of high prevalence in persons of age, dementia has an overall incidence rate of 18.2 percentage per year in persons of high age (Corrada et al., 2010; Forstmeier & Maercker, 2008; Kessler et al. 2005). Chronicity accounts for comorbidity, likely to be accompanied by impairments in sensory perception, imposing difficulties in source monitoring. It is reasonable to presume, that the experience of any critical life event has a high lifetime prevalence as well.

(d) Guideline treatment is based on evidence, accounting for etiology and building on a psychopathology model. To address persons of age, ubiquitous settings in daily living offer prosperous occasions to assist the spontaneous needs in social reminiscence. Though the experience is of momentary effect, its accumulation over time and the generalization across contexts expands resources because functional habits are likely to be reinforced, thereby sustaining self-regulation

(Cappeliez & O'Rourke, 2006; Carstensen, 1995; Carstensen et al. 1999; Fredrickson & Joiner, 2002; O'Rourke et al., 2010). With regard to dementia, mood stabilization is fundamental in subsyndromal states, because a timely aid reduces the risk of disease progression and thus has protective effect. However, cognitive enhancements are of short aftermath and they are constrained by biological conditions.

In cognitive behavioral therapy (CBT), beliefs are best disputed by experience. Directions that favor functional adjustment ought to be followed and reinforced. In case of anxiety disorders, exposure and habituation are essential interventions alongside cognitive restructuring. The former rationale targets extinction learning by collapsing arousal with parasympathetic activation, the latter intervention broadens the perspective by changing expectation and beliefs.

Narrative approaches in psychotherapy originate from simple reminiscence. Structured applications such as Life Review Therapy (LRT) use a psychopathology model on purpose to ease symptoms and to treat the causes of a certain disorder. The rationale encourages the patient to recall critical life events, to remember and to tell about the experience (exposure in sensu), to compose the recollection into anteceding and succeeding episodes (memory consolidation), and to resolve the story in accord to coherence and meaning. This intervention actually resembles Narrative Exposure Therapy (NET), in which the recalled memory is narrated first in sensory detail, to be then put into the preceding and consecutive moments. Habituation arises through repetition until the arousal settles (Pinquart & Forstmeier, 2012; Forstmeier et al., 2023; Lenz et al., 2020; Schauer, 2015). With regard to Posttraumatic Stress Disorder (PTSD), a highly sensory-based traumatic memory is poorly elaborated, thus prominent theories primarily conceptualize a memory disorder resulting from maladaptive encoding of the traumatic memory (Ehlers & Clark, 2000).

Most recently, research on life meaning interventions gained pace in scientific discourse. Well-known from early work on salutogenesis and the sense of coherence, the experience of life meaning is currently being proposed to enhance mental health as well. Robust evidence underscores an overall negative association between life meaning and distress. Evidence is seminal and manifold, here are just some examples, including: the aggravating influence of uncertainty fear on distress (Ostafin et al., 2022), the exacerbating impact of distress on rumination (Ostafin & Proulx, 2022), or brief psychotrauma-focused interventions targeting life meaning (Seidel-Koulaxis et al., 2024). However, search for meaning can also be maladaptive, for instance in combination with deficits in self-regulatory competence and low resources. In this case, the search for meaning is likely to worsen rumination and causes an exacerbative dynamic (Amlashi & Forstmeier, 2025).

### *4.5 Connecting Research Questions in Future Directions*

Temporal orientation and its underlying sociocognitive processes usually operate without careful consideration and beyond conscious attention but may come into focus of mind in principle. In literature, this meta-cognitive notice of observational state is referred as time paradox (Zimbardo & Boyd, 1999). Although the ANIQ measure is particularly designed to capture this facet of self-perception, i.e. the awareness of having a lifestory, no association has been found between this subscale and coherence (Kapoor et al., 2023). This finding opposes as well the originating intent of the measure as the overall foundation of life events, when extra cognitive effort is spent to recover consistency and meaning amid dissonance experience and in response to change (Amlashi et al, 2025; Amlashi & Forstmeier, 2025; McLean & Pratt, 2006; Lazarus & Folkman). Empirical evidence reports that wisdom and creativity are predictive of adaptivity and coherence, together with cognitive executive functioning that has been shown to associate with coherence as well (Fournier et al., 2018). The composition of life episodes to a lifestory of an either redemptive or contaminative meaning will have distinct impact on various psychological outcomes (Cappeliez & O'Rourke, 2006; King et al., 2019; McAdams et al., 2001). However, empiricism is contradictory with regard to the postulated salutogenetic effect of coherence on (mental) health outcomes. Literature explains inconsistent findings by rumination, which can be coherent, yet negative and propagating overgeneralized memory or affect, and therefore is dysfunctional (McAdams et al., 2001; McLean et al., 2020).

(1) This dissertation argues that solution likelihood is fundamental in a decisive context and has to be taken into account in order to capture temporal choice as precise as possible. Elaborating further on this hypothesis draws attention to information theory. Accordingly, the concept of informatory richness airs the idea that any message content or distributional properties of life events can be quantified in terms of knowledge accumulation. The corresponding measure uses probability to provide an estimate. Occurrences of low expectancy are highly informative, whereas the contrary is true for frequent incidents. For instance significance levels in statistical inference that mark thresholds for deciding whether data are compatible with a hypothesized model. Formally, content richness is quantified by entropy, which is defined as the average amount of information that is contained in a message having a certain expectancy to be sent or to be received. Measuring entropy uses the formula: $H = - \Sigma \, ln \, [1/ \, p(x)]$ within $[\infty \mid p(x) = 0; \, 0 \mid p(x) = 1]$. Entropy is a reasonable concept in both data likelihood (posterior probability) and prior probability, respectively. Summarized in a nutshell, the informatory richness of a message that has never been broadcasted yet would be infinite and soon nullifies the more frequently it will be sent. Thus, plotting entropy

provides a reverse curvilinear graph that peaks at $p(x) = 0.5$ and asymptotically approaches zero at the tails of the distribution, hence $p(x) \gg 0$ or $p(x) \gg 1$ implies $H(X) \rightarrow \min!$ (Everitt & Skrondal, 2010[1995, 1207]; Wirtz, 2021, 2022b).

With regard to connecting research, it is hypothesized that cognitive-emotional processes ought to be studied when the odds for either option are even, because entropy will be highest to infer preference. To give an example of a seminal application, probabilistic test theory is based on this assumption to infer person parameters (Rose, 2020; Wirtz, 2022c). In developmental lifespan psychology, possible use cases for the conceptualization of entropy are emotional valence, choice and preference, for instance: (a) highly valued but unrealistic goals, pointing to impossible events, (b) or envisioned threats originating in aversive conditioning that has turned a previous experience into a persuasive belief. In these scenarios, regret or fear are plausible affective states. Likewise the former points towards the past and worsens rumination, so does the latter project the initial experience into the future and evokes anxiety. Either of these outcomes may be conclusive in terms of construed coherence, but only a change in preference will open up choice for a new perspective, ease the dissonance, and create meaning.

Applying these lines of thoughts to time perspective theory reasons that the likelihood of either option has to be considered aside emotional valence in order to examine time perspective and to best study its bias in individuals. Assuming that temporal orientation usually functions beyond notice, high entropy is prerequisite to explore both awareness and temporal preference in order to account for the odds of success based on personal intent. To the authors knowledge, no research has yet been spent on the interrelatedness between likelihood and salience. It is proposed, that a study design has to control for entropy in order to distinguish between salience and relevance, accordingly to separate awareness from preference.

(2) The aptitude to actively disamplify negative arousal is supposed to be adaptive in the elderly, given a prolonged recovery time following an aversive experience or succeeding a demanding (cognitive) task (Forstmeier & Ochel, 2022). However, this competence sometimes fails, causing poor adaptation. Conditions that counteract the positivity effect are: (a) limited cognitive resources, (b) automatic information processing, (c) precedence of context-specific goals, (d) self-regulation is risky (Reed & Carstensen, 2012).

Provided that cognitive pragmatics remain intact in healthy persons of age while cognitive mechanics (fluidity) usually is reduced, it would be of interest to learn more about the conditions which impair the ability to either downsize aversive arousal or volitionally direct attention towards

attractive goals. One possible candidate can be found in executive functioning. The results in this thesis show that positivity associates with both well-being and balancedness. Evidence in current research proposes that the impact of executive control on both well-being and temporal plasticity is primarily influenced by cognitive ability. In particular, storage capacity nullifies the effect of attention control on fluidity when controlling for mental functioning (Chuderski et al., 2012). The aptitude of holding items in active working memory proves to be crucial to executive functioning, implying that the reserve capacity does constrain both selective goal attention and fluid intelligence (Chuderski et al., 2012; Stolarski et al., 2020).

The findings of this dissertation show that the self-control measure is significantly associated with various outcome variables. (a) Large effect: well-being indicators, balancedness indices, and the present time perspective; (b) medium effect: positivity, the past and future time perspective (table 2). In addition, feature engineering identified a trend result between executive functioning and balancedness, proposing that there is indeed some association in conformance with time perspective theory.

Mediation analyses are suitable uses for examining the effect of executive control, mental fluidity and selective goal attention on temporal balancedness in more detail (ibid.; Kapoor et al., 2023; Stolarski, 2020). Possible starting points are for instance: (a) Prosocial reminiscence functions: its impact on psychological outcomes and health is rather indirect and interceded by self-negative and self-positive functions (Cappeliez & O'Rourke, 2006; O'Rourke et al., 2010, 2016). (b) Well-being boosters: exerting an indirect effect on several indicators of life quality, interacting by either mediation or moderation (Burzynska & Stolarski, 2020). (c) Awareness of temporal framing: ANIQ validation study reports null-findings for the association between awareness and coherence. (d) Salience of (mal-)adaptation: mental effort and exhaustive search for meaning, worsening deficiencies in self-regulation and rumination (Amlashi & Forstmeier, 2025; McLean & Pratt, 2006; McLean & Thorne, 2003; Thorne et al., 2004).

(3) It would be interesting to compare mediation models across different analytical frameworks for their outcomes (Baron & Kenny, 1986; Zhao et al., 2010). Firstly, it seems to be inconclusive that the presence of a substantial direct effect is prerequisite in order to proceed with mediation analysis. Second, in some contexts it is misleading to separate partial from total mediation by inference from a change in effect size on the direct path.

(a) The proposition to initially proof the effect on the direct path is not conclusive, because mediation strength will later on be inferred by its absence (or reduction), comparing the initial

*X* – *Y* outcome with a model that is being conditioned on the mediator, i.e. total versus partial mediation. But absence cannot quantify effect size, its magnitude can only be estimated by the strength of the indirect effect itself. In addition, the mediating variables on the indirect path can either cancel out or amplify each other, so that direct and indirect effect may be reverse signed, hence competitive respectively complementary mediation. Notably, the former may nullify the direct effect. And lastly, model completeness can only be inferred by assessing the effects on the indirect path.

(b) Expanding upon this reasoning, it would be interesting to explore analytical models of causality as well, for instance adding confounder and collider from directed acyclical graphs (DAG) to mediation analysis. As mentioned earlier, it would be misleading to interpret the *X* - *Y* outcome as a null result on the direct path if the effects on the indirect path are mutually competitive. But the complementary mediation use case can flaw inference also, when a variable is falsely considered to be a covariate of the outcome but in fact totally mediates the direct effect, although the model does not take note of this option. Formally, [*cov*(x,y)|z] = 0 but [*cov*(x,y) ≠ 0]. Ignoring either configuration can untimely finish analysis and no-effect may be wrongly inferred.

**Publications and Conference Contributions**

Overview of the publications and preregistrations with reference to the cumulative dissertation.

Lenz, H.-J., Zimmermann, S. & Forstmeier, S. (2020). Der Lebensrückblick und Traumafolgestörungen aus der Perspektive der Lebensspanne. *Trauma & Gewalt*, *14* (4), 288–302. https://doi.org/10.21706/tg-14-4-288

Lenz, H.-J., Forstmeier, S., Flöter, L., Hulsmans, N. & Schmidt, M. (submitted). *Experimental analogue trauma study. Personalized Medicine in Psychiatry*, under review.

Lenz, H.-J., Forstmeier, S., Flöter, L. & Hulsmans, N. (submitted). Balanced Time Perspective and Covariates of Well-being. *Frontiers in Psychology*, under review.

**Research Talks**

Lenz, H.-J. (lecturer), Forstmeier, S., Flöter, L., Hulsmans, N. & Schmidt, M. (2024). *Immediate interventions following traumatic exposure in an analogue experiment: explorative results*. 53rd DGPs-Congress, Vienna

Lenz, H.-J. (lecturer), Forstmeier, S., Hulsmans, N. & Flöter, L. (2025). *Balancierte Zeitperspektive: Ergebnisse aus einer quasi-experimentellen Kohortenstudie im Querschnittsdesign*. Tagung der DGPs Fachgruppe Entwicklungspsychologie EPSY 2025, Gießen

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## Supplementary Materials to this Dissertation

### Manuscript 1, published article

Conceptual work [Review on recollective growth and recovery of life meaning]

Lenz, H.-J., Zimmermann, S. & Forstmeier, S. (2020). Der Lebensrückblick und Traumafolgestörungen aus der Perspektive der Lebensspanne. *Trauma & Gewalt*, *14* (4), 288 – 302. https://doi.org/10.21706/tg-14-4-288

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### Manuscript 3, submitted article

Empirical work [Cross-sectional online survey on temporal framing and well-being]

Lenz, H.-J., Forstmeier, S., Flöter, L. & Hulsmans, N. (submitted). Balanced Time Perspective and Covariates of Well-being. *Frontiers in Psychology*, under review.

**Manuscript 1, published article**

*Article: Conceptual work [Review on recollective growth and recovery of life meaning]*

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WISSENSCHAFT

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# Der Lebensrückblick und Traumafolgestörungen aus der Perspektive der Lebensspanne

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**Zusammenfassung:** *Narrative Behandlungsansätze, Biografiearbeit und Interventionen des Lebensrückblicks haben in der Psychotherapie, Geriatrie, Pflegewissenschaft und palliativen Pflege eine hohe Akzeptanz. Effekte zeigen sich bezüglich kognitiver, affektiver und verhaltensbezogener Maße. Menschen jeden Alters erinnern sich und teilen ihre Erfahrungen. Dies ist ein bindungsstiftendes und sinngebendes Bedürfnis und nicht nur dem Alter vorbehalten. Im Gegenteil: Die Vorstellung zukünftiger Ereignisse ist ohne die Erinnerung an vergangene Erfahrungen nicht möglich. Erinnerung, biografisches Gedächtnis und Identität sind eng aufeinander bezogen. Narrative Interventionen bearbeiten das autobiografisch-episodische Gedächtnis. Die meiste Forschung zum Lebensrückblick besteht zur Wirksamkeit bei Depression im Alter und bei demenziellen Erkrankungen. Aktuelle Studien untersuchen den Nutzen dieser Interventionen im mittleren Lebensalter sowie deren Indikation bei der Posttraumatischen Belastungsstörung. Das chronologische strukturierte Vorgehen des Lebensrückblicks unterscheidet sich von dem spontanen Erinnern, der Reminiszenz. Die klinische Anwendung ist der Lebensrückblicktherapie vorbehalten. Trotz guter Behandlungsergebnisse stehen die Verabschiedung therapeutischer Leitlinien und die Empfehlung als Methode innerhalb eines Richtlinienverfahrens jedoch noch aus.*

**Schlüsselwörter:** *Lebensrückblick, Lebensspanne, kritische Lebensereignisse, Posttraumatische Belastungsstörung, Biografiearbeit, Entwicklungsaufgabe*

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## Einleitung

Die Perspektive der Lebensspanne führt unmittelbar zum Lebensrückblick. Unabhängig vom Lebensalter sind die biografische Rückschau auf die Lebensereignisse und das soziale Teilen der Erinnerungen und der Erfahrungen ein spontanes und häufig auftretendes Phänomen. Die Herausforderungen der Lebensabschnitte einer Biografie sowie kritische oder bedrohende Lebensereignisse ziehen regelmäßig eine Anpassungsleistung nach sich. Die Rückschau auf das gelebte Leben und hierin Sinn zu finden, ist eine Entwicklungsaufgabe insbesondere von Menschen im hohen Alter. Aus verschiedenen Gründen greifen also therapeutische Behandlungen und niederschwellige Unterstützungsangebote narrative Interventionen und Erinnerungsarbeit auf. Denn es sind bewährte Verfahren, ihre Wurzeln haben sie in der Pflegewissenschaft und der Gerontologie. Typische klinische Anwendungsbereiche sind depressive Störungen und affektive Beschwerden, die palliative Pflege und demenzielle Erkrankungen (Pinquart & Forstmeier, 2012; Westerhof & Bohlmeijer, 2014). Der

Artikel gibt einen Überblick zur Forschung und Erfahrung aus der Anwendung narrativer Interventionen. Dies betrifft den klinischen Nutzen als ergänzende Methode im Rahmen eines Richtlinienverfahrens, die Anwendung im mittleren und höheren Lebensalter sowie die Indikation für einzelne Störungsbilder oder die Wirkung auf das allgemeine psychische Wohlbefinden (Cotelli, Manenti & Zanetti, 2012; Subramaniam, Woods & Whitaker, 2014; Woods, O'Philbin, Farrell, Spector & Orrell, 2018). Zum Nutzen von narrativen Interventionen bei der Posttraumatischen Belastungsstörung (PTBS) gibt es für das mittlere Lebensalter viele Wirksamkeitsstudien. Dringend benötigt werden Empfehlungen und Richtlinien für alte Menschen, die von einer PTBS betroffen sind. Insbesondere im hohen Alter kann eine unbehandelte PTBS die integrative Rückschau und das Finden von Sinn in der eigenen Biografie sowie das soziale Teilen der eigenen Lebensgeschichte und die Integration von Erfahrungen zu einem kohärenten Narrativ erschweren. Über die Symptomatik der PTBS hinaus begünstigt dies die Entwicklung weiterer psychischer Störungen wie Depression, aber auch körperlicher Beschwerden (Aldwin, Wykle, Kahana & Kowal, 1992; Böttche, Kuwert & Knaevelsrud, 2012; Maercker & Bachem, 2013; Maercker & Forstmeier, 2013). Insbesondere im hohen Alter ist eine unbehandelte PTBS ein Risikofaktor für weitere psychische Erkrankungen, wenn sich frühere Traumaerfahrungen noch heute auswirken und eine integrative Rückschau beeinträchtigen: die Sinnfindung in der eigenen Biografie, das soziale Teilen der eigenen Lebensgeschichte sowie die Integration von Erfahrungen zu einem kohärenten Narrativ. Der Lebensrückblick kommt dem Bedürfnis älterer Menschen nach, diese Entwicklungsaufgaben zu bearbeiten.

**Formen der narrativen Intervention sind die Reminiszenz, der Lebensrückblick und die Lebensrückblicktherapie.**

### Theoretische Hintergründe vom Lebensrückblick bei Traumafolgestörungen

Formen der narrativen Intervention sind die Reminiszenz, der Lebensrückblick und die Lebensrückblicktherapie. Unterschiede zwischen diesen Formen bestehen u. a. hinsichtlich des Strukturierungsgrads, des Vorhandenseins einer klinischen Indikation sowie der Art oder des Schweregrads der Störung. Staudinger (2001) systematisiert die einzelnen Verfahren und spricht sich nicht nur für eine pragmatische, sondern auch für deren konzeptionelle Trennung aus. Die Reminiszenz, das Sicherinnern, beschreibt Butler (1964) als einen entweder spontanen oder willentlich herbeigeführten Prozess. Das spontane Erinnern ist dabei weniger ein Ausdruck der Nostalgie oder einer zeitlich rückwärtsgewandten Ausrichtung des Denkens oder Fühlens, sondern hat für die eigene Identität sowie die Selbst- und Weltsicht eine grundlegende Bedeutung (Pinquart & Forstmeier, 2012). Erfahrungswissen organisiert sich als ein kognitives Schema, das die Erwartungen für die Zukunft lenkt, die Wahrnehmung der Gegenwart steuert, die Erinnerung an Vergangenes färbt und folglich das Handeln lenkt (Pinquart & Forstmeier, 2012; Young et al., 2008).

Erinnerung im Sinne einer willentlich herbeigeführten Aktivität ist in die Motiv- und Bedürfnislage der Person eingebettet, die sich aus einem bestimmten Grund erinnert. Die Verdichtung der Erfahrungen zu einer kohärenten Lebensgeschichte und das Erleben von Identität sind ein grundlegendes psychisches Bedürfnis, nicht nur älterer Menschen (Butler, 1964). Das soziale Teilen und die Narration von Erfahrungen verbinden Zuhörer und Erzähler miteinander, verschaffen Bindung und sind identitätsstiftend. Für junge Menschen dienen sie auch dem Wissenserwerb und dessen Konsolidierung, ältere Menschen folgen demgegenüber vorrangig Motiven der Emotionsregulation (Brandtstaedter & Renner, 1992).

Inhaltsanalytischen Untersuchungen zufolge gibt es wiederkehrende Muster der Erinnerungsaktivität, die sogenannten Erinnerungsstile (Cappeliez & O'Rourke, 2006; Webster, Bohlmeijer & Westerhof, 2010; Wong & Watt, 1991). Die Reminiscence Function Scale (RFS) ist ein Instrument zur Messung von Erinnerungsstilen (Webster, 1993, 1997; Webster, Haight & Webster, 1995). Es unterscheidet folgende Funktionen des Erinnerns: Identitäts- oder Lebensstilformierung, Problemlö-

sung, Langeweilereduktion, Verbitterungspflege, Intimitätsaufrechterhaltung, Belehrung und Information, Kommunikation, Todesvorbereitung. O'Rourke et al. (2016) fassen die Erinnerungsstile auf drei übergeordneten Dimensionen zusammen und unterscheiden in ihrem Dreifaktormodell instrumentelle, integrative und soziale Reminiszenzfunktionen.

Je nach Autor und Untersuchung unterscheiden sich die Klassifikationssysteme geringfügig in ihrer Systematik. Hinsichtlich der Wirkung und Effekte auf die psychische Gesundheit sind weder die Anzahl noch die Granularität der gefundenen Systematiken wesentlich. Vielmehr entscheidend ist die *gewohnheitsmäßige Verwendung* einzelner Erinnerungsstile: Deren Orchestrierung zu einem Narrativ nimmt Einfluss auf das psychische Wohlbefinden und die psychische Gesundheit, ebenso zeigt sich ein Zusammenhang mit klinisch bedeutsamen Symptomen, u. a. Depression, Angststörungen, Schlaf, Wohlbefinden oder kardiovaskulären Beschwerden, Psychosomatosen (King, Cappeliez, Canham & O'Rourke, 2019; O'Rourke et al., 2016). Dies ist gut dokumentiert und betrifft auch die Bewertung und die Integration von Lebenserfahrungen sowie die rückschauende Sinnfindung in der gewordenen Biografie (Blagov & Singer, 2004; McAdams, 2006; McLean & Fournier, 2008; Thorne, McLean & Lawrence, 2004): Der gute Abschluss einer schlechten Erfahrung hat eine andere Wirkung als ein gutes Ereignis, das mit einem schlechten Ergebnis endet.

Die Reminiszenz findet oft als spontanes Erinnern in einem informellen Setting statt. Im Unterschied zur Reminiszenz ist der Lebensrückblick (LR) stärker strukturiert und *bewertet* frühere Ereignisse. Er geht somit über die bloße Erinnerung hinaus und möchte die Integration von Erfahrungen und Lebensereignissen in eine kohärente Sicht auf die eigene Person anregen.

**Erfahrungswissen formt die Identität und die Vorstellung kommender Ereignisse**
**Die Effekte des Lebensrückblicks sind deutlicher ausgeprägt, wenn die Erinnerungsarbeit struk turiert erfolgt.**

Die Effekte auf das Wohlbefinden und psychische Beschwerden sind dabei deutlicher ausgeprägt, wenn die Erinnerungsarbeit strukturiert erfolgt (Pinquart & Forstmeier, 2012), wie es einem therapeutischen oder beratenden Kontext entspricht. Der chronologische Ablauf des LR und die Inhalte der einzelnen Sitzungen orientieren sich an den Lebensabschnitten und bearbeiten die entwicklungsbezogenen Themen der Biografie (Erikson & Erikson, 1998). Die Erinnerungen an die Kindheit, die Jugend, das Erwachsenenalter und die gegenwärtigen Erfahrungen stehen im Mittelpunkt der einzelnen Sitzungen. Den Lebensabschnitten und ihren Themen widmet der LR je eine bis zwei Sitzungen. Das Vor- und Nacharbeiten sowie das Mitbringen von Erinnerungshilfen, wie z. B. Bilder, Gegenstände, Musik oder Ähnliches, ergänzen die Sitzungen.

Der LR eignet sich für die Arbeit in Einzel- oder Gruppensitzungen und ist manualisiert verfügbar (Haight & Haight, 2007; Maercker & Forstmeier, 2013). In einem nicht therapeutischen Setting bestehen außerdem gute Erfahrungen mit der Durchführung trainierte Personen oder angelernte Prozessbegleiter, wie z. B. Angehörige oder Pflegekräfte (Cotelli et al., 2012; Subramaniam et al., 2014; A. Zimmermann et al., 2019). Unabhängig von einer konkreten Indikation wird die allgemeine Wirkung des LR dadurch erklärt, dass er Ressourcen aktiviert sowie frühere Bewältigungsversuche oder Problemlösungen für den gegenwärtigen Kontext utilisiert (Pinquart & Forstmeier, 2012). Als niederschwelliges Angebot sind es die Aktivierung von Ressourcen und die Förderung der Resilienz, auf die der LR günstig einwirkt. Die Behandlung von psychischem Leiden im Sinne von klinisch bedeutsamen Symptomen ist der Lebensrückblicktherapie (LRT) vorbehalten.

Im Unterschied zum LR begründet sich die LRT aus der *klinischen Indikation* des Einzelfalls und kombiniert die narrative Biografiearbeit mit weiteren störungsspezifischen Interventionen. Das Setting der LRT ist therapeutisch ausgerichtet und wendet sich an eine klinische Klientel mit psychischen Störungen. Das Behandlungsrational bezieht oft weitere Verfahren ein, wie z. B. Methoden der Kognitiven Verhaltenstherapie (KVT) (Maercker & Bachem, 2013). Die LRT ergänzt ent-

weder ein psychotherapeutisches Richtlinienverfahren oder eignet sich als eine Methode innerhalb der Behandlungsplanung. Anpassungen und zielgruppenbezogene Erweiterungen beinhalten die biografische Rekonstruktion, eine gemäßigte Exposition sowie die Integration und kognitive Neubewertung der Erfahrungen, wie es beispielsweise dem Vorgehen der Integrative Testimony Therapie (ITT) entspricht (Knaevelsrud, Böttche, Pietrzak, Freyberger & Kuwert, 2017). Die Durchführung der LRT erfordert in der Regel Erfahrung mit dem jeweiligen Störungsbild und dem darauf abgestimmten Behandlungsrational.

**Die Lebensspannenperspektive**

Autobiografisches Erinnern ist ein aktiver Prozess, der frühere Erfahrungen nicht nur abruft und aktualisiert, sondern die Erinnerung aus heutiger Sicht konstruiert. Die Literatur zur Reminiszenz unterscheidet wie oben beschrieben acht Funktionen des Erinnerns (Webster, 1993, 1997; S. Zimmermann & Forstmeier, 2020). Für alle gilt: Der gleichförmige Abruf und Zugriff auf das autobiografische Wissen prägen die sogenannten Erinnerungsstile (King et al., 2019; O'Rourke et al., 2016). Sie beeinflussen das Erleben, Denken, Fühlen und Handeln ebenso wie die Herausforderung durch Ereignisse entlang der Lebensspanne. Entwicklungsregulative Kompetenz ist eine lebenslange Aufgabe (Kessler & Forstmeier, 2017). Gelingende Entwicklung ist progressiv; sie erhält oder vergrößert die individuelle Plastizität und Adaptivität (Greve, Leipold & Kappes, 2018; Leipold, 2015). Auch eine maladaptive Verarbeitung von Lebensereignissen oder Entwicklungsaufgaben ist möglich und korrespondiert in der Regel mit klinischen Symptomen.

Neben den regelhaften und daher erwartbaren Verläufen einer Biografie sind die kritischen Lebensereignisse zu nennen, wie z. B. Trennung, der Verlust des Arbeitsplatzes oder Erkrankungen. Lebensereignisse dieser Art erfordern immer und regelmäßig eine Anpassungsleistung (Aldwin et al., 1992; Bengel & Hubert, 2010; Filipp, 1981). Die Belastung folgt dabei nicht aus dem Lebensereignis an sich, sondern entsteht aus der Wahrnehmung und der Bewertung der Umstände heraus. Das Transaktionale Stressmodell von Lazarus (Lazarus & Folkman, 1987) erklärt das Erleben von Stress als zweistufigen Prozess: die Wahrnehmung eines Ereignisses als gefährlich, herausfordernd oder bedrohlich *und* die gleichzeitige Einschätzung einer ungenügenden Ressourcenlage. Hiernach ist Stress weder ausschließliches Merkmal der Person noch der Umwelt. Es geht um die wahrnehmende Auseinandersetzung mit der Umweltanforderung und die hierauf bezogene Beurteilung der eigenen Kompetenz. Das Erleben von Stress äußert sich kognitiv und im vegetativen Nervensystem: als unangenehme Spannung und sympathikotoner Folgezustand. Verändern sich Wahrnehmung oder Beurteilung, so wandelt sich auch das Stresserleben (Somerfield & McCrae, 2000; Thompson, 1981). Im Unterschied zu kritischen Lebensereignissen *überlasten* traumatisierende Erlebnisse die individuelle Anpassungsfähigkeit. Traumaerfahrungen ereignen sich typischerweise unvorhergesehen, sie sind nicht antizipiert und haben ein existenzbedrohendes Ausmaß. Maladaptive Reaktionen auf derartige Erfahrungen bedingen pathogene Normabweichungen und erfordern meist eine therapeutische Intervention. Typische Symptome einer PTBS sind das intrusive Wiedererleben, das Hyperarousal und die Vermeidung. Für ältere Betroffene ist folgende lebenszeitliche Einordnung der zugrunde liegenden Traumaerfahrung sinnvoll (Böttche et al., 2012; Conway & Pleydell-Pearce, 2000; Maercker, 2002; Maercker & Zöllner, 2002; Zoellner & Maercker, 2006):

- Eine *chronische* PTBS im Alter besteht oft über die Lebensspanne hinweg. Die unbehandelte Symptomatik führt zu Beschwerden und Leiden. Bei der heute lebenden Generation der Älteren sind es frühere Erfahrungen von Krieg, Vertreibung oder rassistisch begründeter Verfolgung. Eine im Alter bestehende PTBS kann insbesondere auch die Reaktivierung oder die Exazerbation einer über die Lebensspanne hinweg bestehenden Störung sein. Auch wenn die Symptomatik in den meisten Fällen im Verlauf der Zeit abnimmt (Böttche et al., 2012), können Entwicklungsaufgaben sowie das Bedürfnis nach Rückschau und Bilanzierung des Lebens eine Belastung für alte Menschen sein, die eine PTBS begünstigt.
- Die Erfahrung von Gewalt, Überfällen oder Erkrankungen kann im Alter zu einer *akuten* Traumatisierung führen. Im Vergleich zu jüngeren Personen berichten Ältere allerdings eine geringere Schwere und Dauer der Symptome.
- Auch das *verzögerte* Auftreten einer PTBS ist denkbar. Dies wird mit dem altersbedingten Verlust an kompensatorischer Kompe-

tenz in Zusammenhang gebracht. Die Abnahme der kognitiven Leistung kann im Alter ein solcher Risikofaktor sein. Hierfür sprechen die Zunahme von Vermeidung und Hyperarousal sowie die geminderte Häufigkeit des Wiedererlebens, wie es dem Beschwerdeprofil vieler betroffener Patienten entspricht (Böttche et al., 2012; Kruse, Schmitt & Re, 1999).

Um Fehlbehandlungen vorzubeugen, ist außerdem die differenzialdiagnostische Expertise gefordert, eine PTBS im Alter zu erkennen und von einer demenziellen Erkrankung abzugrenzen (Davison, Pless, Gugliucci & King, 2006). Ungeachtet der Krankheitswertigkeit der Störung ist eine PTBS gerade für ältere Menschen eine zusätzliche Belastung, da sie die biografische Rückschau erschwert oder gänzlich verhindert. Nach Erikson und Erikson (1998) sind Sinnfindung und Bilanzierung des Lebens eine Entwicklungsaufgabe des Alters. Eine unbehandelte PTBS ist daher ein Risikofaktor dafür, dass Entwicklungsaufgaben des Alters unbewältigt bleiben. Für betroffene Patienten geht es dabei um die Einbindung der Traumaerfahrung in den Alterungsprozess. Dies berührt auch das Bedürfnis nach Sinnfindung und das Erleben von Kohärenz in der eigenen Lebensgeschichte. Gelingt dies nicht, kann eine traumafokussierte Behandlung angezeigt sein.

Brady et al. (2019) sowie Davison et al. (2006, 2016) diskutieren Stressreaktionen im Alter, die im Zusammenhang mit einem lebenszeitlich lange zurückliegenden und bedrohlichen Ereignis stehen (LOSS, late-onset stress symptomatology). Hiernach modulieren frühere Belastungen und deren Verarbeitung das heutige Stresserleben und die Reaktion auf aktuelle Stressoren. Im Gegensatz zu einer PTBS ist die erhöhte Reagibilität auf Stressoren weder krankheitswertig noch Ausdruck einer verzögerten PTBS, da es die Verarbeitung von *normativen* Belastungen im Alterungsprozess betrifft, u. a.: die Berentung, den Tod von Freunden oder Ehepartnern, Erkrankungen, körperliche oder psychische Einschränkungen. Als Risikofaktor des Alters benennen die Autoren die Reminiszenz, ohne jedoch den Erinnerungsstil näher zu beschreiben. Im Kontext altersbezogener Veränderungen korreliert LOSS mit intrapersonalen Risiko- und Resilienzfaktoren und betrifft daher auch die Bewältigung von Entwicklungsaufgaben (ebd.; Fröhlich-Gildhoff & Rönnau-Böse, 2019). Die erhöhte Reagibilität auf Stressoren kann ein subsyndromaler Risikofaktor sein, der die Adaption an Entwicklungsaufgaben erschwert oder verhindert. In diesem Sinn ist die kumulative Wirkung von Stressoren und Belastungen eine weitere Erklärung für die späte Reaktivierung oder Exazerbation einer bestehenden PTBS im Alter.

## Erinnerung und das autobiografische Gedächtnis

Erfahrungswissen steuert Handlungen und Interaktion, beeinflusst die Wahrnehmung und formt die Identität (Conway & Pleydell-Pearce, 2000). Kognitionspsychologisch sind Erinnerungen als hierarchisch strukturiertes Netzwerk von Elementen organisiert. Nach Tulving (1972, 1993, 2002) gliedert sich das Langzeitgedächtnis auf oberster Ebene in das implizite und das deklarative Gedächtnis.

- Dem impliziten Gedächtnis sind sensorische Eindrücke sowie Konditionierungsprozesse und deren Ergebnisse zugeordnet. Die Elemente dieser Gedächtnisstruktur sind inhaltlich nicht elaboriert. Üblicherweise sind sie nicht bewusstseinsfähig.
- Demgegenüber umfasst das deklarative Gedächtnis semantisch repräsentierte und dem Bewusstsein zugängliche Inhalte. Das semantische Untersystem speichert Wissen über Sprache und Konzepte, das episodische Untersystem die zeitliche und örtliche Zuordnung an frühere Erfahrungen.

Für den LR ist das autobiografische Gedächtnis von besonderer Bedeutung, da es selbstbezogenes Wissen über frühere Erfahrungen zeitlich und örtlich speichert. Es gehört zum deklarativen Gedächtnis und verbindet episodisches und semantisches Erfahrungswissen. Nach Conway und Pleydell-Pearce (2000) ist das autobiografische Gedächtnis hierarchisch strukturiert, beginnend mit der Erinnerung an Lebensperioden, gefolgt von den allgemeinen Ereignissen und auf der untersten Ebene schließlich dem ereignisspezifischen Wissen mit den zugeordneten Sinneseindrücken. Diese Systematik betrifft sowohl die Repräsentation der Inhalte als auch den Zugriff auf die Erinnerungen und deren Abruf. Das autobiografische Gedächtnis ist selbstreferenziell in dem Sinn, dass es das Wissen über die gemachte Erfahrung speichert (Conway & Pleydell-Pearce, 2000; Tulving, 1993).

Interessant an dieser Stelle sind ferner Studienergebnisse aus den Neurowissenschaften. Schacter und Addis (2007) sowie Tulving (2002) zeigen in einer empirischen Studie

mit bildgebenden Verfahren, dass die Erinnerung an frühere Erfahrungen und die Vorstellung zukünftiger Ereignisse sowohl gemeinsame als auch unterschiedliche Hirnareale aktivieren. Die Probanden erinnern entweder eine vergangene Erfahrung oder stellen sich ein zukünftiges Ereignis vor. Anschließend elaborieren sie die jeweilige Situation durch die Ergänzung sensorischer Eindrücke oder anderer Details, wiederum erinnert oder vorgestellt. An beiden kognitiven Prozessen ist ganz wesentlich der rechte Hippocampus beteiligt. Die Autoren ordnen ihm daher das neuronale Substrat vom episodisch-autobiografischen Gedächtnis zu. Diesen Ergebnissen zufolge ist die Vorstellung zukünftiger Ereignisse ohne die Erinnerung an frühere Erfahrungen nicht möglich (ebd.).

## Indikationen und Behandlungsanlässe

In den vergangenen Jahrzehnten untersuchte die Forschung zum Lebensrückblick die Wirksamkeit dieser Intervention bei Depressionen im Alter sowie demenziellen Erkrankungen (Cotelli et al., 2012; Pinquart & Forstmeier, 2012). Mit den Fragen nach Bindung und Identität haben narrative Verfahren einen tiefenpsychologischen Ursprung (Conway, 2005; McLean & Fournier, 2008; Westerhof & Bohlmeijer, 2014). Gleichzeitig entsprechen sie dem Bedürfnis nach Sinngebung oder Kohärenz und können auf diese Entwicklungsaufgabe älterer Menschen gut eingehen. Aktuell wendet sich die Forschung auch Patienten mit einer PTBS zu und öffnet narrative Verfahren einem verhaltenstherapeutisch ausgerichteten Anwendungs- und Indikationsbereich (Maercker & Bachem, 2013). Insbesondere für ältere Betroffene und die Genese einer Traumafolgestörung entlang der Lebensspanne besteht Forschungsbedarf (Böttche et al., 2012; S. Zimmermann & Forstmeier, 2020). Forstmeier, van der Hal, Auerbach, Maercker und Brom (2020) untersuchen die Wirksamkeit der LRT bei einer Patientengruppe von Holocaustüberlebenden mit einer PTBS. Der folgende Abschnitt widmet sich zunächst der Indikation der LRT für die Behandlung einer PTBS. Anschließend verdeutlicht eine Kasuistik das therapeutische Vorgehen an einem Fallbeispiel aus einer laufenden Interventionsstudie.

### Posttraumatische Belastungsstörung

Die Erinnerung an traumatische Erfahrungen ist typischerweise nur unzureichend elaboriert, ihre kognitive Repräsentation ist meist fragmentiert (Ehlers, 1999; Ehlers & Clark, 2000; Ehlers & Steil, 1995). Peritraumatische Zustände wie Dissoziation, Hyperarousal und Hypermnesie begünstigen diese kognitiven Normabweichungen. Nach Tulving (1972) lassen sich Traumaerinnerungen dem impliziten Gedächtnis zuordnen und haben konditionierte, sensorische Inhalte. Eine semantische Verarbeitung und eine biografische Integration des Erlebten fehlen. Die Fragmentierung der Erinnerungen korreliert dabei sowohl ursächlich als auch symptomatisch mit den Symptomen einer PTBS, vor allem mit dem Erleben des Bedrohtseins, das wiederum durch intrusives Erleben und Hypervigilanz begünstigt wird. Auch wenn die Traumaerfahrung in der Vergangenheit liegt, besteht der Eindruck des Bedrohtseins fort. Die Erinnerungen an das Ereignis sind weiterhin im impliziten Gedächtnis repräsentiert und werden daher als gegenwärtig erlebt. Häufig sind daher die kognitive oder habituelle Vermeidung. Die fehlende Elaboration der Traumainhalte resultiert aus den psychophysiologischen Besonderheiten, die sich während einer traumatischen Erfahrung einstellen: Infolge der kognitiven Überlastung und des psychophysiologischen Arousals kann es zu einer peritraumatischen Dissoziation kommen. Die Kodierung des Erlebten im deklarativen Gedächtnis bleibt aus, weswegen auch die biografisch-episodische Einordnung des Traumageschehens fehlt. Die Traumaerfahrung ist stattdessen implizit repräsentiert, insbesondere im sensorischen und im Konditionierungsgedächtnis. Typischerweise ist der willentliche Abruf von Traumaerinnerungen fragmentiert, der unwillentliche Abruf intrusiv (Ehlers & Clark, 2000).

**Das intrusive Wiedererleben ist fragmentiert, die Erinnerung an nicht traumatische Erfahrungen ist übergeneralisiert.**

Die erste Reaktion auf eine Traumaerfahrung ist dem Grunde nach adaptiv und zur Abwendung einer akuten Gefahr zunächst funktional

(Ehlers & Clark, 2000). Dem Hypermnesie-Hyperarousal-Modell zufolge (Egloff, Hirschi & von Känel, 2012; Tesarz, Seidler & Eich, 2015) ermöglicht das Hyperarousal eine schnelle Reaktionsbereitschaft, die Hypermnesie begünstigt das effiziente und nachhaltige Lernen von Gefahrenhinweisen. Der Signalcharakter der traumabezogenen Reize ist klassisch konditioniert, das sind die sogenannten Trigger, und der Umgang mit dem Hyperarousal wird operant verstärkt. Nach einer Zeitspanne von vier Wochen kann die maladaptive Verarbeitung der Traumaerfahrung die Diagnose einer PTBS begründen. Für die Pathogenese der Störung sind folgende kognitive Normabweichungen bedeutsam (Brewin, Dalgleish & Joseph, 1996; Ehlers & Clark, 2000; Forstmeier, Maercker, van der Hal-van Raalte & Auerbach, 2014; MacNally, 2005):

- Die traumabezogenen Erinnerungen sind im autobiografischen Gedächtnis nur fragmentiert repräsentiert.
- Häufig kommt es zu einem unwillentlichen Abruf der Erinnerungsfragmente, gekennzeichnet durch ein intrusives Wiedererleben.
- Im Vergleich zu gesunden Personen sind ferner die Inhalte von willentlich abgerufenen Erinnerungen weniger spezifisch. Ebenso ist das Triggern traumabezogener Erinnerungen auch dann möglich, wenn der erinnerte Gedächtnisinhalt keinen Traumabezug hat.

**Affektive Störungen**

Von affektiven Störungen wie auch aus Forschungsergebnissen zum autobiografischen Gedächtnis ist bekannt, dass bei Depressiven die Spezifizität der Erinnerungsinhalte an frühere Erfahrungen gering ist und sich in diesem Aspekt von gesunden Vergleichspersonen systematisch unterscheidet. Hiernach erinnern sich diese Patienten vorrangig an Ereignisse und Lebensperioden auf eine sehr allgemeine Art und Weise. Die autobiografische Erinnerung ist *übergeneralisiert*. Dieses Phänomen steht im Zusammenhang mit einem erschwerten Zugriff auf spezifische Inhalte im autobiografischen Gedächtnis und tritt bei affektiven Störungen, einer PTBS oder auch im Alter gehäuft auf (Maercker & Bachem, 2013; Serrano, Latorre, Gatz & Montanes, 2004; van Vreeswijk & de Wilde, 2004). In einer Interventionsstudie zur LRT bei Depression im Alter zeigen Serrano et al. (2004), dass die narrative Elaboration des autobiografischen Gedächtnisses den Affekt und die Stimmungslage moduliert. Die Wirkung der LRT und den Nutzen narrativer Verfahren für die Behandlung von Depressionen begründen Autoren mit dem verbesserten Zugriff auf spezifische Erinnerungsinhalte. Besteht die affektive Störung komorbid zu einer PTBS, kann die geringe Spezifizität autobiografischer Erinnerungen im Kontext der Traumaerfahrung bestehen (Williams et al., 2007).

**Demenz**

Demenzielle Erkrankungen, wie die vaskuläre oder Alzheimer-Demenz, führen zu einer erworbenen Beeinträchtigung wichtiger kognitiver Funktionen. Betroffene zeigen Defizite im Gedächtnis und in der Sprache, auch die Orientierung und das Urteilsvermögen sind eingeschränkt. In fortgeschrittenem Stadium ist eine selbstständige Lebensführung nicht mehr möglich, und die Betroffenen sind hilflos. Das Risiko der Erkrankung erhöht sich mit fortschreitendem Alter, Frauen sind häufiger betroffen als Männer (Bickel, 2012; Wallesch, Förstl, Bartels & Benninghoff, 2017). In einer alternden Gesellschaft sind demenzielle Erkrankungen eine große Herausforderung.

Obgleich die kognitive Kompetenz über die Lebensspanne hinweg generell abnimmt, werden autobiografische Erinnerungen an das junge Lebensalter von dementen Patienten bei leichter oder mittlerer Schwere der Erkrankung meist noch gut erinnert. Der typische Verlust der Erinnerung an das mittlere Lebensalter erklärt sich als Defizit des autobiografischen Gedächtnisses: Gegenwart und Vergangenheit sind episodisch nicht adäquat kodiert, womit auch der zunehmende Verlust der Identität einhergeht (Woods et al., 2018). Zumindest kurzfristig verbessern die Reminiszenz und insbesondere der LR die Stimmung, das kognitive Funktionsniveau und auch das Verhalten betroffener Patienten (Cotelli et al., 2012; Subramaniam et al., 2014; Woods et al., 2018). Wiederum zeigt das strukturierte Vorgehen des LR bessere Ergebnisse im Vergleich zur Reminiszenz. Das Teilen von Erinnerungen folgt sozialen Motiven der Bindung oder des Kontakts und wird durch die Reminiszenz gut erreicht. Die Integration, Sinnfindung und Bewertung der Erfahrungen bleiben wiederum dem LR bzw. der LRT vorbehalten (ebd.).

## Behandlung und narrative Intervention

Traumafokussierte Interventionen sind Behandlungsansätze, die den Schwerpunkt auf die Verarbeitung

der Erinnerung an das traumatische Ereignis oder seiner Bedeutung legen. Für die Behandlung einer PTBS zählen hierzu die KVT, das Eye Movement Desensitization and Reprocessing (EMDR) und die Narrative Expositionstherapie (NET). Das grundlegende Behandlungsparadigma der KVT besteht aus der Exposition, in sensu oder in vivo, und der biografischen Einordnung der traumatischen Erfahrung. Das EMDR bearbeitet in einem strukturierten Prozess die Traumaerinnerung in sensu und mündet in einen assoziativen Prozess der Verarbeitung, der auf eine Umstrukturierung der traumabezogenen Kognitionen abstellt (Shapiro, 2002; Shapiro & Maxfield, 2002). Die NET beruht auf einer Exposition in sensu, verbunden mit einer Kontextualisierung der Traumaerinnerung (Schauer, Elbert & Neuner, 2017; Schauer, Neuner & Elbert, 2005).

Nicht leitlinienkonforme Behandlungsansätze einer Traumafolgestörung sind die Ego-State-Therapie, die sich an komplex Traumatisierte wendet, und die LRT. Die Indikation dieser Interventionen ist noch nicht abschließend geklärt. Wie der folgende Abschnitt aber zeigt, sind die Effekte der LRT und narrativer Interventionen durchaus mit einer Standardbehandlung vergleichbar.

Psychische Störungen können die Funktionsfähigkeit beeinträchtigen und herabsetzen. Die Behandlungsplanung muss bestehende Einschränkungen berücksichtigen. Dem Bedürfnis älterer Menschen nach Sinnstiftung und Kohärenz können narrative Interventionen auch dann nachkommen, wenn frühere Traumaerfahrungen die biografische Elaboration der Erinnerungen erschweren oder kognitive Einbußen die Verfügbarkeit der Erinnerungen beeinträchtigen. Auch in diesen Fällen hat sich der Einsatz narrativer Interventionen bewährt und verbessert den Zugriff auf das autobiografische Gedächtnis.

Allerdings stellt die LRT – im Vergleich zum LR oder zur Reminiszenz – höhere Anforderungen an die kognitive Leistungsfähigkeit und die Affekttoleranz. Das ausgewogene Verhältnis von stabilisierenden und konfrontativen Interventionen stellt auf die Bedürfnisse und Möglichkeiten der Patienten ab. So bearbeitet die Narrative Expositionstherapie (NET) nicht nur die eigentliche traumatische Erfahrung, sondern stellt das Narrativ der Erinnerung immer auch in einen biografischen Lebensbezug (Neuner, Schauer, Klaschik, Karunakara & Elbert, 2004). Weitere Varianten bieten die Testimony-Therapie (Corradi, Garretón Merino & Fagen, 1992) sowie die ITT (Knaevelsrud et al., 2017; Knaevelsrud, Kuwert & Böttche, 2013). Wie oben gezeigt, sind Erinnerungen an die Traumaerfahrung bei einer PTBS fragmentiert, und es kommt zu einem intrusiven Wiedererleben, begleitet von Hyperarousal und Vermeidung. Für Gewaltopfer ist die Narration daher sowohl eine Voraussetzung als auch die Möglichkeit, über das erfahrene Leid oder die Menschenrechtsverletzungen Zeugnis geben zu können.

### Studien zur Wirksamkeit narrativer Interventionen

Die meiste Forschung zu den Effekten des LR gibt es zur Wirksamkeit bei Depressionen im Alter und demenziellen Erkrankungen. Studien zum Nutzen des LR bei der PTBS greifen eher neue Forschungsinteressen auf und beschränken sich bislang auf das mittlere Lebensalter.

Pinquart, Duberstein und Lyness (2007) diskutieren die Ergebnisse einer Metaanalyse von Interventionsstudien bei depressiven Symptomen im Alter. Sie vergleichen die Wirksamkeit und den Nutzen von unterschiedlichen Formen der narrativen Intervention (Reminiszenz, LR, LRT) gegenüber einer Kontrollbedingung (treatment as usual, Wartebedingung oder Placebogruppe). Den Studienergebnissen zufolge ist der Effekt der LRT auf eine depressive Symptomatik mit der Wirksamkeit einer Standardbehandlung, hier der KVT, mit jeweils großen Effektstärken grundsätzlich vergleichbar, mit $d$ = 1.06 für die KVT und $d$ = 1.00 für den LR (Pinquart et al., 2007).

Neben dem Affekt verbessert die LRT auch weitere Parameter der psychischen Gesundheit, u. a. die kognitive Leistungsfähigkeit, das Erleben von Selbstwirksamkeit oder die soziale Integration. Pinquart und Forstmeier (2012) vergleichen in einer weiteren Metaanalyse die Wirksamkeit verschiedener Interventionen auf diese Parameter. Im Posttest der eingeschlossenen Studien berichten die Autoren eine Effektstärke von $d$ = 1.28 für die LRT, gegenüber $d$ = 0.31 für den LR und $d$ = 0.52 für die Reminiszenz. Diese Rangfolge besteht auch im Follow-up nach sechs Monaten fort. Hinsichtlich der Wirksamkeit sind der LR und die Reminiszenz miteinander vergleichbar, da sich die Konfidenzintervalle der Effektstärken überschneiden (ebd.). Wenn auch in einem geringeren Ausmaß profitieren ebenfalls demenzielle Patienten von der LRT. Die Autoren finden für demenzielle Erkrankungen kleine Ef-

fekte der LRT *d* = 0.31, für depressive Symptome wiederum große Effektstärken *d* = 1.09. Eine Nacherhebung kann diese Ergebnisse für beide Patientengruppen nach sechs Monaten bestätigen, mit *d* = 0.37 bei Demenz und *d* = 1.29 bei Depression (ebd.; Pinquart & Forstmeier, 2013).

Pinquart und Forstmeier (2012, 2013) erklären den differenziellen Effekt und mögliche Einflussgrößen für diese Befundlage wie folgt:

- Für klinische Populationen scheint der Strukturierungsgrad der narrativen Intervention einen moderierenden Einfluss zu haben: Insbesondere Patienten mit einer ausgewiesenen Psychopathologie profitieren von der LRT, also einer Form der narrativen Intervention mit sowohl einer Indikation als auch einem hohen Strukturierungsgrad.
- Das Ausmaß und die Schwere klinisch bedeutsamer Erkrankungen oder komorbider Störungen können zu statistischen Effekten führen. Zu Interventionsbeginn ist zu erwarten, dass Extremwerte im Follow-up zur Gruppenmitte streben werden, ohne dass der Veränderung eine höhere Wirksamkeit zugrunde liegen muss. Dennoch ist es plausibel, dass teilnehmende Patienten von einer indikationsbezogenen Intervention profitieren und den Effekt als (Teil-)Remission wahrnehmen.
- Hinsichtlich der Systematisierung der Erinnerungsstile zeigen sich positive Effekte für den integrativen und instrumentellen Stil (Cappeliez & O'Rourke, 2006; O'Rourke et al., 2016).
- Auch die sequenzielle, entsprechend der Lebenslinie chronologische Anordnung der Erinnerungen beeinflusst das Erleben und psychische Parameter (Westerhof & Bohlmeijer, 2014).

## Posttraumatische Belastungsstörung

Im Folgenden geht es um die Anwendung der LRT bei einer PTBS. Erinnerungen und Gedächtnis sind eng mit der persönlichen Identität verbunden, die Auswahl von Handlungsalternativen und das Treffen von Entscheidungen sind ein steter Anpassungsprozess. Wie Schacter und Addis (2007) berichten, ist die Vorstellung zukünftiger Ereignisse nur aus den Erinnerungen und dem Erfahrungswissen heraus möglich. Dies betrifft sowohl das autobiografische Gedächtnis als auch die Erinnerung an Sinneseindrücke oder konditionierte Gedächtnisinhalte. Bei einer PTBS ist die Traumaerfahrung autobiografisch nur unzureichend elaboriert und oftmals nur implizit repräsentiert. Für ihre Behandlung sind die biografische Einordnung des Erlebten, die narrative Exposition, die Rekonstruktion der Ereignisse und die psychovegetative Habituation wesentliche Wirkfaktoren einer abgestimmten Intervention, ebenso wie die empathische Würdigung des Leidens innerhalb einer stabilisierenden Bindungserfahrung. Narrative Verfahren vereinen Gedächtniselaboration, Exposition und kognitive Interventionen und sind daher für die Behandlung einer PTBS gut geeignet (Böttche, Kuwert & Knaevelsrud, 2019; Forstmeier et al., 2020; S. Zimmermann & Forstmeier, 2020). Das Reprozessieren der Erinnerung beinhaltet Elemente, die sich in Richtlinienverfahren bereits bewährt haben: die Exposition und die kognitive Umstrukturierung. Als Behandlungsergebnis entsteht das Narrativ der Traumaerfahrung im autobiografischen Gedächtnis (Ehlers & Clark, 2000). Zur Behandlung der kognitiven, affektiven, sozialen, verhaltensbezogenen und psychovegetativen Symptome diskutieren Knaevelsrud und Maercker (2010) daher die LRT und andere narrative Ansätze in Verbindung mit Methoden der kognitiven Verhaltenstherapie:

- Expositionsverfahren haben sich bewährt, in sensu wie in vivo.
- Die Elaboration des Gedächtnisses und die chronologische Einordnung der Lebensereignisse stellen auf die Ressourcenaktivierung, die Integration und kognitive Neubewertung ab.

Durch die Rekonstruktion und die Bilanzierung des Erlebten soll eine autobiografische Repräsentation des Ereignisses entstehen. Adaptive Kognitionen können beispielsweise sein: »Es war schlimm …, … aber ich habe daraus gelernt, … es ist vorbei, … heute bin ich sicher.« Unabhängig von einer konkreten Intervention beschreibt Grawe (2000) weitere methodenunabhängige Wirkfaktoren, die allen Veränderungsprozessen zugrunde liegen: Bindung, motivationale Klärung, Problemaktualisierung, Ressourcenaktivierung. Die Wirkung narrativer Interventionen begründet sich sowohl symptomatisch als auch ursächlich wie folgt:

- Die chronologische Elaboration der Lebensgeschichte, inklusive der Anfertigung eines traumabezogenen Narrativs.
- Das Teilen biografischer Erinnerungen mit einem Gegenüber, d. h.

in Bindung, eingebettet in einen sozialen Kontext.

- Die strukturierte Bearbeitung begünstigt das Erinnern an frühere Erfahrungen von Selbstwirksamkeit und problem- oder emotionsorientiertes Coping. Dies kann Ressourcen aktivieren und die Resilienz fördern.
- Die Elaboration angenehmer Erinnerungen hat stimmungsaufhellenden Effekt und reichert diese um sensorische Details an oder stellt den Situationsbezug wieder her. Als therapeutische Intervention ist bei affektiven Störungen insbesondere die LRT angezeigt. Die geführte und willentliche Erinnerung an angenehme Ereignisse sowie die Elaboration der zugehörigen Erfahrung kompensieren die bestehende Neigung von Depressiven, angenehme Erfahrungen abstrakt zu repräsentieren.
- Bei demenziellen Erkrankungen wie auch kognitiven Einschränkungen anderer Genese verbessern sich die Gedächtnisleistungen, inklusive der räumlichen, zeitlichen und situativen Orientierung der Betroffenen. Hiervon profitieren auch die kommunikativen Fertigkeiten und die Stimmungslage. Die Verbesserung der kognitiven Leistungen zeigt sich dabei über einen Zeitraum von vier bis sechs Wochen stabil.

Die biografische Einordnung des Erlebten beschreiben Neuner et al. (2004) und Schauer et al. (2017) als Kontextualisierung der Erinnerung. Aus der Elaboration von zunächst impliziten Gedächtnisinhalten entsteht ihre Repräsentation als explizites episodisches Erfahrungswissen (Conway & Pleydell-Pearce, 2000; Tulving, 1993). Dies erfasst auch dysfunktionale Erinnerungsstile, die als Risikofaktoren für einen deprimierten Affekt oder die Ausbildung einer Verbitterung bekannt sind (Webster et al., 2010; Westerhof, Bohlmeijer & Valenkamp, 2004; Westerhof & Bohlmeijer, 2014).

Unabhängig von einem konkreten Behandlungsanlass folgt die LRT grundsätzlich den einzelnen Lebensabschnitten. Dies sind zunächst die normativen Entwicklungsaufgaben einer Biografie, wie sie das Entwicklungsmodell von Erikson und Erikson (1998) mit seinen acht Phasen beschreibt, beginnend vom Säuglingsalter bis ins hohe Alter. Die Therapiesitzung, die sich der Traumaschilderung und der Exposition widmet, wird vor die Lebensphase geordnet, in der sich das Trauma ereignete. Der Ablauf der LRT gliedert sich in folgende Abschnitte:

- Vorbereitungsphase. Die Klientel macht sich zunächst mit dem Behandlungsrational und dem Vorgehen vertraut. Die Exploration der Ressourcen, die motivationale Klärung und der Aufbau eines therapeutischen Arbeitsbündnisses ordnen sich hier ein. Dies entspricht den allgemeinen Wirkfaktoren im Sinne von Grawe (2000).
- Mittlere Phase. Es folgt der strukturierte Lebensrückblick mit indikationsspezifischen Abschnitten. Die einzelnen Sitzungen widmen sich den Lebensphasen der Biografie und bearbeiten die jeweiligen Entwicklungsaufgaben in ihrer chronologischen Abfolge. Kritische Lebensabschnitte können sich über mehrere Sitzungen erstrecken. Dies beinhaltet die gemäßigte Exposition der traumatischen Erinnerung in vivo oder in sensu. Die Berichte über die Erlebnisinhalte können in der Ich-Perspektive der Gegenwartsform (typisch für die imaginative Exposition) oder in der Vergangenheitsform (typisch für die narrative Exposition) erzählt werden. Eine ausreichende Affekttoleranz ist für diesen Behandlungsabschnitt unbedingt erforderlich, Stabilisierungstechniken können vorab oder schrittweise im Kontext der Expositionssitzungen geübt werden. Die gedächtnisbezogene Elaboration entsteht aus dem erinnerten Wiedererleben und der sich anschließenden chronologischen Einordnung dieser Erfahrung. Ebenso für depressive Störungen oder demenzielle Erkrankungen verbessert das Behandlungsrational den Zugriff auf spezifische Erinnerungsinhalte im autobiografischen Gedächtnis und ist hier vorteilhaft.
- Abschluss. Bilanzierende Therapiegespräche regen schließlich die kognitive Neubewertung an. Der Transfer wird vorbereitet und gebahnt, das neu Gelernte soll sich im Alltag bewähren. Nicht nur die Schilderungen der Erinnerung, sondern gerade auch die Reflexion und die Bewertung aus heutiger Sicht finden in diesem Behandlungsabschnitt statt.

Die ITT strukturiert die Behandlungsabschnitte in die gemäßigte (narrative oder imaginative) Exposition, die Integration sowie die kognitive Neubewertung und die biografische Rekonstruktion. Von ihrem Ablauf her ist die ITT mit elf Sitzungen eine Kurzintervention. Im Anschluss an die Exposition und die chronologische Einordnung der Erinnerung stellt sie bilanzierende Fra-

gen, die eine Neubewertung anregen. Die 22 Patienten schreiben aus heutiger Sicht einen Brief an die Person, die sie zum Zeitpunkt der traumatischen Erfahrung waren.

In Zusammenarbeit mit einer israelischen Hilfsorganisation untersuchen derzeit Forstmeier et al. (2020) in einer randomisierten Interventionsstudie die Effekte der LRT auf die Reduktion von PTBS-, Depressions- und Trauersymptomatik von Holocaustüberlebenden. Die Behandlung erfolgt in Israel und umfasst 20 – 25 Sitzungen mit den Modulen Einführung, strukturierter Lebensrückblick, narrative Exposition, Bearbeiten von Knackpunkten *(stuck points)*, Zurückerobern des Lebens und Beendigung der Therapie (siehe Kasuistik).

Die chronologische Einordnung der Erinnerung wie auch die Kontextualisierung des Erlebten im Narrativ fördern vorteilhafte Erinnerungsstile und begünstigen die kognitive Umstrukturierung. Wenn vielleicht auch nicht der gute, doch der entlastende Abschluss ist die Antwort auf die Frage nach der Möglichkeit des posttraumatischen Wachstums oder der gewonnenen Erkenntnis (McAdams, 2006).

## Kasuistik: Der Verlauf einer Lebensrückblicktherapie. Fallbeispiel einer Holocaustüberlebenden mit der Diagnose einer PTBS (F43.1) im Alter

*Angaben zur Person und Vorgeschichte:* Die 89-jährige Holocaustüberlebende erfuhr vom psychotherapeutischen Angebot im »social club« der israelischen Hilfsorganisation »AMCHA« (The National Israeli Center for Psychosocial Support of Survivors of the Holocaust and the Second Generation), an deren Treffen sie regelmäßig teilnahm. Die Patientin gibt an, unter multiplen Ängsten (u. a. Angst vor dem Alleinsein) zu leiden. Ferner erlebe sie sich aufdrängende Erinnerungen, massive Selbstzweifel und Schuldgefühle. Im Kontakt weinte sie schnell, sie lebt alleine und hat keine psychotherapeutische Vorerfahrung. Sie ist in einer Großfamilie in Rumänien aufgewachsen. Kindheit und Jugend sind von multiplen traumatischen Erlebnissen geprägt, darunter eine Naturkatastrophe, Antisemitismus, die Bombardierung ihrer Heimatstadt sowie der Verlust nahestehender Angehöriger. Im Jahr 1950 emigrierte die Patientin nach Israel. Zu Beginn zeigen sich die Symptome einer PTBS und einer leichten bis mittelgradigen Depression. Die kognitiven Fähigkeiten sind als gut einzustufen.

*Behandlungsverlauf und Studienprotokoll:* Entsprechend dem manualisierten Studienprotokoll nutzte die betreuende Therapeutin die ersten gemeinsamen Sitzungen zur Diagnostik, Motivation und Zielvereinbarung. Auf einem Zeitstrahl wurden stichpunktartig die wichtigsten biografischen Stationen der Patientin festgehalten, darunter auch ihre Kerntraumata. Im Anschluss begann der strukturierte Lebensrückblick. Mithilfe der im Manual vorgeschlagenen biografischen Fragen (abgeleitet der Life Review Form von Haight & Haight, 2007) sowie Erinnerungsstützen in Form von Fotografien und mitgebrachten persönlichen Gegenständen wurden Kindheit, Jugend, mittleres und späteres Erwachsenenalter besprochen.

Dreimal wurde der strukturierte Lebensrückblick unterbrochen, um konkrete traumatische Erinnerungen mittels narrativer Exposition vertieft zu bearbeiten. Dies geschah jeweils vor der Sitzung, in welcher die Lebensphase, in der sich das Trauma ereignete, besprochen werden sollte. Die Patientin berichtete ihre Traumaerfahrung in diesen Expositionssitzungen detailliert, mit vielen sensorischen Details, von Anfang bis Ende. Das Ende dieser Sitzungen war von einem Gefühl der Erleichterung begleitet. Das Traumanarrativ wurde in der Folgesitzung nochmals durchgelesen. Die Nachbesprechung half ihr, eine Brücke zwischen aktuellen Symptomen (z. B. Vermeidung bestimmter Orte) und auslösenden Ereignissen zu schlagen und das Erlebte in ein Gesamtnarrativ einzuordnen.

Schwerpunkt der Folgesitzungen war dann die Bearbeitung dysfunktionaler Überzeugungen im sokratischen Dialog. Unter Rückgriff auf die Ergebnisse des Lebensrückblicks wurde die beeindruckende Bewältigungsleistung der Patientin herausgearbeitet. Symbolisch hielten Patientin und Therapeutin das so erarbeitete, ressourcenorientierte Selbstbild in einem Brief an das »frühere Ich« fest, in dem sie dem früheren Kind gegenüber Empathie ausdrückte und aus der heutigen Sicht Sicherheit und Trost spendete.

Die letzten Sitzungen der Therapie wurden genutzt, um positive Aktivitäten zu planen und über den Verbleib des während der Therapie erarbeiteten »Lebensbuches« zu sprechen. Die Patientin entschied, ihre Lebensgeschichte und die darin enthaltenen positiven wie negativen Erinnerungen erstmals mit ihren Kindern zu teilen. Sie konnte gut von der Lebensrückblicktherapie profitieren. Nach dem Abschluss

der LRT erfüllte sie die Kriterien für eine PTBS nicht mehr. Ein halbes Jahr später war auch die depressive Symptomatik deutlich zurückgegangen.

## Diskussion

Das Erinnern, in Gesellschaft oder alleine, ist ein grundlegendes psychisches Bedürfnis und Merkmal psychischer Reifungsprozesse entlang der Lebensspanne. Für supportive Anwendungsbereiche haben sich narrative Verfahren als niederschwellige Intervention seit Langem bewährt. Auch bei einer klinischen Indikation, wie affektiven Störungen oder einer PTBS, sind sie für die ergänzende Behandlung zu einem Richtlinienverfahren effektiv. Der Wirkmechanismus narrativer Interventionen ist theoretisch fundiert, ihr Nutzen für eine klinische Anwendung ist empirisch belegt. Die Elaboration der Erfahrungen verbessert den Abruf der Erinnerungen und ihre Repräsentation im autobiografischen Gedächtnis.

Für die Behandlung von depressiven Störungen zeigen sich sowohl gedächtnisbezogene als auch affektive Effekte. Auch bei psychischen Störungen im mittleren Lebensalter sind narrative Interventionen angezeigt. Bei einer PTBS führen die Narration und die Elaboration der Traumaerfahrung zu einer Exposition in sensu mit nachfolgender Habituation und adäquater Repräsentation im autobiografischen Gedächtnis. Für demenzielle Erkrankungen verbessert sich die kognitive Leistungsfähigkeit zumindest kurzfristig, richtet sich aber grundsätzlich nach der Schädigung des neuronalen Substrats.

Der Lebensrückblick kann ferner zu einer kognitiven Umstrukturierung beitragen und auf die Ich-Integrität einwirken, die aus der Sicht der Lebensspanne ein Korrelat des autobiografischen Gedächtnisses ist. Das Erlangen von Ich-Integrität fasst Erikson als eine Entwicklungsaufgabe auf. Zur Behandlung von psychischen Störungen können 25 narrative Verfahren günstige Erinnerungsstile bahnen und fördern. Insbesondere bei einer PTBS ist der therapeutische Lebensrückblick bedürfnisgerecht und gut geeignet.

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## Posttraumaticstress disorder and life review from a lifespan perspective

**Abstract:** *Narrative approaches and interventions are well accepted within the domain of psychotherapy, geriatrics, nursing science and palliative care. Good efficacy is reported for life review or relating biographical interventions. Effects are reported for cognitive, affective or behavioral outcomes. To share memories is a basic human need which strengthens attachment and helps people to establish meaning in life. Autobiographical memory and identity are tightly linked together. It is not possible to envisage future events without the episodic recall of the past. Therefore, narrative interventions target the autobiographical memory. Most of the related studies address typical mental health problems of age, e. g. dementia and affective disorders. More recent work dedicates itself to posttraumatic-stress disorder or investigates the benefit of life review techniques for middle-aged persons. Life review follows a structured protocol and shows more impact on mental outcomes than mere reminiscence. Life review therapy is the clinical application of a narrative approach. In spite of good treatment results it has not been listed in official guidelines yet.*

**Keywords:** *Life review, lifespan, critical life events, posttraumatic-stress disorder, biographical work, developmental task*

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**Manuscript 2, submitted article**

*Article: Empirical work [Longitudinal RCT in TAP on brief interventions]*

Lenz, H.-J., Forstmeier, S., Flöter, L., Hulsmans, N. & Schmidt, M. (submitted). Experimental analogue trauma study. *Personalized Medicine in Psychiatry*, under review.

**Title**

Immediate Interventions Following Traumatic Exposure in an Analogue Experiment: Exploratory Results and Methodological Considerations

**Author(s)**

To be submitted for anonymous peer review

**Abstract**

*Purpose*: Traumatic experiences are common worldwide and can lead to severe psychological distress and mental health problems. Post-traumatic stress disorder (PTSD) is a mental disorder that is associated with significant personal and societal costs. Although several evidence-based treatments for PTSD exist, interventions that can be administered immediately after a traumatic event remain lacking.

*Methods*: This study employed trauma film paradigm to evoke PTSD symptoms in a non-clinical sample of German university students. Using a two-week longitudinal design with ten measurement points, this study assessed the effect of three immediate interventions.

*Results*: A visual interference task (Tetris), an adapted version of Narrative Exposure Therapy (NET), and a combination of both all proved ineffective in reducing PTSD symptoms compared to a control group. In a secondary data analysis, Latent Growth Curve Modeling (LGCM) was used to examine potential covariates in conditional models. Both, emotional reactivity to the film clip and female sex, significantly predicted a higher number of intrusions. Emotional reactivity was also associated with negative trends across various aspects of mood. In an additional exploratory step, LGCMs with varying numbers of measurement points were successively compared to provide methodological recommendations for efficient experimental design. Model fit indices suggest that four measurement points are sufficient to study trauma analogues.

*Conclusions*: Analogue effects differ from clinical symptoms. Methodological implications suggest that four measurement points are sufficient for capturing the effects of an analogue design. Future study protocols and designs have to consider the choice of stressor and should carefully account for ecological validity.

*Keywords*: PTSD, trauma film paradigm, visual interference, narrative exposure therapy, emotional reactivity

## Introduction

Traumatic experiences are a ubiquitous aspect of human life. Recent epidemiological studies indicate that approximately 71% of surveyed individuals worldwide have been exposed to at least one potentially traumatic event during their life time (Benjet et al., 2015; Knipscheer et al., 2020). According to the ICD-10, a traumatic event is defined as "a stressful event or situation (of either brief or long duration) of an exceptionally threatening or catastrophic nature, which is likely to cause pervasive distress in almost anyone" (World Health Organization, 2016, p. 309). Examples of potentially traumatic events include exposure to war, kidnapping, natural disasters, torture, physical violence, and sexual assault (American Psychiatric Association, 2013). Exposure to such distressing events may lead to the development of post-traumatic stress disorder (PTSD).

PTSD is conceptualized as a trauma-and-stress related disorder that describes a severe and persistent trauma response (American Psychiatric Association, 2013). It is primarily characterized by the presence of the following symptoms: intrusions, hypervigilance, hyperarousal, and avoidance of trauma-related stimuli (World Health Organization, 2016). Lifetime prevalence estimates of PTSD vary greatly between countries (Koenen et al., 2017). Notably, despite the large number of individuals who experience potentially traumatic events over the course of their lives, only a fraction develops a PTSD after exposure (ibid. Koenen et al., 2017). Several models have been proposed to explain the etiology of PTSD (Brewin & Holmes, 2003). The most prominent theories today primarily conceptualize PTSD as a memory disorder, resulting from maladaptive encoding and consolidation of the traumatic memory. Ehlers and Clark (2000) formulated a highly influential cognitive model of PTSD development that places a strong emphasis on the processing style employed during and after the traumatic event. The model distinguishes between two types of processing that occur simultaneously: a conceptual and verbal processing style focused on contextual information, and a data-driven and sensory processing style focused on perceptual and visuospatial information. The model suggests that a dominance of sensory processing and low conceptual processing increases the odds of developing PTSD since a highly sensory-based traumatic memory typically is poorly elaborated.

PTSD is associated with significant personal and financial costs to both individuals and society. The debilitating and persistent symptoms often have negative consequences for an individual's quality of life (Campbell & Renshaw, 2018; Darves-Bornoz et al., 2008). The disorder also imposes a substantial burden on the economy and the healthcare system, particularly because of its chronic nature (Al Jowf et al., 2022). This burden is further exacerbated by the high comorbidity rates of PTSD with other mental health conditions such as substance abuse, depression,

anxiety disorders, and suicidality (Difede et al., 2014). Though the diagnosis requires the exposure to a distinct stressor, PTSD is not a common occurrence of affected persons.

Several evidence-based treatments for PTSD exist today (Schrader & Ross, 2021). However, interventions that can be administered immediately after a potentially traumatic event are still severely lacking. Research on such interventions is hindered by ethical and practical challenges, which makes it difficult to conduct rigorous experimental designs with individuals who have just experienced a potentially traumatic event (Ehring et al., 2011). Yet, experimental designs that allow for controlled and standardized circumstances are essential for drawing causal conclusions about the relationship between pretraumatic variables and the development of PTSD, as well as the efficacy of immediate interventions. Longitudinal and prospective studies are needed to identify risk factors and distinguish them from trauma outcomes (DiGangi et al., 2013). Analogue studies offer a way to simulate pathological processes in non-clinical participants, thereby providing valuable insight into the etiology in clinical populations (James et al., 2016).

The trauma film paradigm (TFP) serves as an experimental psychopathology model that replicates both trauma exposure and subsequent symptom development. Since its inception, the TFP has been extensively used to examine risk factors and possible interventions for PTSD (Holmes & Bourne, 2008; James et al., 2016). In its current form, the TFP involves presenting participants with a film clip containing highly distressing content to simulate traumatic exposure. These film clips can evoke analogue PTSD symptoms, such as intrusions, changes in mood, and physical arousal. The choice of film clip is a critical factor, since different stimuli may elicit varying responses. Weidmann et al. (2009) found that rape scenes elicited the strongest physiological responses, the most intense emotions of disgust and anger, and the highest number of intrusions. Despite its widespread use, there is currently no standardized methodology for implementing the TFP (James et al., 2016). Past studies have varied in terms of the film clip used, its duration, the outcome measures selected, design choices, and the number of measurement time points. To date, there is little to no research comparing different TFP protocols (Arnaudova & Hagenaars, 2017; Herzog & McNally, 2024). However, these methodological differences may be crucial for explaining some of the heterogeneous results in the field of analogue trauma research.

In the 2000s, a novel form of PTSD intervention was proposed based on the idea of visuospatial interference during traumatic exposure. Occupying the limited visuospatial working memory was hypothesized to reduce future PTSD symptoms. Supporting this idea, Holmes and colleagues found in multiple studies that engaging in a visuospatial task during the TFP was associated with a reduction in intrusion frequency (Holmes, 2003; Holmes et al., 2004). Visuospatial tasks have varied in the past, with early research including tasks such as visuospatial

tapping patterns (ibid.) or clay shaping (Stuart et al., 2006). More recently, the computer game Tetris (Nintendo of America, 1989) has emerged as a widely used visuospatial task due to its simplistic design, accessibility, and intuitive gameplay mechanics. Its taxing effect on visuospatial working memory has also been documented (Lau-Zhu et al., 2017), even a hallucinatory replay beyond extensive application time (Stickgold & McConnor, 2000). Early studies focused on performing the visual interference task during memory encoding while viewing the trauma film (Holmes et al., 2004); subsequent research has also demonstrated its effectiveness even when administered after the film clip (Bourne et al., 2010). For instance, studies have found that playing Tetris after delays of 30 minutes (Deeprose et al., 2012; Holmes et al., 2009), four hours (Holmes et al., 2010), and even 24 hours (James et al., 2015) was associated with decreased intrusion frequency. However, it is important to acknowledge that several studies could not replicate findings regarding the efficacy of visuospatial tasks in reducing intrusions (Asselbergs et al., 2018; Brühl et al., 2019; Meyer et al., 2020)

Narrative Exposure Therapy (NET) is a component of trauma-focused Cognitive Behavior Therapy (CBT) that was developed in the early 2000s and first manualized in 2005 (Schauer et al., 2005). NET involves narrative retelling of traumatic events as a form of imaginal exposure. The aim is to connect sensory impressions, emotional reactions, and bodily sensations (referred to as *"hot memories")* with episodic memories of spatial, temporal, and factual information about the event (termed "*cold memories")*. Integrating these memory types contextualizes the event and facilitates its integration into autobiographical memory (Schauer, 2015). Recent meta-analyses support the efficacy and safety of NET across a variety of populations (Lely et al., 2019; Siehl et al., 2021). However, despite its status as an evidence-based intervention within trauma-focused CBT, NET has not yet been evaluated as a possible acute intervention administered shortly after trauma exposure.

The aim of this study is threefold. First, it seeks to compare the efficacy of different treatments, i.e. an adapted form of NET, a visuospatial interference task, and a combination of both, in reducing analogue PTSD symptoms following exposure via the TFP. For each intervention, the effect is evaluated for superiority relative to a control group. Second, the study aims to generate methodological recommendations for future TFP research. Currently, the analogue paradigm has no standardized protocol concerning the selection of film clips, the number of measurement points, or the duration of assessments, all of which contribute to heterogeneity in the field. This study takes an initial step toward a more standardized approach by systematically evaluating the number of measurement time points from both economic and methodological perspectives. Lastly, this study has a prospective view to settle risk factors and to separate them from symptoms (DiGangi et al., 2013).

## Methods

### *Sample*

Power analysis conducted a conservative protocol and was based on reported effect sizes of trauma-focused interventions (James et al., 2015, Lely et al., 2019). Moderate estimates were taken ($d$ = .80, one-sided α = .05, power = .80), resulting in a sample size of $N$ = 84 of equally distributed $n$ = 21 over the 4 treatments. The analyzed sample consisted of German students, predominantly studying psychology. Convenience recruitment invited interested individuals to complete an initial questionnaire via the online survey platform LimeSurvey to screen for vulnerability factors. Exclusion criteria included: being under 18 years of age, proximate or witnessed experience of severe traumatic events, psychopathology, abuse disorders, intake of psychotropic pharmaceuticals. A total of 145 individuals completed the screening questionnaire. However, 46 participants had to be excluded from the study. Thus, the final sample size included 99 participants. The sample comprised 26 male and 73 female participants, with ages ranging from 18 to 55 years old ($M$ = 22.28, $SD$ = 4.84). However, most participants (96%) were 31 years old or younger.

The four treatments were similar in age [$F$ (3, 95) = 1.19, $p$ = .32)] and sex [($\chi^2$ (3, $N$ = 99) = 0.63, $p$ = .89)]. As well was homoscedasticity met for age [$F$ (3, 122) = 2.14, $p$ = .099)] and sex [($F$ (3, 122) = .727, $p$ = .538)]. Table 1 provides descriptive statistics about the distribution of the participants' age and sex (*table 1*).

**---- please insert table 1 about here ----**

***Table 1: Sex and Age Distribution by Group***

### *Design*

This experimental study employed a mixed design that combines the assigned intervention group as a between-subjects factor and time as a within-subjects factor. Participants were randomly assigned to one of four groups; however, an equal distribution of gender across groups was aimed for. A comprehensive overview of the entire study flow can be found in figure 1. The study spanned a time frame of the two weeks, during which participants attended two laboratory appointments. There were ten different measurement points over the course of time. Three assessments were conducted during the first laboratory appointment: before viewing the film ($t$0), after viewing the film ($t$1), and after the intervention ($t$2). The remaining assessments were conducted over the following seven days ($t$3 to $t$9), with a final assessment two weeks after the initial laboratory appointment ($t$10).

*Material*

Trauma film

This study employed a clip from the film 'Irréversible' (Noé, 2002) to simulate traumatic exposure. The 15-minute excerpt depicts a woman leaving a party alone and subsequently experiencing sexual assault and physical violence by a man she encounters in an underpass. This scene has been used in past studies to successfully induce analogue symptoms commonly observed in individuals with PTSD (Arnaudova & Hagenaars, 2017). Its selection was based on widespread prior usage in trauma analogue research and empirical evidence indicating that film clips depicting sexual assault or rape are particularly effective in eliciting intrusions (Weidmann et al., 2009).

**---- please insert figure 1 about here ----**
***Figure 1; Study flow***

Interventions

Four different groups were compared in this experimental study: three receiving a form of immediate intervention and one serving as a control group. The first intervention group received a brief, adapted intervention based on the principles of NET (Schauer et al., 2005), designed to help participants construct a narrative about the events of the film. In the study, a semi-structured interview consisting of 20 questions guided the narrated recall of the depicted film scenes. Following the model proposed by Ehlers and Clark (2000), the interview aimed to facilitate integration into autobiographical memory, potentially reducing the number of future intrusions. After the 30-minute intervention, participants were emailed a copy of their narrative and instructed to review it for five minutes daily over the following week.

A second group received a visual interference task using the computer game Tetris, chosen for its well-documented demand on visuospatial cognitive resources (James et al., 2016). Specifically, the free app Brick Game (PerseusGames, 2016), a standard Tetris game with a simple black-and-white design, was utilized. Participants played Tetris for 30 minutes immediately after viewing the film clip and were then directed to engage in an additional 10 minutes of Tetris each hour for the next six hours, totaling 90 minutes of game-play.

The third group received both the adapted NET intervention as well as the visual interference task. To keep the total intervention time comparable at 30 minutes, they completed 20 minutes of NET followed by 10 minutes of Tetris. As in the other two groups, these participants were instructed to review their narrative and play Tetris for the six hours following the initial intervention.

The control group received no active intervention after viewing the film. Instead, they completed various knowledge tasks on the computer (e.g. naming as many fruits as possible). Since verbal distractors show minor effect according to previous research (Bourne et al., 2010; Krans et al., 2010a), participants in the control group during the post-assessment also received the narrative intervention to ensure they received a potentially helpful intervention for any possible remaining analogue symptoms.

*Measures*

Mood and Emotional Reactivity

The *Mehrdimensionaler Befindlichkeitsfragebogen* (Multidimensional Mood Questionnaire, MDBF) is based on Latent-State-Trait theory. This self-report inventory assesses mood by capturing both its current state and generalized variance attributed to trait components (Steyer et al., 1997). The MDBF comprises three bipolar subscales – Mood, Alertness, and Calmness - all three are assessed with eight items each, for a total of 24 items. Each item presents an adjective describing a current state, and participants rate how accurately it describes them on a five-point Likert scale ranging from 1 (*not at all*) to 5 (*very*). The proportion of positively and negatively worded adjectives is balanced within each subscale. Averaging the items of each subscale yields participants' current levels of mood, alertness, and calmness, with higher scores indicating more positive mood, greater alertness, and higher calmness, respectively. Therefore, higher scores may reflect feelings of happiness, and easiness, whereas lower scores suggest negative mood and restlessness. An overall mood score can be calculated by taking the mean across all 24 items (Steyer et al., 1997). The daily mood assessments at home administered a validated short form of the questionnaire that comprises scales of four items each to enhance compliance and reduce the risk of dropouts. Previous scale analyses suggest to use short form B of which we applied the subscales Mood and Calmness. To provide a unique measure, the short form B of the MDBF was used in the statistical analyses. The MDBF demonstrates favorable psychometric properties (Hinz et al., 2012). Reliability was also acceptable among the current study sample, with Cronbach's α ranging from .76 to .80 (supplement).

Emotional reactivity toward the film clip reflects how strongly the scene negatively affected an individual's overall mood. We defined emotional reactivity as the change in mood from before to after exposure. A larger discrepancy indicates greater emotional reactivity. MDBF scores collected before and after the trauma analogue were used to assess changes in emotional reactivity.

Intrusions

The *Impact of Event Scale – Revised* (IES-R) is a well-established and widely used self-report measure that assesses the psychological response to a specific traumatic events, focusing on the three main symptoms of PTSD: intrusions, hyperarousal, and avoidance (Maercker & Schützwohl, 1998). The questionnaire consists of 22 items: eight items form the Avoidance subscale, and seven items each comprise the Intrusions and Hyperarousal subscales. Each item has four response options, with item scores ranging from 0 (*not at all*) to 5 (*often*). The middle options correspond to scores of one and three, respectively. Some item wordings were slightly adapted to better fit the context of viewing a film clip. Additionally, three items were removed because they were not suitable for the study's design (e.g. an item about nightmares). The scale is straightforward to interpret, with higher scores indicating more severe PTSD symptoms (Maercker & Schützwohl, 1998; Weiss & Marmar, 1996). Elevated scores on the Intrusions subscale indicate the presence of intrusive thoughts and images associated with the traumatic event. Although the IES-R is not used as a standalone diagnostic tool for PTSD, it remains a valid measure for assessing PTSD symptoms and tracking changes over the course of an intervention (Motlagh, 2010). The IES-R has a well-validated three-factor structure and demonstrates good psychometric properties (Maercker et al., 2003).

A daily intrusion assessment was adapted based on the Trauma Screening Questionnaire (Brewin et al., 2002). This version assesses the frequency of intrusive images and thoughts, as well as feelings of re-experiencing the film clip over the past 24 hours. To measure intrusion occurrence, participants rated the frequency of intrusions on a five-point Likert scale ranging from 1 (not at all) to 5 (multiple times per hour). Additionally, two more items asked participants to estimate the specific number of intrusions and moments of re-experiencing. Internal consistency for both questionnaires was acceptable to high among the current sample, with Cronbach's α ranging from .79 to .83 (supplementary material).

**Statistical analysis**

This study reports results from a two-step data analysis process. In a first step, the efficacy of the different treatment interventions was assessed using a General Linear Model (GLM) for repeated measures, with time and treatment as independent variables. After an initial screening, 99 out of 145 participants were included in the experiment. The dropout rate was low (0.274) over the course of the study and the pattern of missing data was shown to be completely at random (MCAR). Cook's *D* identified influential cases, that were winsorized if they had large values above *p* (.50).

Analyses were carried out with listwise deletion of missing data. Dropouts were handled as intention-to-treat (ITT), a protocol especially suited for conservative inference in superiority comparisons. In our model, time specifies the error term and was the within-subject factor of the design, the four treatments constituted the between-subject factor and the interaction term was defined by the covariation of both. Dependent variables included mean values of the MDBF subscales Mood and Calmness, as well as intrusions assessed by the IES-R and the daily intrusion questionnaire. To ensure comparability across all measurement points, only items from the MDBF short form B were included in the analyses. For the daily intrusion assessment, the items rating the general occurrence of imagery-based intrusions were included in the analysis. Pairwise contrasts were used to compare different study groups and Bonferroni corrections were applied to account for multiple testing on the same dataset.

Secondary data analyses were conducted after evaluating the results of the primary data analysis. Specifically, research questions addressed future methodological considerations. One aim was to determine whether the primary results were influenced by the way GLMs handle data and whether a different approach to statistical modeling would affect the results. Secondary analyses also explored whether the consideration of random effects improved model fit and what number of measurement points was most suitable from a perspective of model fit and parsimony. Additionally, to expand upon previous findings, the predictive effects of treatment, sex and emotional reactivity were examined in conditional models. To address these research questions, Latent Growth Curve Models (LGCM) were utilized. LGCM allow for the adequate handling of autocorrelated error terms and are suitable for modeling changes over time.

Furthermore, our measures and indicators demonstrated scalar invariance over time, enabling the analysis of mean structures. However, for intrusions, scalar invariance was only partially met, so modification indices were applied to refine the model. Each of the dependent variables was assessed in separate LGCMs. Assuming larger effects closer to trauma film exposure, the time metric was weighted backwards, expressed by a negative slope. Thus, the base model included all time points [$t10$; $t1$]. Subsequently, a stepwise removal of measurements decrementally reduced model complexity until no further improvement in model fit was observed. This iterative process aimed to identify the most parsimonious solution that adequately described the data.

To evaluate the goodness of fit, broadly accepted indices were used (such as AIC, BIC, CFI, $\chi^2$ LRT, SRMR, and RMSEA) to compare the nested models for improvements. In order to justify advancing to a model with fewer measurement points, the respective estimates had to satisfy conventionally accepted cutoff criteria for the fit indices, demanding that the likelihood of data for neighbored models adhered to established thresholds (Byrne, 1994; Hu & Bentler, 1999;

Schumacker & Lomax, 2004). Beginning with fixed-effects models, the analysis was then extended to include a random intercept, and finally a random slope. Lastly, the best-fitting solution was extended into conditional models in which the initial values of the latent growth factors were regressed on treatment, sex and emotional reactivity.

A sequence of nested comparisons, corresponding to the measurement points of the design, gives insight into the likelihood of the data at each level of complexity. The analysis utilized a calculus of Pseudo-$R^2$ [1 - (ln $L_M$/ ln $L_0$)] that expresses the decrease in likelihood across time. The estimate iteratively matches the log likelihood of the data for two models, i.e. the nullmodel as opposed to the evaluated model (Everitt & Skrondal, 2010, 2799; Rudolf & Vogel-Blaschka, 2023; Wirtz, 2020). A volatile change of this index indicates a loss in model deviance and provides, aside from convergence in other fit indices, evidence for better fit. Note that since the nullmodel axiomatically has no predictors, it is oblivious to change in feature variables over time, so that *df* is zero.

Primary analyses were conducted using IBM SPSS Statistics 28 and secondary analyses were performed by using R 4.4.3 (lavaan 0.6-19). The study was preregistered on the Open Science Framework (Lenz et al., 2025). The secondary data analysis was preregistered after the primary analyses had been conducted but prior to the execution of the secondary analyses.

## Results

### *Primary Data Analysis*

Two univariate GLMs for repeated measures were conducted to assess whether any of the interventions had a positive effect on participants' self-reported mood or intrusion frequency over the course of the study. Greenhouse-Geisser corrected degrees of freedom applied for violation of sphericity in model variance. Contrary to our initial hypotheses, neither of the intervention groups outperformed the outcomes in the control group as measured by intrusion and mood. So did the interaction of time and treatment fail to reach significance [4 measurements, $F$ (63, 218) = 1.12, $p$ = .27, $\eta p^2$ = .24); 6 daily assessments, $F$ (60, 111) = .95, $p$ = .58, $\eta p^2$ = .34)]. Contrary, a large share in within-variance of the model was observed, accountable to the repeated measurements over the course of time [$F$ (21, 73) = 23.84, $p$ < .001, $\eta p^2$ = .87); $F$ (20, 37) = 34.90, $p$ < .001, $\eta p^2$ = .95)]. A multivariate evaluation of the outcomes also confirmed this finding, where lower estimates in Wilks Λ indicated the impact of the within-factor as opposed to the effects of treatment and interaction with higher values in this estimate (*table 2*).

**---- please insert table 2 about here ----**
***GLMs for Repeated Measures: Effectiveness of Interventions on Mood and Intrusion***

To summarize, the GLMs provided no evidence for the effectiveness of either of the treatments. This raised demand for a further examination of these effects using a different form of data modeling. The secondary data analysis is now reported in greater detail.

*Secondary Data Analysis*

Efficiency

Model efficiency relates to our research questions concerning model complexity and parsimony, particularly focusing on the optimal number of measurement points and the inclusion of random effects. An exploratory, stepwise approach was applied, comparing LGCMs that varied in the number of measurement points and in complexity (i.e., fixed effects vs. random effects). The likelihood of the data, as supported by the respective model, was estimated by convergence in fit indices to provide a comprehensive evaluation of model performance.

In a first step, fixed effects only models were analyzed. For each of the three outcomes, i.e. intrusion, mood and calmness, the base model included all ten measurement points. As expected, model parameters showed bad fit to the data (*table 3*): for intrusion ($\chi^2(53) = 585.33$, $p < .001$, CFI = .01, TLI = .16, RMSEA = .32, SRMR = .41, AIC = 2417.75, BIC =2448.89), for mood ($\chi^2$ (53) = 502.20, $p < .001$, CFI = .02, TLI = .17, RMSEA = .29, SRMR = .39, AIC = 2283.95, BIC = 2315.09) and for calmness ($\chi^2(53) = 528.16$, $p < .001$, CFI = .02, TLI = .16, RMSEA = .30, SRMR = .41, AIC = 2279.40, BIC = 2310.54).

Afterwards, random effects were added to examine the potential for improvements in fit. The findings suggest that it is important to account for individual variability, as captured by the indices of the respective baseline models: for intrusion ($\chi^2$ (50) = 155.58, $p < .001$, CFI = .80, TLI = .82, RMSEA = .15, SRMR = .12, AIC = 1993.99, BIC =2032.92), for mood ($\chi^2(50) = 103.33$, $p < .001$, CFI = .88, TLI = .90, RMSEA = .10, SRMR = .10, AIC = 1891.08, BIC = 1930.01) and for calmness ($\chi^2(50) = 89.91$, $p < .05$, CFI = .92, TLI = .93, RMSEA = .09, SRMR = .09, AIC = 1847.15, BIC = 1886.07). Though inclusion of random effects improved model fit, it still was suboptimal yet, as long as all measurement points were considered.

To proceed, the next step decremented the number of measurement points to assess model fit at varying degrees of parsimony. Table 3 provides an overview of the change in fit indices across the course of measurements. For each run of nested comparisons, the fit indices were evaluated for convergent results of model fit. Details are shown for intrusions, for the other outcome measures of

mood and calmness see supplementary material. As the multiple comparisons indicate, model performance is better when the number of measurements is rather low than high, so that model simplicity implies parsimony. The model containing only four measurement points demonstrated the best overall fit, which is true for mood and calmness also.

**---- please insert table 3 about here ----**
***Efficiency: Performance of Likelihood based Estimates in the Course of Time [t10; t1]***

Expanding upon this finding, details are examined for exogenous covariates of treatment, sex and emotional reactivity, whether they are essential to further enhance model fit. As primary analyses have already showed that emotional reactivity is a predictor of future intrusions, this result could be replicated again. Within the statistical framework of LGCM, the estimation of intrusion yields the only model that fulfilled all fit criteria, whereas for mood and calmness some of the indices remained suboptimal. In general though, model fit had improved for all of them under a sparse design, so that the covariates attested relevance to be considered as predictors. Exemplary in the model when intrusion is controlled for emotional reactivity, figure 2 depicts the trajectory of fit indices over the course of measurements. Note that the decremental evaluation is limited by model saturation, i.e. when degrees of freedom is zero.

**---- please insert figure 2 about here ----**
***Trajectories of Fit indices for Intrusion in Conditional Model: Emotional Reactivity***

A comprehensive overview of the estimates can be summarized as follows: intrusion ($\chi^2$ (7) = 4.47, $p > .05$, CFI = 1.00, TLI = 1.02, RMSEA = .00, SRMR = .03, AIC = 839.30, BIC = 867.84), mood ($\chi^2(7) = 17.55$, $p < .001$, CFI = .92, TLI = .89, RMSEA = .12, SRMR = .06, AIC = 798.13, BIC = 826.68), calmness ($\chi^2(7) = 22.21$, $p < .001$, CFI = .91, TLI = .87, RMSEA = .15, SRMR = .07, AIC = 793.22, BIC = 821.77). With respect to text fluency, further details for the two other predictors of treatment and sex are provided in our supplementary material. In case of emotional reactivity, table 4 gives a comparative view of model fit. Overall, our longitudinal design suggests that the data likelihood is highest at four measurements. Both, performance and model fit, decline beyond this point of optimal likelihood such that further measurements inflate model complexity.

**---- please insert table 4 about here ----**
***Estimates of Model Efficiency: Performance at t4***

Efficacy

So far, good fit implies (only) that the data likelihood is high under the hypothesis of a given model. Whether treatment, sex or emotional reactivity actually do effect the outcomes, can be inferred by conditional models. Inferred from the previously presented findings of model complexity, conditional models with random effects perform best at four measurements. To find out whether the null effects from the initial findings persisted in different types of statistical modeling, the between-factors of the primary data analyses were specified as exogenous predictors on initial values of intercept and slope. That is, conditional models for treatment, sex and emotional reactivity were now assessed to evaluate their impact on our three outcome measures of intrusion, mood and calmness. Table 5 displays the results of the respective LGCM.

**---- please insert table 5 about here ----**

***Conditional Effects at t4***

Once again, neither treatment condition was superior to the others or significantly accounted for between-group variance (intrusion: $b$ = [-0.130, −0.027, 0.116]; mood: $b$ = [-0.141, −0.115, −0.202]; calmness: $b$ = [-0.159, −0.067, −0.169]; all intercept estimates *ns* at $t4$). The same was true for the rates of expected change over time, that equaled across the treatments (intrusion: $b$ = [0.038, 0.100, 0.078]; mood: $b$ = [−0.099, -0.079, −0.068]; calmness: $b$ = [-0.039, −0.073, −0.036]; all slope estimates *ns* at $t4$).

For intrusions, data revealed an effect of sex, indicating that women reported a higher number of intrusions than men (intercept: $b$ = 0.059, $SE$ = 0.182, $p \leq .05$). Over time, women also exhibited a steeper increase in intrusions (slope: $b$ = 0.121, $SE$ = 0.058, $p \leq .05$). In contrast, neither mood (intercept: $b$ = -0.052, $SE$ = 0.177, *ns*) nor calmness (intercept: $b$ = -0.276, $SE$ = 0.155, *ns*) was significantly predicted by sex.

Contrary, and like the findings of the primary analyses, emotional reactivity in response to the film clip significantly predicted the number of intrusions, proposing that a stronger emotional response was associated with an increased occurrence of intrusive imagery (intercept: $b$ = −0.368, $SE$ = 0.107, $p \leq .01$). While emotional reactivity did not predict between-subject differences neither in mood (intercept: $b$ = -0.103, $SE$ = 0.094, *ns*) nor in calmness (intercept: $b$ = -0.047, $SE$ = 0.089, *ns*), it significantly influenced the rate of change of mood (slope: $b$ = -0.185, $SE$ = 0.028, $p \leq .01$) and calmness (slope: $b$ = −0.158, $SE$ = 0.026, $p \leq .01$) over time.

Altogether, results of this study indicate that reducing the number of measurements improved model fit, with a four-point model offering the best balance of simplicity and explanatory power. Especially, adding random effects enhanced the model fit by accounting for individual

variability. No significant differences were found between treatment groups in calmness, mood or intrusions. However, as women reported higher intrusion levels and greater increases in intrusions over time, sex showed to predict outcomes of this measure. As to speak of emotional reactivity, this covariate was highly predictive towards the amount of intrusions. It also is distinctly influential on changes in mood and calmness over time.

## Discussion

Primary data analyses were conducted as repeated measurement ANOVA, so that the presumptions of GLM had to be adhered. A 4x4 mixed design specified a 4-level graded between-factor, corresponding to the four treatments, and time as the within-factor over the measurements (4x6 respectively for the daily assessments). Findings revealed the importance of an adequate statistical modeling of longitudinal data. In particular required are analyses that can straight handle autocorrelative variance instead of employing compensatory adjustments for violations of sphericity, such as corrections of degrees of freedom for the *F*-statistic. Relating to the effect of trauma-focused interventions in the TFP, neither the between-factor nor the interaction term reached significance, so that neither active treatment outperformed the control group. Corresponding to that result, the significant within-factor accounted for most of the variation in the data. Multivariate estimates pointed in the same direction and favored the effect of time over the relevance of treatment. Further analyses indicated that emotional reactivity towards the film is a predictor for the future occurrence of intrusions. Women experienced more intrusions than men, which can be related to the type of stressor utilized in the design.

Secondary data analyses were conducted to find out whether statistical models that especially comply to methodological requirements of longitudinal data gain further insight into our first findings. Subsequent analyses cover both the efficiency of different models as expressed by estimates of performance and fit and the efficacy of varying interventions. While efficiency addresses model complexity and parsimony, efficacy relates to the superiority of a treatment. A further objective covers the impact of covariates, such as treatment, sex and emotional reactivity, as predictors for initial values of intercept and slope in conditional models.

### Comparison with previous research

Firstly, multiple comparisons of nested models of varying complexity indicate that statistical models of a trauma analogue require mixed models and perform best at four measurements. To reduce the costs of the experiment and to limit the burden for the participants, evidence suggests a

sparse design of four measurements (one before, one after the film, two after the intervention) as being sufficient to assess the effect. Recommendations are given based on efficiency, parsimony, model fit, and efficacy. The consideration of random effects elevates model fit and is mandatory to adequately analyze data in a longitudinal design.

Although randomly assigned to the four study arms and analyzed by proper statistical models, neither active treatment outperforms the outcomes of the waiting control group. Therefore, and as already known from our primary data analyses, none of the trauma-focused interventions has superior effect in TFP experiment. Overall, a vast decrease of analogue symptoms has been reported in related studies (Bourne et al., 2010; Krans et al., 2010b; Logan & O'Kearney, 2012), no effects were found for interference tasks (Nixon et al., 2009), or the elaboration of the film content has a selective effect, i.e. raises the duration of recall but leaves other outcomes untouched (Buck et al., 2009). Further more, while intrusive recall is accompanied by rumination, a combination of different styles of cognitive processing has no effect on the occurrence of intrusions (Luo et al., 2013). In line with our findings reported Hagenaars and colleagues (2010) that negative affect correlates with a higher number of intrusions when assessed in a TFP.

Secondly, though sex is equally distributed over all treatments, do women experience more intrusions than men. This finding can likely be attributed to a film clip depicting a rape scene. Accordingly, does the type of pictural exposure primarily influence the experience of displeasing emotions such as shame, embarrassment or disgust, while this is not directly true for the amount of arousal or valence ratings (Arnaudova & Hagenaars, 2017). Sensory load, rumination and negative appraisal are broadly known to interfere with perceptual information processing (Ehlers & Clark, 2000), so that impaired cognitive processing is likely in presence of these risk factors. Insofar adaptive plasticity is limited by stereotyped and reinforced traits such as gender, a restricted style of coping is associated with vulnerability (Kamboj et al., 2014). Accordingly, the dislike of imaginary recall in our sample is elevated in women, as well as the change of mood over time.

Lastly and to summarize, emotional reactivity augments the amount of intrusions, worsens mood and decreases its plasticity. Although this vulnerability is already well known, it is especially meaningful in a prospective longitudinal design that can separate risk factors from symptoms (DiGangi et al., 2013). In our experiment, the future occurrence of intrusions can best be predicted by the amount of emotional reactivity towards a distressing scene. Further, for an imaginary trauma analogue, there is no advantage in assessing mood as a target measure in addition to intrusion.

Our results further indicate that a trauma analogue has lower impact on the subjects than a critical real-life event. Though broadly accepted as an experimental model of psychopathology, the ecological validity of trauma analogues has again been challenged (Herzog & McNally, 2024;

Weidmann et al., 2009). Accordingly, the TFP relates more to stress than psychopathology such that findings indicate a rapid decrease of analogue induced symptoms. Therefore, effective guideline interventions may not directly be adequate for trauma analogues, although meta-analyses in general suggest high impact of trauma-focused interventions (Lely et al., 2019; Schäfer et al., 2019). Corresponding to these considerations, effect size was conservatively estimated for the purpose of this experiment. Findings now conclude that it should be assumed as being rather small than medium.

As the likelihood of the data was best at measurement *t*4 when the model also contains random effects, a comparative look gives insight in how the performance of particular fit indices differ from each other in detail. While the SRMR is equally stable over time and outperforms the RMSEA, the latter is especially biased when degrees of freedom are low (Kenny et al., 2014; Hu & Bentler, 1999). Implied by model complexity, the SRMR can be the better choice, while the RMSEA is usually and mostly cited in research.

**Limitations**

The results may be specific to a scientific sample, mostly comprising of students in psychology. On a more general level, having a gender effect points to the ecological validity of the design, proposing that the choice of a stressor is essential. Subsuming our findings in already reported results in literature, the amount of disgust and distress is likely to interact with gender. Though controlled for sex and randomly assigned to the treatments, an overly female sample is biased in principle. Therefore, maladaptive processing first of all touches confounded effects, but in presence of trait-related dispositions, such as gender, it may also indicate vulnerability. In presence of these conditions, emotional reactivity is not only a stable predictor for the occurrence of intrusions, but also interferes with either intervention. Generalization is further restricted by sample size, especially if effect size is lower than initially even conservatively assumed.

Though the analogue paradigm serves as an accepted model that safely allows for studies of psychopathology under controlled conditions, each stressor potentially lacks of ecological validity since the effects are studied in otherwise healthy participants. As effective psychotherapeutic treatments usually afflict patients, which specifically is true for trauma-focused interventions, the burden for the participants is too high. Both, the TFP and trauma analogues in general, are suited best for basic research. Thus, inference to applied research in psychotherapy is limited.

## Conclusion

The analogue paradigm allows to safely study trauma related etiology under experimentally controlled conditions. While clinical trials are mostly retrospective and research is limited by practical and ethical issues, the paradigm opens ways to gain prospective insight in factors that raise vulnerability for the disorder. Results imply that psychopathology and stress differ as well in terms of etiology as in consequences for the experiencing person. So that otherwise effective psychotherapeutic interventions have to be adapted, as analogue stressors lack of ecological validity and are studied in healthy persons. Therefore, effect size may be less than initially assumed. If the study was in fact underpowered, it was impossible to determine treatments efficacy. Yet, valuable conclusions can be inferred.

To begin with, it is sound to consider the true nature of analogue stressors already while designing the study. As NET aims for encoding contextual information into memory, so does Tetris directly compete with the processing of the imaginary input, and afterwards a hallucinatory replay can interfere intrusive recall. Results suggest to counterbalance moral or emotional embarrassment had been a more appropriate treatment. Though, both treatments may be less crucial than to compensate for a change in the state of mood. Beyond these general objections, further advice can be given from evidence of parsimony.

We believe that the statistical models of the secondary analyses are adequate to give substantial proof of tailored models. An efficient design not only is optimal in terms of measures and measurements, it also reduces costs and burden. Given the large diversity in trauma analogue literature regarding experimental design, type of stressors, outcome measures and interventions, evidence is provided to guide future analogue studies:

Firstly, we recommend to limit the number of measurements to four at most, since this count corresponds to optimal data likelihood across nested comparisons of models at varying degrees of parsimony.

Secondly, the composition of measures has to be aligned with the type of stimulus, concluding that pictural stressors are best captured by intrusions, so that additional mood assessment is obsolete.

Thirdly, random effects outperform fixed effects only models. For longitudinal data, mixed models should be first choice, pointing the adequacy of GEE over analytical models in the GLM.

Finally, emotional reactivity towards imaginary stressors raises the odds of a PTSD as it predicts future occurrence of intrusions, confines the plasticity of mood and in consequence restricts adaptivity.

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The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Tables

**Table 1**

*Sex and Age Distribution by Group*

| | NET | Tetris | NET + Tetris | Control Group | Full Sample |
|---|---|---|---|---|---|
| Sample Size | 23 (23.24%) | 25 (25.25%) | 26 (26.26%) | 25 (25.25%) | 99 (100%) |
| Age (years) | 21.91 (4.24) | 22.36 (4.44) | 21.19 (2.14) | 23.68 (7.16) | 22.28 (4.84) |
| Sex | | | | | |
| Male | 6 (23.1%) | 8 (30.8%) | 6 (23.1%) | 6 (23.1%) | 26 (26.3%) |
| Female | 17 (23.3%) | 17 (23.3%) | 20 (27.4%) | 74 (26%) | 73 (73.3%) |

*Note*. $N$ = 99. Narrative Exposure Therapy (NET). There were no significant differences in sex or age between the groups

**Table 2**

*GLMs for Repeated Measures: Effectiveness of Interventions on Mood and Intrusion*

| Effect | *df* | Wilks' Λ | *F* | *p* | $\eta_p^2$ |
|---|---|---|---|---|---|
| | | *mood and intrusion: 4x4 design* | | | |
| Time | 21, 73 | .13 | 23.84 | < .001 | .87 |
| Treatment | 21, 250 | .77 | 1.14 | .31 | .08 |
| Time × Treatment | 63, 218 | .43 | 1.12 | .27 | .24 |
| | | *mood and intrusion: 4x6 design, daily assessment* | | | |
| Time (daily assessment) | 20, 37 | .05 | 34.9 | < .001 | .95 |
| Treatment | 12, 140 | .66 | 2.02 | < .05 | .13 |
| Time × Treatment | 60, 111 | .29 | 0.95 | .58 | .34 |

*Note*. Treatment: Narrative Exposure Therapy (NET), Tetris, NET + Tetris, control group; 4x4 design: post film (*t*1), post treatment (*t*2), one week after treatment (*t*9), two weeks after treatment (*t*10); 4x6 design: one to six days after treatment (*t*3-*t*8); Greenhouse-Geisser correction was used to correct the violation of sphericity assumption; Mood: Mehrdimensionaler Befindlichkeitsfragebogen (MDBF); Intrusion: Impact of Event Scale – Revised (IES-R)

**Table 3**

*Efficiency: Performance of Likelihood based Estimates in the Course of Time [t10; t1]*

| t *n* | AIC | BIC | $\chi^2$ | df | $\chi^2$/ df | *p*(LL) | LL | CFI | TLI | RMSEA | SRMR | null-deviance | model-deviance | Pseudo-$R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **fixed effects/ intrusion** | | | | | | | | | | | | | | |
| 10 | 2417.75 | 2448.89 | 585.33 | 53 | bad | 0.00 | -1196.87 | 0.01 | 0.16 | 0.32 | 0.41 | 1987.30 | 238.40 | 0.12 |
| 9 | 2177.35 | 2205.90 | 457.74 | 43 | bad | 0.00 | -1077.68 | 0.02 | 0.18 | 0.31 | 0.39 | 1748.91 | 226.52 | 0.13 |
| 8 | 1948.83 | 1974.79 | 383.45 | 34 | bad | 0.00 | -964.42 | 0.02 | 0.19 | 0.32 | 0.38 | 1522.39 | 256.05 | 0.17 |
| 7 | 1690.78 | 1714.14 | 329.20 | 26 | bad | 0.00 | -836.39 | 0.02 | 0.21 | 0.34 | 0.38 | 1266.34 | 242.47 | 0.19 |
| 6 | 1446.31 | 1467.07 | 261.09 | 19 | bad | 0.00 | -715.16 | 0.02 | 0.22 | 0.36 | 0.39 | 1023.87 | 240.98 | 0.24 |
| 5 | 1203.34 | 1221.50 | 224.64 | 13 | bad | 0.00 | -594.67 | 0.01 | 0.24 | 0.41 | 0.40 | 782.89 | 240.67 | 0.31 |
| 4 | 960.67 | 976.24 | 154.69 | 8 | bad | 0.00 | -474.34 | 0.01 | 0.26 | 0.43 | 0.38 | 542.23 | 250.20 | 0.46 |
| 3 | 708.47 | 721.44 | 88.10 | 4 | bad | 0.00 | -349.23 | 0.01 | 0.26 | 0.46 | 0.33 | 292.02 | 250.12 | 0.86 |
| 2 | 456.35 | 466.73 | 41.90 | 1 | bad | NA | -224.17 | 0.00 | 0.00 | 0.64 | 0.27 | 41.90 | 229.16 | 0.18 |
| 1 | NA | NA | NA | NA | NA | NA | -109.59 | NA | NA | NA | NA | NA | NA | NA |
| **random intercept/ intrusion** | | | | | | | | | | | | | | |
| 10 | 2039.24 | 2072.97 | 204.82 | 52 | bad | 0.00 | -1006.62 | 0.72 | 0.76 | 0.17 | 0.14 | 1606.79 | 168.73 | 0.11 |
| 9 | 1868.51 | 1899.65 | 146.89 | 42 | bad | 0.00 | -922.25 | 0.75 | 0.79 | 0.16 | 0.15 | 1438.06 | 158.22 | 0.11 |
| 8 | 1708.29 | 1736.83 | 140.91 | 33 | bad | 0.00 | -843.14 | 0.70 | 0.74 | 0.18 | 0.16 | 1279.84 | 247.41 | 0.19 |
| 7 | 1458.88 | 1484.83 | 95.30 | 25 | bad | 0.00 | -719.44 | 0.77 | 0.81 | 0.17 | 0.15 | 1032.43 | 226.28 | 0.22 |
| 6 | 1230.59 | 1253.95 | 43.37 | 18 | moderate | 0.00 | -606.30 | 0.90 | 0.91 | 0.12 | 0.13 | 806.15 | 219.19 | 0.27 |
| 5 | 1009.40 | 1030.16 | 28.70 | 12 | moderate | 0.12 | -496.70 | 0.92 | 0.94 | 0.12 | 0.12 | 586.96 | 188.06 | 0.32 |
| 4 | 819.34 | 837.51 | 11.36 | 7 | good | 0.92 | -402.67 | 0.97 | 0.97 | 0.08 | 0.08 | 398.90 | 194.46 | 0.49 |
| 3 | 622.88 | 638.45 | 0.51 | 3 | good | NA | -305.44 | 1.00 | 1.03 | 0.00 | 0.03 | 204.44 | 204.44 | 1.00 |
| 2 | 416.44 | 429.42 | 0.00 | 0 | good | NA | -203.22 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 187.26 | 0.00 |
| 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **random intercept slope, random slope/ intrusion** | | | | | | | | | | | | | | |
| 10 | 1993.99 | 2032.92 | 155.58 | 50 | bad | 0.00 | -982.00 | 0.80 | 0.82 | 0.15 | 0.12 | 1557.55 | 138.16 | 0.09 |
| 9 | 1853.84 | 1890.17 | 128.22 | 40 | bad | 0.00 | -912.92 | 0.79 | 0.81 | 0.15 | 0.13 | 1419.39 | 203.97 | 0.14 |
| 8 | 1647.87 | 1681.61 | 76.49 | 31 | moderate | 0.00 | -810.94 | 0.87 | 0.88 | 0.12 | 0.12 | 1215.43 | 215.22 | 0.18 |
| 7 | 1430.65 | 1461.79 | 63.07 | 23 | moderate | 0.04 | -703.32 | 0.87 | 0.88 | 0.13 | 0.12 | 1000.20 | 210.28 | 0.21 |
| 6 | 1218.37 | 1246.91 | 27.14 | 16 | good | 0.83 | -598.18 | 0.95 | 0.96 | 0.08 | 0.13 | 789.92 | 225.88 | 0.29 |
| 5 | 990.48 | 1016.44 | 5.78 | 10 | good | 0.99 | -485.24 | 1.00 | 1.02 | 0.00 | 0.06 | 564.04 | 176.01 | 0.31 |
| 4 | 812.47 | 835.83 | 0.49 | 5 | good | 0.89 | -397.24 | 1.00 | 1.04 | 0.00 | 0.01 | 388.03 | 184.08 | 0.47 |
| 3 | 626.39 | 647.15 | 0.02 | 1 | good | NA | -305.20 | 1.00 | 1.03 | 0.00 | 0.00 | 203.95 | 203.95 | 1.00 |
| 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| t *n* | AIC | BIC | $\chi^2$ | df | $\chi^2$/ df | *p*(LL) | LL | CFI | TLI | RMSEA | SRMR | null-deviance | model-deviance | Pseudo-$R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **conditional model: treatment/ intrusion** | | | | | | | | | | | | | | |
| 10 | 2069.26 | 2128.82 | 184.70 | 74 | moderate | 0.00 | -1013.63 | 0.79 | 0.78 | 0.11 | 0.11 | 1388.91 | 155.87 | 0.11 |
| 9 | 1911.39 | 1968.11 | 154.53 | 61 | moderate | 0.00 | -935.69 | 0.77 | 0.76 | 0.11 | 0.11 | 1233.04 | 215.26 | 0.17 |
| 8 | 1694.13 | 1748.02 | 109.91 | 49 | moderate | 0.00 | -828.06 | 0.83 | 0.82 | 0.10 | 0.10 | 1017.78 | 213.36 | 0.21 |
| 7 | 1478.77 | 1529.82 | 89.99 | 38 | moderate | 0.00 | -721.38 | 0.83 | 0.81 | 0.10 | 0.10 | 804.42 | 206.51 | 0.26 |
| 6 | 1270.26 | 1318.47 | 54.01 | 28 | good | 0.29 | -618.13 | 0.89 | 0.87 | 0.09 | 0.10 | 597.91 | 227.77 | 0.38 |
| 5 | 1040.49 | 1085.87 | 21.84 | 19 | good | 0.36 | -504.25 | 0.99 | 0.98 | 0.03 | 0.05 | 370.14 | 175.95 | 0.48 |
| 4 | 862.54 | 905.09 | 12.07 | 11 | good | 0.14 | -416.27 | 0.99 | 0.99 | 0.03 | 0.03 | 194.19 | 187.33 | 0.96 |
| 3 | 673.22 | 712.92 | 6.87 | 4 | good | NA | -322.61 | 0.96 | 0.88 | 0.08 | 0.03 | 6.87 | 214.92 | 0.03 |
| 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **conditional model: sex/ intrusion** | | | | | | | | | | | | | | |
| 10 | 2060.97 | 2111.57 | 152.80 | 58 | moderate | 0.00 | -1013.48 | 0.81 | 0.82 | 0.11 | 0.12 | 1381.97 | 156.08 | 0.11 |
| 9 | 1902.89 | 1950.51 | 127.43 | 47 | moderate | 0.00 | -935.44 | 0.80 | 0.81 | 0.11 | 0.13 | 1225.89 | 214.22 | 0.17 |
| 8 | 1686.67 | 1731.32 | 84.28 | 37 | moderate | 0.00 | -828.33 | 0.86 | 0.87 | 0.09 | 0.11 | 1011.67 | 213.23 | 0.21 |
| 7 | 1471.44 | 1513.11 | 69.74 | 28 | moderate | 0.04 | -721.72 | 0.86 | 0.86 | 0.10 | 0.11 | 798.44 | 211.51 | 0.26 |
| 6 | 1257.93 | 1296.62 | 32.54 | 20 | good | 0.91 | -615.96 | 0.95 | 0.94 | 0.07 | 0.12 | 586.93 | 228.76 | 0.39 |
| 5 | 1027.17 | 1062.89 | 6.78 | 13 | good | 0.97 | -501.58 | 1.00 | 1.04 | 0.00 | 0.05 | 358.17 | 173.19 | 0.48 |
| 4 | 851.98 | 884.72 | 1.83 | 7 | good | 0.87 | -414.99 | 1.00 | 1.06 | 0.00 | 0.02 | 184.98 | 184.70 | 1.00 |
| 3 | 665.28 | 695.04 | 0.28 | 2 | good | NA | -322.64 | 1.00 | 1.07 | 0.00 | 0.01 | 0.28 | 207.08 | 0.00 |
| 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **conditional model: emotional reactivity/ intrusion** | | | | | | | | | | | | | | |
| 10 | 2047.97 | 2092.08 | 156.00 | 58 | moderate | 0.00 | -1006.98 | 0.81 | 0.82 | 0.13 | 0.12 | 1386.94 | 155.88 | 0.11 |
| 9 | 1890.08 | 1931.61 | 129.72 | 47 | moderate | 0.00 | -929.04 | 0.80 | 0.81 | 0.13 | 0.13 | 1231.06 | 216.33 | 0.18 |
| 8 | 1671.75 | 1710.68 | 83.94 | 37 | moderate | 0.00 | -820.88 | 0.87 | 0.87 | 0.11 | 0.11 | 1014.73 | 214.12 | 0.21 |
| 7 | 1455.63 | 1491.96 | 66.94 | 28 | moderate | 0.04 | -713.81 | 0.87 | 0.87 | 0.12 | 0.11 | 800.61 | 208.61 | 0.26 |
| 6 | 1245.02 | 1278.76 | 32.60 | 20 | good | 0.73 | -609.51 | 0.95 | 0.95 | 0.08 | 0.12 | 592.00 | 226.42 | 0.38 |
| 5 | 1016.60 | 1047.74 | 9.55 | 13 | good | 0.72 | -496.30 | 1.00 | 1.02 | 0.00 | 0.05 | 365.58 | 175.31 | 0.48 |
| 4 | 839.30 | 867.84 | 4.47 | 7 | good | 0.22 | -408.65 | 1.00 | 1.02 | 0.00 | 0.03 | 190.27 | 187.27 | 0.98 |
| 3 | 650.02 | 675.97 | 3.00 | 2 | good | NA | -315.01 | 0.99 | 0.97 | 0.07 | 0.04 | 3.00 | 210.54 | 0.01 |
| 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Table 4**

*Estimates of Model Efficiency: Performance at t*4

| Estimates | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Effect* | **AIC** | **BIC** | **$\chi^2$** | **df** | **$\chi^2$/df** | ***p*** | **CFI** | **RMSEA** | **SRMR** | **Pseudo-$R^2$** |
| ***Intrusion*** | | | | | | | | | | |
| Treatment | 862.54 | 905.09 | 12.07 | 11 | good | 0.1431 | 0.99 | 0.03 | 0.03 | 0.96 |
| Sex | 851.98 | 884.72 | 1.83 | 7 | good | 0.8693 | 1.00 | 0.00 | 0.02 | 1.00 |
| Emotional Reactivity | 839.30 | 867.84 | 4.47 | 7 | good | 0.2231 | 1.00 | 0.00 | 0.03 | 0.98 |
| ***Mood*** | | | | | | | | | | |
| Treatment | 839.14 | 881.68 | 15.38 | 11 | good | 0.2941 | 0.95 | 0.06 | 0.05 | 0.98 |
| Sex | 829.82 | 862.56 | 12.63 | 7 | good | 0.4084 | 0.94 | 0.07 | 0.06 | 0.99 |
| Emotional Reactivity | 798.13 | 826.68 | 17.55 | 7 | moderate | 0.0024 | 0.92 | 0.12 | 0.06 | 0.94 |
| ***Calmness*** | | | | | | | | | | |
| Treatment | 846.07 | 888.61 | 23.62 | 11 | moderate | 0.0236 | 0.89 | 0.10 | 0.06 | 0.94 |
| Sex | 832.36 | 865.1 | 8.65 | 7 | good | 0.2152 | 0.99 | 0.04 | 0.04 | 0.98 |
| Emotional Reactivity | 793.22 | 821.77 | 22.21 | 7 | bad | 0.0004 | 0.91 | 0.15 | 0.07 | 0.92 |

a) Reference coded effect against: cg (Treatment), male (Sex)

b) Emotional Reactivity: negative values indicate reactivity

**Table 5**

*Conditional Effects at t*4

Growth Factors: Latent Variables

| *Measure* | ***intercept*** | ***b*** | ***SE*** | ***p*** | ***95-CI [L; U]*** | ***slope*** | ***b*** | ***SE*** | ***p*** | ***95-CI [L; U]*** |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Treatment*** | | | | | | | | | | |
| *Intrusion* | | | | | | | | | | |
| NET | | -0.130 | 0.285 | *ns* | [-0.689; 0.429] | | 0.038 | 0.075 | *ns* | [-0.109; 0.185] |
| Tetris | | -0.027 | 0.268 | *ns* | [-0.553; 0.499] | | 0.100 | 0.073 | *ns* | [-0.042; 0.242] |
| NET+Tetris | | 0.116 | 0.272 | *ns* | [-0.417; 0.648] | | 0.078 | 0.079 | *ns* | [-0.076; 0.233] |
| *Mood* | | | | | | | | | | |
| NET | | -0.141 | 0.268 | *ns* | [-0.667; 0.385] | | -0.099 | 0.090 | *ns* | [-0.275; 0.078] |
| Tetris | | -0.115 | 0.224 | *ns* | [-0.555; 0.325] | | -0.079 | 0.083 | *ns* | [-0.241; 0.084] |
| NET+Tetris | | -0.202 | 0.211 | *ns* | [-0.615; 0.211] | | -0.068 | 0.073 | *ns* | [-0.210; 0.075] |
| *Calmness* | | | | | | | | | | |
| NET | | -0.159 | 0.222 | *ns* | [-0.593; 0.275] | | -0.039 | 0.072 | *ns* | [-0.180; 0.101] |
| Tetris | | -0.067 | 0.204 | *ns* | [-0.466; 0.332] | | -0.073 | 0.071 | *ns* | [-0.212; 0.066] |
| NET+Tetris | | -0.169 | 0.202 | *ns* | [-0.565; 0.228] | | -0.036 | 0.068 | *ns* | [-0.169; 0.097] |
| ***Sex*** | | | | | | | | | | |
| *Intrusion* | | 0.059 | 0.182 | $p \leq .05$ | [0.201; 0.916] | | 0.121 | 0.058 | $p \leq .05$ | [0.008; 0.235] |
| *Mood* | | -0.052 | 0.177 | *ns* | [-0.398; 0.295] | | 0.078 | 0.055 | *ns* | [-0.030; 0.185] |
| *Calmness* | | -0.276 | 0.155 | *ns* | [-0.579; 0.027] | | 0.058 | 0.052 | *ns* | [-0.044; 0.159] |
| ***Emotional Reactivity*** | | | | | | | | | | |
| *Intrusion* | | -0.368 | 0.107 | $p \leq .01$ | [-0.578; -0.158] | | -0.010 | 0.034 | *ns* | [-0.077; 0.057] |
| *Mood* | | -0.103 | 0.094 | *ns* | [-0.288; 0.081] | | -0.185 | 0.028 | $p \leq .01$ | [-0.240; -0.130] |
| *Calmness* | | -0.047 | 0.089 | *ns* | [-0.128; 0.222] | | -0.158 | 0.026 | $p \leq .01$ | [-0.209; -0.106] |

a) Reference coded effect against: cg (Treatment), male (Sex)

b) Emotional Reactivity: negative values indicate reactivity

## Figures

**Figure 1**

*Study Flow*

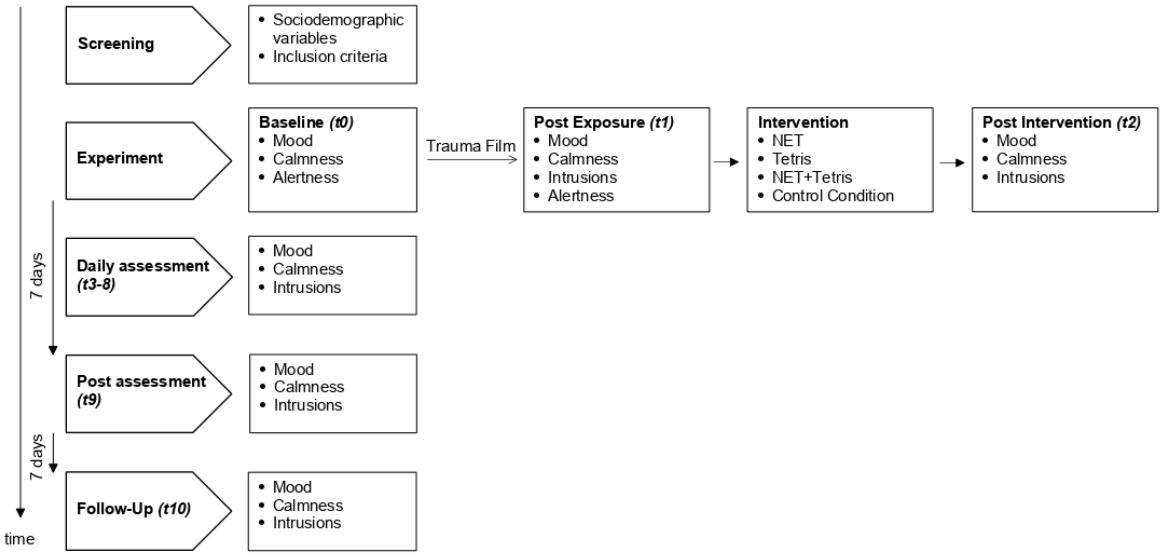
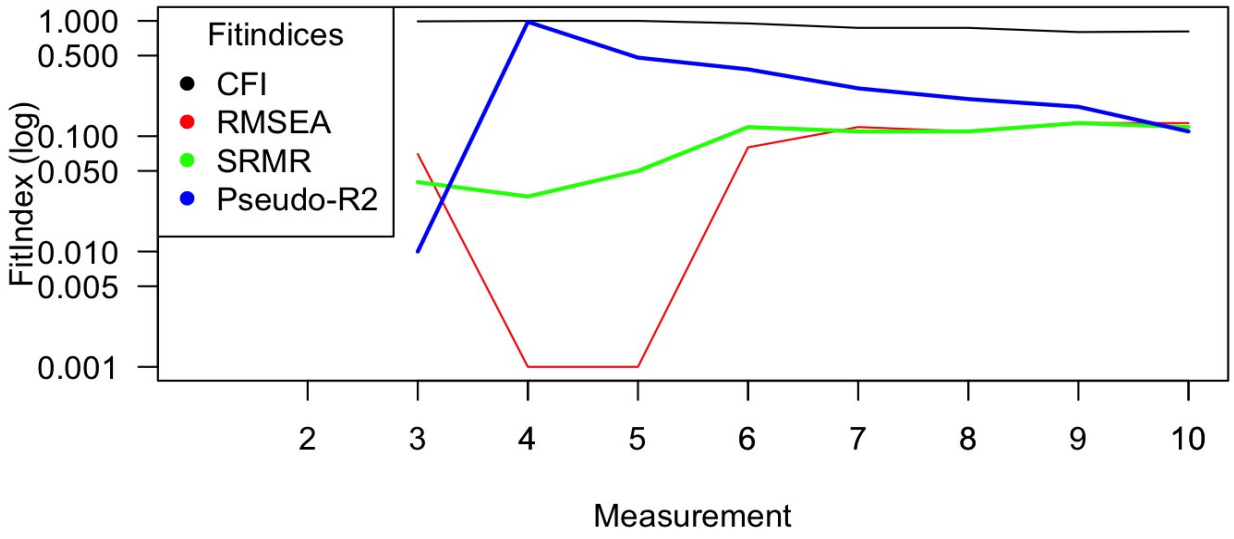



**Figure 2**

*Trajectories of Fit indices for Intrusion in Conditional Model: Emotional Reactivity*



**Manuscript 3, submitted article**

*Article: Empirical work [Cross-sectional online survey on temporal framing and well-being]*

Lenz, H.-J., Forstmeier, S., Flöter, L. & Hulsmans, N. (submitted). Balanced Time Perspective and Covariates of Well-being. *Frontiers in Psychology*, under review.

**Title**

Balanced Time Perspective and Covariates of Well-being

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***Abstract***

*Purpose:* This study aims for evidence of how to best capture balancedness in temporal framing. Balancedness is assumed to be adaptive, predicting well-being and other indicators of mental health. Additionally, time perception is fundamental in human functioning, directing time perspectives (TP) into past, present and future orientations. There are various proposals to measure it, differing in both construct dimensionality and operationalization. Analyses are conducted in the broader context of well-being and life quality, aiming for practical implications in lifespan psychology. Comparing the Balanced Time Perspective Scale (BTPS) with the modified BTPS, methodological issues address whether two or three dimension sufficiently capture time perspective, also to quantify explained model variance, and its incremental gain from using two compound measures, Deviation from Balanced Time Perspective (DBTP) and Structural Equation Model coefficient (SEM).

*Methods:* Observational cross-sectional study in a quasi-experimental design. Neither blinding nor random assignment of subjects applied. Observations are uniformly distributed across 6 groups [18; 71+] for age and sex. Observations are evenly distributed for balancedness. Accuracy of the model is 5-fold cross-validated employing a training and test subset. Adherence to the requirements of the analytical models is ensured. Linear Discriminant Analyses applied to infer evidence.

*Results:* Balancedness in temporal framing covaries with well-being and life quality. The share of explained variance in a model that is containing mBTPS exceeds BTPS, hence three time perspectives are better than two. DBTP and SEM, two comprehensive indicators of alternate application, in addition increase the explanational power above the usage of three TP. The overall predictive ability of the model is excellent and ranges in the upper percentile of correct estimations.

Specifically, evidence suggests that DBTP is more predictive towards the absence of balancedness, whereas SEM better captures its closeness. Experience of subjective well-being is on average higher in balanced observations. Balancedness does neither interact with age nor sex.

*Conclusions:* Evidence supports both the distance semantic of DBTP and proximity in case of SEM. The upper quartile of ratings in experienced Subjective Well-being (SWB) is confirmed as a threshold with clinical implication. To capture balancedness, three time perspectives are sufficient.

*Keywords*: Time Perspective, Balancedness, Lifespan, Well-being, Quality-of-Life, Bayesian Inference

## *Introduction*

### *Time Perspective*

The construct of the time perspective (TP), as understood in current psychological research, is based on the work of Lewin (1942) in the middle of the 20th century (Stolarski et al., 2018). Lewin described TP as “the totality of an individual’s views of his psychological future and psychological past existing at a given time” (Lewin, 1951, p. 75). While useful, this more general definition makes it difficult to differentiate TP from other psychological constructs such as *mental time travel* or *intertemporal choices* (Stolarski et al., 2018). Zimbardo and Boyd (1999) provided a more specific definition and described TP as a subconscious process that sorts personal and social experiences into temporal categories or contexts. This process allows individuals to bring order, meaning, and coherence to their life experiences. Humans can shift their TP between past, present, and future biographical points of their life. Some research conceptualizes TP as an orientation toward the past and future (Webster, 2011), while other models include the presence as well (Vowinckel et al., 2017; Zimbardo & Boyd, 1999). A past TP refers to the way individuals think about their past and how they give meaning to past experiences (Webster, 2011; Zimbardo & Boyd, 1999). For example, whether they reminisce the past as a resource respectively ruminate about losses, i.e. redemptive versus contaminative framing (Cappeliez et al., 2006; McAdams, 2001; Vowinckel et al., 2017; Webster, 2011). The present TP describes a focus on the current moment and the experience the here and now (Burzynska & Stolarski, 2020; Prezpiorka & Sobol-Kwapinska, 2021; Vowinckel et al., 2017). Lastly, a future TP represents the temporal orientation toward the future and anticipated goals (Simons et al., 2004; Webster, 2011; Zimbardo & Boyd, 1999). It also

encompasses motivation, anticipation, goal setting, and goal achievement (Stolarski et al., 2018; Zimbardo & Boyd, 1999).

*Time Perspective and Well-Being*

TP is an important variable to consider in the context of psychological research because it is linked to several different other psychological constructs, many of which are associated with quality of life, health, and well-being. A positive orientation toward the past TP is associated with increased well-being (Diaconu-Gherasim et al., 2021) and positive affect, whereas a negative orientation toward the past is linked to decreased well-being (Boniwell et al., 2010; Desmyter & De Raedt, 2012). Additionally, a positive past orientation in autobiographical memory is recollective towards resources (Ely & Mercurio, 2011), emotional intelligence (Stolarski et al., 2011), and self-esteem (Anagnostopoulos & Griva, 2012). A strong focus on the present TP is associated with living in the moment, seeking immediate pleasure, and yielding to temptations (Burzynska & Stolarski, 2020). However, the latter findings relate to studies using the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999), therefore focusing on the here and now experience (Fieulaine & Martinez, 2010; Keough et al., 1999). Positive associations with mindfulness, flow experiences, and improved mental health have been found with the present TP in the modified Balanced Time Perspective Scale (mBTPS; Vowinckel et al., 2017). Additionally, research highlights positive correlations with well-being (Przepiorka & Sobol-Kwapinska, 2021; Stolarski et al., 2018; Vowinckel et al., 2017), increased mood (Stolarski et al., 2014), emotional intelligence (Stolarksi et al., 2011), extraversion, and openness to new experiences (Stolarksi et al., 2018). A positive future TP orientation has been linked to better health-conscious behaviors such as lower substance use (alcohol and tobacco) or increased seatbelt use (Daugherty & Brase, 2010), attending preventative cancer screenings (Roncancio et al., 2014), and smoking cessation (Kovač & Rise, 2007). Additional correlations include lowed distress following traumatic events Holman & Silver, 1998, 2005), reduced procrastination (Ferrari & Díaz-Morales, 2007), higher income and educational attainment (Shores & Scott, 2007), greater capacity for delayed gratification (Daugherty & Brase, 2010), and well-being (Vowinckel et al., 2017).

Overall, research shows individual TPs to be correlated with positive constructs such as health-conscious behavior (Daugherty & Brase, 2010) or increased resilience (Indirasari et al., 2019). However, a dominant focus on one individual TP to the exclusion of others can lead to negative consequences (Boniwell et al., 2010). The positive effect of a specific TP also seems to be dependent on the situational context. For example, a future TP is particularly useful in the context of

goal attainment, possibly due to its negative association with procrastination (Boniwell et al., 2010; Ferrari & Diaz-Morales, 2007). Therefore, Zimbardo and Boyd (1999) looked beyond individual TPs and described the idea of a *balanced time perspective* (BTP).

*Balanced Time Perspective*

Zimbardo and Boyd (1999) conceptualized BTP as an adaptive ability to flexibly switch between a past, present, and future TP, and utilize them in a situationally appropriate manner. Boniwell and Zimbardo (2004) also emphasized flexible use and situational adequacy as central aspects of BTP. In an optimally balanced TP, the individual TPs of past, present, and future function together in a flexible manner (Zimbardo, 2002). A BTP allows for adaptive and functional behavior without being rigid and stuck in a single TP (Boniwell & Zimbardo, 2004; Zimbardo & Boyd, 1999). After an initial empirical examination of different TP profiles (balanced vs. unbalanced) Drake et al., 2008; Zhang et al, 2013), multiple studies have been conducted on BTP, particularly due to its broad informational value (Stolarski et al., 2018; 2020). A high BTP is correlated with several measures of well-being and markers of physiological and psychological health (Boniwell & Zimbardo, 2004; Oyanadel & Buela-Casal, 2014). For example. associations with have been found with sleep quality (Rönnlund & Carelli, 2018), health-related quality of life (Oyanadel & Buela-Casal, 2014), and symptoms of anxiety, obsessive-compulsive disorders, depression, stress, and substance abuse (Stolarski et al., 2020). Additionally, a high BTP is correlated with better adaptation following potentially traumatic experiences (Tomich & Tolich, 2021), which could explain the association between a high BTP and a lowered risk for PTSD (Stolarski & Cyniak-Cieciura, 2016). BTP has been shown to be more strongly correlated with measures of well-being than individual TPs (Diaconu-Gherasim et al., 2021). In some studies, it explained up to 40% of the variance in the measure of well-being (Stolarski et al., 2020; Zhang et al., 2013). Therefore, the degree of balance seems to be an explanatory variable for risk factors of physiological and psychological illness.

TP's impact on well-being and health is probably mediated by decision-making and chosen behavior (Boniwell, 2005; Lennings, 1996). A two-path model has been formulated to explain the effect of BTP on well-being (Chen et al., 2021), with an indirect and a direct path (Cunningham et al., 2015). The indirect path, also referred to as the bottom-up path, accounts for the effect of individual TPs on an individual’s behavior that improve their life circumstances and, in turn, their well-being (Cunningham et al., 2015). TP is associated with experience, the evaluation of past and present events, and the preference of future goals, therefore impacts behavioral outcomes (Cummins

et al., 2019). Due to the recursive nature of choice and overall life quality, the mutual impact of living conditions, habits and well-being is bidirectional, thus influence can be exerted in either way, top-down and bottom direction is possible (Burzynska & Stolarski, 2020; Schimmack et al, 2002). The former describes a direct path on which the mental representation of a given context impacts life quality and well-being, whereas the latter relates to an indirect effect by which behavioral choice builds habits that shape life quality. However, adaptation can be restrictive or flexible, whether supportive or dysfunctional. Thus, evidence links TP to a broad field of mental and health related outcomes, spanning among others risky or health promoting behavior, addiction, diet, gratitude, mindfulness and flow, experience of joy or savoring (Benowitz, 1992; Boniwell et al., 2010; Burzynska & Stolarski, 2020; Cunningham et al., 2015; Roglic, 2016; Rothspan & Read, 1996; Schimmack et al., 2002; Swan & Lessov-Schlaggar, 2007). Additionally, mental anticipation of one's own future has a direct effect on well-being (Holman & Silver, 2005) and present TP is associated with positive affect and joy, which can have a direct impact on well-being (Stolarski et al., 2014). Overall, past TP primarily impacts well-being via the direct path of the immediate interpretation of past events. Meanwhile both present and future TPs have a more pronounced effect via both paths (Cunningham et al., 2015). While the significant effects of a BTP have strong empirical evidence, there is ongoing debate on the assessment of BTP.

*Measures of (Balanced) Time Perspective*

Reliable and valid psychometric instruments are required to adequately assess BTP's impact on well-being and the etiology of physical and mental health issues (Vowinckel et al., 2017; Webster, 2011; Zimbardo & Boyd, 1999). Additionally, past research has utilized different methods of aggregating subscales into an overall BTP score, which affects the reliability of the measurements (Jankowski et al., 2020; Zhang et al., 2013). In past research, the ZTPI (Zimbardo & Boyd, 1999) has established itself as the most widely studied and utilized questionnaire for assessing TPs and BTP (Laureiro-Martinez et al., 2017; Stolarski et al., 2018). The ZTPI contains 56 items that can be divided into five subscales: past-negative (PN), past-positive (PP), present-fatalistic (PF), present-hedonistic (PH) and future (F). These scales measure temporal orientation as a cognitive-emotional representation of time (Boniwell, 2010). However, discourse on the instrument states that the evaluative component is not distinct across all scales and that some items of the future scale rather capture time management than affective concerns (Vowinckel et al., 2017). However, the instrument shows a good retest reliability of $r$ = .70 to .80 for a gap of four weeks (Zimbardo & Boyd, 1999). Additionally, it demonstrates good validity (Boniwell et al., 2010;

Zimbardo & Boyd, 1999), as indicated by significant correlations with measures of mental health ( $r$ = -.41 to .38; Vowinckel et al., 2017) and psychological strength such as vitality, resilience and hope ($r$ = -.47 to .37; Davis & Cernas Ortiz, 2017).

More recently, the mBTPS (Vowinckel et al., 2017), an expansion of the Balanced Time Perspective Scale (BTPS; Webster, 2011) was developed to include an assessment of the present TP. Both of which are construed by items that consistently feature an affective component (Vowinckel et al., 2017; Webster, 2011). The mBTPS consists of 38 items that are divided into three subscales or factors. The past and future subscales contain 14 items each, while the subscale for the present TP has 10 items. Reliability for all three scales ranges from α = .88 to .92 (ibid.), which falls within a good to excellent range (Cronbach, 1951; Zinbarg et al., 2005, 2006). Regarding validity, the mBTPS correlates with several measures of mental health to varying degrees ($r$ = .30 to .56; Vowinckel et al., 2017). The inclusion of subscale subscale for the present TP increases the explained factor variance with measures of mental health by almost 11% when compared with the original BTPS (ibid.). Additionally, the present subscale shows only a weak to mild correlation with the factors of past and future. However, past and future TP have a moderate to strong correlation with each other (ibid.).

The ZTPI and mBTPS differ in a few significant ways, that are related to the decomposition of the mental time into the representation of cognitive and affective facets. The mBTPS assesses only the positive orientation of past TP, meanwhile the ZTPI also includes a negative orientation. As expected, there is a strong overlap between the questionnaires' respective subscale assessing a positive past TP, but less so between the ZTPI's negative past subscale and the mBTPS past subscale (Vowinckel et al., 2017). Another key difference is the different conceptualization of the present TP. The mBTPS subscale was derived from 10 items from the Present-Eudaimonic Scale (Vowinckel et al., 2017) and is based on the concept of eudaimonia, whereas the ZTPI's subscale is based on the concept of hedonism (Huta & Waterman, 2014). This difference affects the association with well-being, as the construct of well-being is often divided into two perspectives: subjective (hedonic) well-being and eudaimonic well-being (Eid, 2021; Martela & Sheldon, 2019). Just as hedonism reflects subjective well-being, eudaimonia is an important aspect of well-being (Eid, 2021; Vowinckel et al., 2017). Eudaimonia encompasses aspects such as personal growth, meaning in life, and self-realization, and authenticity (Ryan & Deci, 2001; Huta & Waterman, 2014). Hedonism reflects aspects such as pleasure, joy, and the absence of suffering (Huta & Waterman, 2014). In research on BTP, subjective well-being usually functions as the criterion variable (Diaconu-Gherasim et al., 2021). Subjective well-being consists of life-satisfaction and positive/

negative affect (Eid, 2021; Martela & Sheldon, 2019). Life satisfaction is usually considered to be a relatively stable trait, and affect is understood as a variable state (DeNeve & Cooper, 1998). Life-satisfaction reflects a cognitive evaluation of one's own experiences and overall quality of life (Cummins et al., 2010; DeNeve & Cooper, 1998; Veenhoven, 2015).

The ZTPI also contains more items and factors, allowing for a more detailed assessment. However, it is also less economical compared to the mBTPS due to its length (Vowinckel et al., 2017; Webster, 2011; Zimbardo & Boyd, 1999). Additionally, the ZTPI assesses both negative and positive orientation of past and present TPs, while the mBTPS only captures positive orientations (Vowinckel et al., 2017; Zimbardo & Boyd, 1999). Although the factors of the two scales correlate, the mBTPS shows a more substantial association with mental health, particularly its subscale for the present TP (Vowinckel et al., 2017). Finally, the mBTPS was specifically conceptualized for the assessment of a BTP, whereas the ZTPI was not (Vowinckel et al., 2017).

*How to balance Time Perspectives?*

Beyond the differences between the questionnaires, several different methods for calculating BTP have been proposed in past research (Stolarksi et al., 2011; Jankowski et al., 2020; Vowinckel et al., 2017). Studies on the ZTPI have shown that the method used to aggregate individual TPs into a total BTP score can influence the interpretability of the results (Zhang et al., 2013).

The median split approach has been applied to both the ZTPI and the mBTPS (Webster, 2011). By splitting the sample along the median, every participant can be assigned to either the low-scoring or the high-scoring group. Since this can be done for each individual TP, different profile combinations can be distinguished. For example, four different combinations have been described for the BTPS with its two subscales: *time restrictive* (low past and future TP), *reminiscers* (high past and low future TP), futurists (low past and high future TP), and time expansive (high past and future TP) (Webster 2011). The time expansive profile has been associated with increased well-being and happiness (Webster, 2011), as well as better mental health (Webster & Ma, 2013). However, approaches to measure BTP coexist and evidence has been collected for both instruments, but precedence of a particular metric still is undetermined.

Cluster analysis is a descriptive method that groups a large pool of data into homogeneous subgroups (Wirtz, 2022a). Hierarchical cluster analysis (HCA) combines data into increasingly larger groups in a stepwise process until all cases are grouped into one large cluster. Detailed descriptions of HCA have been provided in past research (Frades & Matthiesen, 2010; Köhn &

Hubert, 2015). Prior studies have either identified four to five clusters (Boniwell et al., 2010) or have chosen a two-cluster solution (Zhang et al., 2013). Individuals in different clusters differ in their respective TPs and in measures of well-being such as life-satisfaction. The clusters can be further evaluated according to their proximity to a BTP. However, just like the median split, HCA is dependent on the analyzed sample (Boniwell et al., 2010).

To address this limitation, an aggregation method introduced an approach which is independent of the analyzed sample (Wiberg et al., 2012). TPs are categorized based on predetermined and sample-independent reference values in accord to a certain ZTPI profile (Boniwell & Zimbardo, 2004). The mean for each TP subscale is calculated and then compared against the reference value. In a second step, overall BTP is assessed by counting how many means fall within the respective optimal range. Zero scores in the optimal ranges is considered to be a completely unbalanced profile and all scores being optimal represents a perfectly BTP.

Another sample-independent aggregation method a distance metric (Stolarski et al., 2020), i.e. Deviation from Balanced Time Perspective (DBTP), which quantifies the Euclidean distance between the recommended and actual values of an observed TP. The reference values are in accord to a certain ZTPI profile, which is assumed to be optimal (Boniwell & Zimbardo, 2004). Of note is that, this property has not been inferred by evidence but rather is argued to be balanced (Stolarski et al., 2020).

*Covariates of Balanced Time Perspective and well-being*

Past research has examined three potentially relevant sociodemographic covariates in the relationship between BTP and well-being: age, sex, and cultural context (Diaconu-Gherasim et al., 2021; Stolarski et al., 2020). Results regarding the effect of age have been heterogeneous. A meta-analysis from 2017 reported a positive correlation between age and the positive-past subscale of the ZTPI, but no association with future TP (Laureiro-Martinez et al., 2017), or found a negative association between future TP and age (Henry et al., 2017) . A recent meta-analysis revealed a differentiated effect of age on measures of well-being (Diaconu-Gherasim et al., 2021). Specifically, BTP appears to be correlated with life-satisfaction among younger individuals, whereas it rather covaries with global well-being in persons of age. Evidence from our own study on BTP is in support this finding, since adequate levels well-being can be found across all age classes (Lenz et al, 2025). Literature does not support an effect of sex on BTP (Stolarski et al., 2020). In addition,

though culture modulates a variety of psychological outcomes, no influence has been reported for future TP or BTP (Diaconu-Gherasim et al., 2021).

*Study Purpose*

The optimal calculation of an overall BTP remains a particularly important topic of research. While several studies have focused on the aggregation of the BTP with the ZTPI, other instruments such as mBTPS have received little to no research. It therefore remains unclear whether the interpretability and predictive value of the BTP scores measured with the mBTPS can be improved or enhanced by different aggregation methods. The aim of the present study was to compare the calculation method for BTP proposed by the authors of the mBTPS with other potential calculation methods in terms of criterion validity. Aggregation methods from other measurement instruments (e.g., Jankowski et al., 2020; Stolarski et al., 2015; Zhang et al., 2013) were considered and incorporated into the current study to derive new potential calculation methods for the mBTPS. Additionally, a data-driven calculation approach based on a structural equation model (SEM) was included for comparison. Caution has been taken in accord to the prior distribution of BTP, which inevitably varies in accord to the respective measure. Classification scenarios are sensitive to prevalence (Kuhn & Johnson, 2020), so that the empirical proportions of balancedness between groups are supposed to influence empirical outcomes of the statistical model at most.

## *Methods*

*Sample*

The sample of the present study comprises $N = 302$ persons. Recruitment was carried out via an external service provider (https://mingle.respondi.de). Considering the existing literature, which reports medium effect sizes (e.g. Diaconu-Ghersaim et al., 2021; Vowinckel et al., 2017), the sample size can be regarded as sufficient.

The only eligibility criterion for participation in the study was a minimum age of 18 years. In addition, an equal distribution in terms of age and sex was requested as part of the acquisition process via the external provider.

Recruitment was carried out by the service provider, who invited the individuals with the link to participate in the online study and ensured that the inclusion criteria and equal distribution

were met. Data collection took place between 20.03.2022 (soft launch on 16.03.2022, $n$ = 30) and 28.03.2022.

Missing values: listwise deletion, pattern of missing data is in accordance with missingness completely at random (MCAR). A total of $N$ = 80 participants failed in the quality check, which ensured the carefulness of the answers by three items spread over the survey and had to be filled out according to the instruction, resulting in a sample size of $N$ = 302. For Subjective Well-being (SWB) a binomial logistic regression is non-significant [ $\chi$2 (1) = 0.122, $p$ = .727], so that missings on that measure are substituted by the mean. Outlier controlled for balancedness, Cook's $D$ applied (*statistical analyses; supplementary materials*). Additionally, $n$ = 26 cases with extreme values in processing time (+/- 3 x IQR) were inspected. Because explanatory analyses showed no systematic differences on outcomes, these observations remained in the data set.

The final sample ($N$ = 302) consisted of 151 (50.0 %) females, 150 (49.7 %) males, and 1 (0.3 %) diverse individual. The mean age of the individuals was $M$ = 50.54 ($SD$ = 17.49). In the lower age groups, female persons are dominant, while this is reversed in the higher age groups [ $\chi^2(5) = 19.18$, $p$ = .002] (*supplementary materials*). As sex is no covariate of balancedness, the unequal distribution can be neglected at this point (Stolarski et al., 2020).

*Procedures and Design*

The study is based on an online survey in which data is collected from participants who are not randomly assigned to a treatment. All data was collected at one measurement point. No blinding is involved in this cross-sectional observational study. Correlational quasi-experimental design, equally distributed assignment of age and sex across 6 classes [18; 71+]. Random draws prepare 5-fold cross-validating which had been conducted on subsets of 80:20 proportion for training and testing the model. Throughout, BTP prevalence is conditioned on even odds.

Participation took place via a link to the study. After giving informed consent, the subjects were given access to the questionnaires, being presented in a fixed order. The average processing time was $M$ = 23.93 minutes (*supplementary materials*). Once all questionnaires had been completed, the individuals were forwarded back to the external provider for payment.

*Research questions and general hypotheses*

The study objective connects to primary analyses in this research project. Most of the following hypotheses are exploratory, due to the state of knowledge in scientific literature. Methodologically, Linear Discriminant Analysis (LDA) will examine which model can best estimate balancedness, either in classifying or predicting purpose. It is expected that metric indices outperform categorical predictors in both efficiency and accuracy. Evidence will be collected whether the measurement of both balancedness and psychological covariates of temporal framing requires the assessment of two or three time perspectives, thus:

Which predictor set is most appropriate for adequately classifying and predicting BTP? Ordering TP (past, present, future) in accord to their importance, what is their relative share in capturing BTP? Adding present TP, what is the incremental gain in explained variance, compared to a model that comprises past and future TP only, i.e. mBTPS versus BTPS?

To what extent do metric indices, DBTP and SEM, outperform the usage of TP scales in mBTPS or BTPS in classifying or predicting balancedness? Expectation is that both DBTP and SEM yield predictions of higher accuracy.

Subjective well-being is expected to differ between balanced and unbalanced observations so that (a) the balanced subsample reports SWB in the upper quartile of average ratings (i.e. L-1 ≥ Q75; Cummins et al., 2010), alike that (b) the covariation between BTP and SWLS is significant but reverse signed for both subsamples of balanced and unbalanced observations.

Does balancedness negatively covary with Age? To what extend do Age and SWB covary?

*Materials*

*Modified Balanced Time Perspective Scale (mBTPS)*. The mBTPS (Vowinckel et al., 2017) is based on the two subscales (past and future) of the BTPS (Webster, 2011), supplemented by a third subscale for the present time perspective. The instrument comprises a total of 38 items, which can be answered on a 6-point scale (1 = never, 6 = always). The authors suggest using the DBTP

coefficient to calculate a total BTP score (Vowinckel et al., 2017). The internal consistency of the subscales is in the range of α = .88 (past and present) and α = .92 (future).

*Satisfaction with Life Scale (SWLS)*. The German version of the Satisfaction with Life Scale (Janke & Glöckner-Rist, 2012) is used in the present study to assess life quality. The SWLS measures the cognitive-evaluative component of well-being containing five items that can be answered on a 7-point scale (1= strongly disagree, 7 = strongly agree). The sum of all items forms the total scale value. The internal consistency is α = .92.

*Short scale to measure general life satisfaction (L-1)*. The L-1 (Beierlein et al., 2015) consists of one item that measures well-being in the sense of global life satisfaction. This study asks “How satisfied are you with your life as a whole?” (adapted, original wording Cummins et al., 2010), ratings can be given on a scale from 1 (dissatisfied) to 100 (satisfied). The test-retest reliability (6 weeks) is $r_{tt}$ = .67. In addition, values of $r$ = .70 to .73 are reported for the correlation between the L-1 and the SWLS (Beierlein et al., 2015).

*Patient Health Questionnaire-15 (PHQ15).* The PHQ15 (Kroenke et al., 2002) enables a dimensional assessment of somatic symptoms severity. Items 1-13 address various somatic complaints. A filter question prefixes the subsequent symptom list: "How often do you feel bothered by the following somatic complaints in the last 4 weeks?". Items 14 and 15 complement symptoms referring to a somatic syndrome in the context of a depressive disorder, again preceded by "How often do you feel bothered by the following symptoms in the last 2 weeks?". The first 13 items are answered on a 3-point scale (0 = not bothered at all, 2 = bothered a lot), while items 14 and 15 can be answered on a 4-point scale (0 = not at all, 3 = nearly every day). Summing up the items of the two respective subscales yields two total scores. The internal consistency is α = .83.

*Self-Control Scale (SCS-K-D)*. The short from of the SCS in German language (Bertrams & Dickhäuser, 2009) is used to measure the dispositional self-control of the individuals. The short form comprises 13 items, which can be answered on a 5-point scale (1 = not at all, 5 = very much). An internal consistency of α = .80 is reported.

*Savoring Belief Inventory (SBI)*. The SBI (Bryant, 2003) comprises 24 items, which are equally distributed across three factors. Each of these three factors (Anticipating, Savoring the Moment, Reminiscing) contains four positively and four negatively polarized items. The items are answered on a 7-point scale (1 = strongly disagree, 7 = strongly agree). Both an overall score across all items and a score per factor can be calculated. Negatively polarized items must be inverted. The internal consistency ranges from α = .68 to .94.

*Prioritizing Positivity (PPQ).* The PPQ measures cognitive-emotional processes expressing selective goal attention, "[…] the extent to which people seek out positive emotional experiences […]" (Catalino et al., 2014, p. 4). The questionnaire consists of 6 items, which can be answered on a 9-point scale (1 = strongly disagree, 9 = strongly agree). An internal consistency of α = .81 is reported.

*Reminiscence Function Scale (RFS)*. The RFS measures reminiscence in service of different psychological functions comprising 43 items, which can be answered on a 6-point scale (1 = never, 6 = very frequently). The original version of the RFS (Webster, 1993, 1997) contains eight facets of reminiscence (Identity, Problem Solving, Death Preparation, Teach and Inform, Conversation, Bitterness Revival, Boredom Reduction, and Intimacy Maintenance), while joining the first two facets to one dimension (Identity/ Problem Solving) favors a factorial structure of seven subscales (Robitaille et al., 2010; Webster, 1997). In general, evidence proposes a model of eight functions, clustered into three latent 2nd-order factors on prosocial, self-positive and self-negative reminiscence (Cappeliez & O'Rourke, 2006; O'Rourke et al., 2016). On purpose to focus on adaptive usage, this study is measuring the construct on three scales (Identity, Problem Solving, Death Preparation), within the tripartite model that corresponds the self-positive functions. The internal consistency ranges between α = .76 and .87.

*Prevalence of Balancedness, Choice of Prior*

In LDA, a criterion of equal proportions is fundamental, because skewed classes would alter the odds and account for model bias. An even chance has the least data likelihood for either group and is ideal to determine posterior probability. To update the posterior to the prior resolves by $X \sim U(\,) \propto X \sim B(p, q)$.

A series of random draws first levels out balancedness $X \sim U$ (150, 150) and then chops the resulting observations into subsets of $n \approx 240$ and $n \approx 60$ cases. Hence, 0.80 of the observations serve as a training sample and the remaining quota of 0.20 setup the test cases. Cross-validating builds on test data in order to evaluate the ability of the model to correctly predict class membership for observations which the algorithm previously has not been trained on (Backhaus et al., 2023; Wirtz, 2021; Rudolf & Buse, 2020).

Aside from mediansplit, Hierarchical Cluster Analysis (HCA) has also been used in research to capture balancedness (Stolarski et al., 2020; Wiberg, 2012; Zhang et al., 2013). Using HCA to classify balancedness generates a skewed prevalence of 189 balanced observations and 133

unbalanced observations, which is *f* (62.6) respectively *f* (37.4) of sample *N* (302). Restricted by these initial proportions will subsequent random draws result in small subsets for training *n* (70, 70) and testing *n* (20, 20).

Likewise further predictors exist, i.e. HCA 4, Median-split and Wiberg, but are hard to interpret as they imply a multinominal differentiation of the criterion. Such a scenario produces multiple equations in LDA, for which the number of discriminant functions is given by min [$g - 1$, $k$], with $g$ [1; $g$] groups and $k$ [1; $k$] predictors.

**--- please insert table 1 around here ---**

***Table 1: Prior Probability of Balancedness under different Operationalizations***

*Operationalizations of BTP*

The DBTP coefficient uses formula $DBTP = \sqrt{\sum_{1}^{3\,TP} (observed - optimal)^2}$. However, scale means on the three time perspectives are used as observed data, the respective maximum (= 6) specifies the optimal value. The index quantifies a metric measure of balancedness, hence BTP (Stolarski et al., 2011; Vowinckel et al., 2017).

The authors of the present study would also like to propose a further operationalization, based on a structural equation model. This coefficient relates to a second order latent variable, estimated by first order latent constructs of time perspective and life satisfaction, i.e. three TP scales and SWLS measure (SEM; *supplementary materials*). Both coefficients, DBTP and SEM, are compared against each other for their aptitude to classify and predict cases in regard to balancedness.

*Statistical Analyses*

*Data Preparation.* Feature engineering assured for adequacy of predictors in the resulting model. In classification tasks, prior information is fundamental to model accuracy. Thus, attention has been spent of how to preset the prevalence of balancedness in the sample.

*Analytical Models.* The concern of LDA is twofold, first to classify observations and second to predict an either binary or multinominal outcome. LDA expects that the multivariate feature

variables are Gaussian. Depending on the respective purpose, the analytical model either classifies cases, or predicts the posterior probability for a categorical criterion. A Linear Discriminant Function (LDF) denotes by $B_jX_i \rightarrow Y_{ig}$, where $Y_{ig}$ maps to individual discriminant values; *j* [1; k] predictors, *i* [1; n] observations, *g* [1, g] groups. The statistical model is capable to operate complex classifications.

LDA resembles Principal Components Analysis (PCA) in some aspects, as it decomposes multivariate variation and recursively maximizes eigenvalues in vectors described by linear equations. Unlike PCA, in which covariation is an emergent property in the data, does LDA preserve group membership and propagates the classifier into the model. Thus, the solution vectors also capture psychometric properties (Dunn & Everitt, 2004[129-198]; Rudolf & Buse, 2020[182]; Wirtz, 2022b).

*Inferential decision criteria, exploratory analyses.* Use case of discriminant analysis is exploratory for most of the hypotheses, assuming an error level of α .05 and a Power of .80. Rank correlations illustrate the bivariate associations between the feature variables. Their effect size is rated according individual differences guidelines: low, $|r| \leq .1$; moderate, $|r| \leq .2$, strong $|r|, \geq .3$ (Cohen, 1992; Gignac & Szodorai, 2016; Leonhart, 2022).

Statistical inference is drawn by: χ2 to infer model's ability to correctly classify and predict observations, *F*-Test and Wilks Lambda to evaluate the eigenvalues of the model and to assess the significance of the discriminant coefficients, *z*-test to infer significance of logistic estimates ($Y_{ig}$, group membership). A cross-validation procedure segments the sample into a training and a testing subset of *p* (0.80, 0.20). The explained model variance is maximized; lower values on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) indicate a better fit.

*Prerequisites of the Analytical Models.* LDA maximizes the explained model variation by a metric discriminant value, which emerges as the eigenvalue from LDF. The centered estimate of this metric specifies the cutoff by which cases are classified. Values greater (less) zero of the categorical criterion are allocated into distinctive and homogeneous groups. Of note is that multiple LDF apply in case of a multinominal criterion. To ensure estimates of good quality, the feature variables have to adhere to the subsequent requirements. However, for models of $k \leq 5$ predictors and $n \geq 20$ per group, LDA proves to be robust (Backhaus et al., 2023, p. 258; Rudolf & Buse, 2020[181]).

- normally distributed feature variables
- uniform prevalence of balancedness
- equal covariance-matrices between the groups

- no influential cases in the predictors
- no multicollinearity among the feature variables

*Multivariate normality.* Succeeding data transformation (bestNormalize Package R; Peterson 2021; Peterson & Cavanaugh, 2020), measures were normally distributed (present and future TP, SWB, SWLS, SCSKD, PHQ15 Somatoform, PPQ, RFS, SBI, DBTP, SEM and age). Exclusion of 14 influential cases established on all predictors, including past TP as well (past: $W = 0.9904$, $p = 0.0617$; present: $W = 0.9935$, $p = 0.264$; future: $W = 0.9941$, $p = 0.347$; SWB: $W = 0.9974$, $p = 0.9316$; SWLS: $W = 0.9951$, $p = 0.5104$; DBTP: $W = 0.9907$, $p = 0.0712$; SEM: $W = 0.9911$, $p = 0.0888$; age: $W = 0.9983$, $p = 0.9951$).

A caveat remains for the health measures (PHQ4, PHQ15, ADNM), most likely due to psychometric shortcomings of these scales, for which a restricted number of response alternatives suggests an ordinal scaling. All of them fail to approximate normality.

*Uniform prevalence*. Applying median-split procedure establishes an even prevalence among both subsets of unbalanced and balanced observations. Sampling continued to assign cases into a training set ($p = 0.8$) and a testing ($p = 0.2$), for which equal odds of balancedness prevailed.

*Homogeneous covariance-matrices.* This presumption is evaluated by *Box'M*-test. A non-significant statistic [$\chi^2$ (3) = 2.098, $p = 0.552$] implies homogeneous variances for balanced and unbalanced observations.

*Influential cases*. Cook's *D* identified 14 influential cases, using either DBTP or SEM metric; exclusion established normality on all predictors. This finding proofs construct validity, since both coefficients show to be selective for balancedness across all TPs. *Note*: Elimination preserved proportions, because outliers were evenly distributed for BTP, thus $X \sim U$ (143, 143). Observations were randomly assigned to a set of training data *n* (114, 117), and a set of testing data *n* (30, 29).

*Multicollinearity.* The relative importance of predictors is inferred by the sequence in which the feature variables become relevant, i.e. a stepwise entry into the analytical model. For this purpose, linear (in-)dependency of predictors is essential to get unbiased and stable estimates. Hence, variance inflation (VIF) and tolerance (1/ VIF) are indicative. Normalizing transformation reduces collinearity, due to centering the data and applying unique scaling, suggesting that the model is more robust against redundancy and suppressing effects. As expected, DBTP and SEM are

mutually multicollinear; including TP into a model rules out both of them. SWB and SWLS may be analyzed aside from each other, also in presence of TP. Complying to these restrictions, any model may be estimated, since VIF ranges within [1.147; 2.904] (*supplementary materials*).

## *Results*

*Bivariate association among predictors*

To start with an exploratory overview of the interrelatedness among the feature variables (*figure 1*), so are measures of temporal framing broadly associated with indicators of well-being and life quality. They also share variance with further covariates of balancedness, e.g. executive functioning, positivity and savoring, with health problems covary negatively. Measuring three time perspectives (mBTPS) and the usage of compound indices of balancedness, DBTP and SEM, provide overall highest covariation. Their association is reverse signed, Both DBTP and SEM are mutually reverse signed, due to their respective semantic, which captures distance for the former and proximity for the latter. Age does negatively correlate with future TP, but shows no relevant covariation with either of the other measures. Contemporary research has verified that sex is not predictive on balancedness (Stolarski et al., 2020), so that it is not considered here.

**--- please insert figure 1 around here ---**
***Figure 1: Bivariate Associations among Feature Variables***

Rank correlations conducted to adequately report covariation and to gain consistent estimates, since the measures are of both metric and categorical scale level (*table 3*). Overall. significant coefficients are of moderate to strong effect size. Age is negatively correlated with future TP ($r$ = -.25, $p \leq .001$), but associates with neither other measure.

Except Age and the health measure (PHQ15) does temporal framing, being assessed by the three TP scales, significantly correlate with all constructs on a moderate level and has the strongest effects for DBTP (past: $r$ = -.85; present: $r$ = -.84; future: $r$ = -.85, all: $p \leq .001$) and SEM (past: $r$ = .81; present: $r$ = .88; future: $r$ = .84, all: $p \leq .001$) aside Prioritizing Positivity (past: $r$ = .50; present: $r$ = .48; future: $r$ = .40, all: $p \leq .001$), followed by Savoring Beliefs (past: $r$ = .44; present: $r$ = .40; future: $r$ = .43, all: $p \leq .001$) and both well-being measures, of which SWLS has marginally larger effects (past: $r$ = .42; present: $r$ = .46; future: $r$ = .44, all: $p \leq .001$) than Subjective Well-

being (past: $r = .36$; present: $r = .43$; future: $r = .38$, all: $p \leq .001$). Replacing the originating TP scales by either DBTP or SEM yields consistent correlations of equal size with these measures.

RFS shows to not covary with well-being (assessed by SWLS, SWB) and neither with executive functioning (SCSKD) nor savoring beliefs (SBI). Unlike TP scales, so does reminiscence positively correlate on an average moderate level (past: $r = .39$, $p \leq .001$; present: $r = .30$, $p \leq .001$; future: $r = .21$, $p \leq .05$), as well with PHQ15 ($r = .21$, $p \leq .05$) as Prioritizing Positivity ($r = .25$, $p \leq .001$).

**--- please insert table 2 around here ---**
***Table 2: Bivariate Rank Correlations***

*Analytical Models*

LDA aims to assess how selective the three TPs are towards balancedness and to compare the two compound coefficients of DBTP and SEM. Data likelihood provides insight in the explanational property of the classifiers as expressed in model fit. Evidence is collected for a set of feature variables and will be cross-validated on test data in order to assess the predictive ability of the model. Parsimony and group size adhere to formal constraints of the statistical model, while also ensuring that an even prevalence of balancedness is being hold between the subsets. Median-split applied to preset the prior, $X \sim U$ (0.494, 0.506).

Comparing three versus two TP yields a standardized eigenvalue of 0.5040 for BTPS ($F$ (2, 228) = 116.38, $p <$. 001; Wilks $\lambda = 0.4959$, $\chi^2$ (2) = 159.92, $p < .001$; AIC 130.86) and 0.5751 for mBTPS ($F$ (3, 227) = 102.85, $p < .001$; Wilks $\lambda = 0.4249$, $\chi^2$ (3) = 194.72, $p < .001$; AIC 73.35). Accordingly, the explained model variance incrementally increases by 0.08, respectively mBTPS over BTPS. Therefore, data likelihood is higher in a model of three TP compared to two TP.

Replacing the originating TP scales in mBTPS by a compound indicator of balancedness gives a close surplus of additional 0.02 explained model variance. The usage of DBTP has an eigenvalue of .5952 ($F$ (1, 229) = 338.10, $p < .001$; Wilks $\lambda = 0.4048$, $\chi^2$ (1) = 206.65, $p < .001$; AIC 97.56), and SEM converges at 0.5845 ($F$ (1, 229) = 323.60, $p < .001$; Wilks $\lambda = 0.4155$, $\chi^2$ (1) = 200.69, $p < .0001$; AIC 107.90).

Model fit raises even more, when prevalence initially is clustered by HCA: up to 0.6397 for DBTP coefficient ($F$ (1, 134) = 239.64, $p < .0001$; Wilks $\lambda = 0.3603$, $\chi^2$ (1) = 134.24, $p < .0001$; AIC 42.45), and 0.6131 for SEM coefficient ($F$ (1, 134) = 252.90, $p < .001$; Wilks $\lambda = 0.3869$,

$\chi^2$ (1) = 124.87, $p$ < .0001; AIC 36.35). The downside of this approach is, that it yields a distinctly skewed prior of $n$ = 189 balanced observations. Aiming for even prevalence, will result small subsets as well. In addition, this type of model would bear the risk of being overfitted.

Therefore, prevalence is still allocated by median-split. However, relying on one feature variable for modeling is probably too sparse, proposing that the LDF will profit from additional predictors in order to enhance its selective quality.

*Comprehensive Evaluation of Intermediary Results*

Up to this point, the goal of feature engineering has been to select predictors that are likely eligible for quantifying the degree to which DBTP or SEM usage outperforms time perspective scales, BTPS and mBTPS, and to evaluate additional covariates of balancedness. Suggested by preliminary findings, estimates of both indicators, DBTP and SEM, yield similar data likelihood (*supplementary materials*). All appropriate measures will be entered into a comprehensive final model that evaluates selectivity and predictive accuracy. Hence, the analyses are conducted first with a DBTP metric and will then be compared to a structurally equivalent model that issues SEM.

Training the models to fit the data provides evidence of how good the measures can describe the observations in terms of balancedness. An eligible classifier will be able to distinctly separate cases and allocate group membership. In order to be entered into the final analytical model, a measure has to be as well selective as predictive. In LDA, multivariate analyses of variance (MANOVA) and Wilks Lambda infer model fit: univariate analyses of variance (ANOVA) evaluates the significance of discriminant coefficients and a logistic regression estimates the predictive property of a predictor. Failing on either of these criteria excludes a feature variable from subsequent analyses. Accordingly, so is age not sensitive to consistently capture states of balancedness across all time perspectives [$F$ (1, 229) = 0.029, *ns; b* = -0.023, *ns*], neither do PHQ15 [$F$ (1, 229) = 3.020, *ns; b = -0.240, ns*], SWB [$F$ (1,229) = 19.66, $p$ < .0001; $b$ = .01453, *ns*] and SCSKD [$F$ (1, 229) = 3.075, *ns; b* = -0.057, $p$ = .045] perform adequately well (*supplementary materials*). The remaining set of measures specifies the target model. Since mBTPS has already been proofed to outperform BTPS in terms of model fit, the coefficients of DBTP and SEM are being operationalized across all 3 TP. Hence, two models are exceedingly being compared:

Balancedness ~ SWLS + PPQ + SBI + RFS + DBTP and

Balancedness ~ SWLS + PPQ + SBI + RFS + SEM

Overall, both models are capable to classify cases and separate unbalanced from balanced observations. Multivariate modeltest reports a standardized eigenvalue of 0.6015 in case of DBTP ($F$ (5, 225) = 68.22, $p < .0001$; Wilks λ = 0.3985, $\chi^2$ (5) = 208.39, $p < .0001$; AIC 102.07), SEM yields a share of 0.6234 explained variance ($F$ (5, 225) = 74.82, p < .001; Wilks λ = 0.3766, $\chi^2$ (5) = 21.19 $p < .001$; AIC 87.42).

**--- please insert table 3 around here ---**
***Table 3: Multivariate Statistics of the LDF Equations***

Though initial analyses suggest an overall fit of PPQ, SBI and RFS, does the analytical model not fully support this view. While these feature variables perform well in selectivity to classify observations for balancedness, they account for only small shares in overall model variance. Correspondingly, discriminant coefficients (*table 5*) express relevance in the resulting discriminant value of the LDF (centered at zero). Higher values account for precedence. Ordering predictors by precedence metric indicators hold distinct relevance in both models, followed by well-being. In general, measures may account to share in overall modelfit (significant $F$-statistic), but are not as good in prediction (non-significant logistic estimate). Results indicate, that DBTP (-1.628; $F$ (1, 229) = 338.14, $p < .001$; $b$ = -6.097, $p < .001$) and SEM (1.910; $F$ (1, 229) = 323.56, $p < .001$; $b$ = 9.103, $p < .001$) are throughout as well relevant classifiers as significant predictors of balancedness, the same applies to SWLS. More specifically, SWLS is both selective and predictive aside from SEM (-0.5107; $F$ (1, 229) = 34.87, $p < .001$; $b$ = -2.665, $p < .001$), but only is selective apart from DBTP (-0.1684; $F$ (1, 229) = 35.65, $p < .001$; $b$ = -0.274, *ns*).

Univariate ANOVA contrasts indicate, that average ratings on SWB [unbalanced: -0.2981 (63.56); balanced: 0.2610 (75.92)] differ between levels of balancedness ($F$ (1, 229) = 19.86, $p < .001$). This effect is not moderated by age ($b$ = 0.085, *ns*), but interacts with temporal framing ($b$ = 0.624, $p < .001$).

**--- please insert table 4 around here ---**
***Table 4: Inferential Statistics of the Discriminant Coefficients***

Both models are evaluated for their ability to correctly classify and predict balancedness. Cross-validating the trained estimates by a testing subset provides evidence of model accuracy.

Selectivity can further be decomposed into sensitivity and specificity. A trade-off between false discoveries (Type I error) and false omissions (Type II error) will comparatively evaluate the performance of DBTP and SEM for their respective positive and negative predictive value. Predictive accuracy is strongly dependent on prevalence (Cohen et al., 2016; Murad et al., 2023).

5-fold cross-validating conducted on a test sample, for which forecasts of balancedness were parametered by the estimates from the training data. Both indicators perform very well: DBTP estimates have .918 correct predictions ($\chi^2$ (1) = 158, $p < .0001$) and a precision of .922 for SEM ($\chi^2$ (1) = 161.63, $p < .0001$).

**--- please insert table 5 around here ---**
***Table 5: Cross-validated Accuracy of Predictions***

Youden-Index specifies cutoff values, for which the Area Under the Curve (AUC) becomes maximized [∫sensitivity x (1 - specificity) → max!]. DBTP converges at .8363, SEM at .8548. For a binary criterion, the distance between Youden-estimate and 1 quantifies the value range in which a categorical criterion misclassifies. Overall, both models show a very good up to excellent performance within the upper percentile of precise estimations. Specifically, SEM shows slightly better performance in predicting the presence of balancedness, whereas DBTP is marginally more accurate in assigning its absence (*supplementary materials*).

***Discussion***

Findings are by and large supportive of that balancedness in temporal framing is adaptive and shows to be influential in well-being and associated covariates, such as positivity and indicators of selective goal attention. Reminiscence is relevant across all three temporal directions, but does not correlate with either well-being measure, rather associates with both the health measure and prioritizing positivity. Therefore, the impact of reminiscence on life quality and health is seemingly indirect, relating to selective goal attention. Replacing TP scales by compound indices of time perspective gains overall fit in explained model variance, but on scale level, covariation remains of equal size with regard to either DBTP or SEM and the remaining measures.

The study compares feature variables for their capacity to precisely capture time perspectives and balancedness in temporal framing. In the beginning, choice of feature variables is

conceptually founded considering covariates of balancedness (Stolarski et al., 2020), whereas subsequent quality selection is data driven, modeled by LDA. The respective analytical models address open questions in research: (a) construct dimensionality on balancedness in temporal framing and whether two or three time perspectives are required to assess psychological processes related to well-being and life quality; (b) adequacy of metrics, being broadly discussed for categorical indices (median-split), ordinal measures (Wiberg coefficient) and metric indicators (DBTP) of balancedness (Webster, 2011; Wiberg et al., 2012; Zhang et al., 2013; Zimbardo et al., 2019); SEM coefficient has previously been introduced in our research project and is now compared for incremental performance as opposed to DBTP.

Presuming that indicators on a metric scale level in general outperform categorical or ordinal measures, arguing that measuring has to be proved under the restriction of prevalence in order to gain precise estimates (Döring, 2022; Kuhn & Johnson, 2020). Sensitivity and specificity, or a compound measure of both (AUC) to quantify model accuracy in terms of correctly predict balancedness (Goldhammer & Hartig, 2020, pp. 179 – 183). 5-fold cross-validation applies to infer accuracy of model prediction.

Comparing three versus two time perspectives, mBTPS exceeds BTPS with a surplus of 0.08 explained variance (Vowinckel et al., 2017). Substituting TP scales by either DBTP or SEM slightly increments model fit. However, the initial assumption that balancedness establishes by executive functioning is not supported by the findings, as SCSKD rules out during feature engineering process and thus is not considered in the analytical model. While cognitive ability is adaptive in general, reserve capacity has to controlled for in order to assess the impact of self-regulatory on balancedness (Chuderski et al., 2012; Stolarski et al., 2020). Age does negatively covary with future TP, but neither varies across the 6 age groups [18; 71+] nor systematically impacts the remaining measures.

In accordance with state of the art knowledge is balancedness in temporal framing associated with well-being and life quality (Burzynska & Stolarski, 2020; Przepiorka et al., 2020). In both analytical models, well-being yields high predictive precedence in share of overall modelfit. However, whereas SWLS is selective and predictive towards balancedness aside from SEM, it only is selective apart from DBTP. The mean experience of subjective well-being differs with regard to balancedness. In balanced observations, SWB ranges in the upper value quartile and is below otherwise. The corresponding threshold is being proposed as a cutoff with clinical implications (Cummins et al., 2019).

Although all feature variables significantly contribute to modelfit, balancedness is in particular adequately captured by well-being aside from either DBTP or SEM. The examination of logistic estimates suggests the redundancy of PPQ, SBI and RFS in addition, so that these measures can be omitted in a parsimonious model. Notwithstanding that the experience of well-being is fundamental in positive psychology, the construct clearly is more but happiness (Webster & Vowinckel, 2021) as results underscore that positivity and balancedness are mutually distinct concepts. Therefore, a parsimonious model is sufficiently specified by a well-being in conjunction with either DBTP or SEM. A balanced TP can captured by a metric index at best, which is in accordance with current evidence (Zhang et al., 2013).

The results indicate, that the SEM coefficient is slightly more accurate to discover the presence of balancedness, as opposed to DBTP, which captures its absence marginally better. The two coefficients differ with regard to their semantic, because the former is founded in proximity, while the latter indicates distance.

***Limitations***

The results may be specific to a scientific sample, including panelists at most. However, age span and socioeconomic status of the participants are broadly spread, and quality items assured that the responses had been given thoroughly. Conclusion about causality is not possible to draw, since a cross-sectional design does not allow the differentiation of predictor and criterion for cause and effect. While this methodological consideration is true in general, external cross-validation does indicate excellent model accuracy. The magnitude of selectivity, specificity, but also the predictive values is excellent. Covariation suggests that balancedness relates to processes of selective goal attention. Anyhow, the recursive nature of biographical memory across experiences in the life span leaves open, whether balancedness or well-being emerge bottom-up or top-down (Cunningham et al., 2015). More specifically, either living conditions improve well-being or traits foster adaptive habits, both directions accumulate resources and contribute to psychological relevance (Boniwell et al., 2010; Roglic, 2016, Stolarski et al., 2014). This suggests, that the effect on well-being is indirect and should be studied using mediation analyses. In case of reciprocal interdependence, cross-lagged models and experimental designs provide insight in causality and moderation (Burzynska & Stolarski, 2020). Finally, the psychometric properties remain an open issue, whether balancedness is a state or a trait (Stolarski et al., 2018, 2020).

***Conclusion***

Evidence suggests the psychological relevance of three time perspectives, past, present and future TP, and a parsimonious model preferably uses a compound measure, DBTP or SEM, to evaluate balancedness. Hence, mBTPS outperforms BTPS. In terms of explained model variance, the latter two indices incrementally improve parameter estimation, as opposed to the usage of TP scales. As both indices are mutually multicollinear, a model may only contain one of them. However, complementary indication is advised, since DBTP has a slightly more predictive value for the absence of balancedness, whereas the SEM captures its presence marginally better. Both concepts, well-being and life quality, provide high quality estimates of balancedness. In the analytical models, this is DBTP or SEM aside from SWLS.

Additional findings support that the upper quartile in average ratings on subjective well-being has clinical relevance. Age does not moderate this effect, it rather depends on the time perspective used in temporal framing.

Prior information ought to be taken into consideration first, rather than focusing on scale levels in measures and indicators. To externally cross-validate a model is strongly recommended in order to evaluate model accuracy. In this study, the percentage of true assignments ranges in the upper percentile of precise estimates for both classification and prediction.

***Statements and Declarations***

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

***Data Availability Statement***

The study and its design had been preregistered. The datasets presented in this study can be accessed in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://osf.io/9p2yc/?view_only=b30358166b6a4e33beace6a47109c90e

***Ethics Statement***

The studies involving humans were approved by ethics committee at the University of Siegen (code: LS_ER_49/2021). The studies were conducted in accordance with the local

legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

### *Author Contributions*

Writing, conceptualization, formal analyses, methodology, project administration, validation, visualization, principal author [Lenz, Hans-Joachim]; writing, conceptualization, methodology, validation, visualization [Flöter, Lukas]; writing, conceptualization, methodology, validation, visualization [Hulsmans, Nik]; conceptualization, supervision [Forstmeier, Simon].

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### *Conflict of Interest*

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Tables

### Table 1

*Table 1: Prior Probability of Balancedness under different Operationalizations*

| Coefficients | n | balanced | mean | sd | median | trimmed | min | max | range | skew | kurtosis | se |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HCA 2* | 302 | low | 1.37 | 0.48 | 1.00 | 1.34 | 1.00 | 2.00 | 1.00 | 0.52 | -1.74 | 0.03 |
| HCA 4* | 302 | low | 2.19 | 0.83 | 2.00 | 2.19 | 1.00 | 4.00 | 3.00 | 0.08 | -0.81 | 0.05 |
| Median-split | 302 | high | 2.92 | 1.40 | 4.00 | 3.61 | 0.00 | 7.00 | 7.00 | -0.03 | -1.66 | 0.17 |
| Median-split* | 302 | high | 1.54 | 1.22 | 2.00 | 1.55 | 0.00 | 3.00 | 4.00 | -0.03 | -1.59 | 0.07 |
| Wiberg | 302 | high | 0.66 | 0.99 | 0.00 | 0.46 | 0.00 | 3.00 | 3.00 | 1.30 | 0.36 | 0.06 |
| DBTP | 302 | low | 3.87 | 1.40 | 3.67 | 3.82 | 0.19 | 8.66 | 8.47 | 0.50 | 1.03 | 0.08 |
| SEM | 302 | high | 0.00 | 0.70 | 0.10 | 0.03 | -2.46 | 1.77 | 4.22 | -0.59 | 1.25 | 0.04 |

*Note:* * Ordered factor. HCA: Hierarchical Cluster Analysis, 2 resp. 4 clusters. Semantic of coefficients: HCA, DBTP: [low: balanced, high: unbalanced]; Median-split, Wiberg, SEM: [low: unbalanced, high: balanced]. Mediansplit: $2^{3\ TP} = 8$ grades of balancedness. Wiberg: compound index, combines ordinal and categorical measures ~ count of TP == 1 | $\delta$ (balanced profile, observed data) $\in$ tolerance $\rightarrow$ 1, either 0; with an adapted definition of tolerance ~ [4.5; 6]

**Table 2**

*Table 2: Bivariate Rank Correlations*

| | Past | Present | Future | SWB | SWLS | PHQ15 | SCSKD | PPQ | SBI | RFS | DBTP | SEM | AGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Past | 1 | . | . | . | . | . | . | . | . | . | . | . | |
| Present | .65 *** | 1 | . | . | . | . | . | . | . | . | . | . | |
| Future | .57 *** | .65 *** | 1 | . | . | . | . | . | . | . | . | . | |
| SWB | .36 *** | .43 *** | .38 *** | 1 | . | . | . | . | . | . | . | . | |
| SWLS | .42 *** | .46 *** | .44 *** | .75 *** | 1 | . | . | . | . | . | . | . | |
| PHQ15 | -.11 | -.19 * | -.19 * | -.42 *** | -.38 *** | 1 | . | . | . | . | . | . | |
| SCSKD | .18 * | .29 *** | .23 *** | .33 *** | .32 *** | -.39 *** | 1 | | | | | | |
| PPQ | .50 *** | .48 *** | .40 *** | .35 *** | .41 *** | -.14 | .23 ** | 1 | . | . | . | . | |
| SBI | .44 *** | .40 *** | .43 *** | .46 *** | .44 *** | -.25 *** | .27 *** | .47 *** | 1 | . | . | . | |
| RFS | .39 *** | .30 *** | .21 ** | .02 | .05 | .21 ** | -.06 | .25 *** | .09 | 1 | . | . | |
| DBTP | -.85 *** | -.84 *** | -.85 *** | -.44 *** | -.50 *** | .20 ** | -.27 *** | -.53 *** | -.46 *** | -.32 *** | 1 | . | |
| SEM | .81 *** | .88 *** | .84 *** | .53 *** | .62 *** | -.24 *** | .32 *** | .55 *** | .51 *** | .30 *** | -.98 *** | 1 | |
| AGE | .03 | .06 | -.25 *** | .14 | .09 | -.12 | .11 | .09 | .10 | .02 | .07 | -.04 | 1 |

* $p < .05$, ** $p < .01$, *** $p <. 001$ (effect sizes: Gignac & Szodorai, 2016)

**Table 3**

*Table 3: Multivariate Statistics of the LDF Equation*

| | *r* | *Wilks λ, $\chi^2$(df)* | *F-Statistic* | *AIC* | *r* | *Wilks λ, $\chi^2$ (df)* | *F-Statistic* | *AIC* |
|---|---|---|---|---|---|---|---|---|
| ***Mediansplit*** | **DBTP** | | | | **SEM** | | | |
| *Analytical Model DBTP* | 0.6015 | λ = 0.3985<br>$\chi^2$ (5) = 208.39<br>$p < .0001$ | $F(5, 225) = 68.22$<br>$p < .0001$ | 102.07 | NA | NA | NA | NA |
| *Analytical Model SEM* | NA | NA | NA | NA | 0.6234 | λ = 0.3766<br>$\chi^2$ (5) = 221.19<br>$p < .0001$ | $F(5, 225) = 74.82$<br>$p < .0001$ | 87.24 |

*Note:* Prevalence by mediansplit, for some models compared to binary clustering (HCA2). Gamma: Standardized eigenvalue of the LDF, expresses explained variance.

**Table 4**

*Table 4: Inferential Statistics of the Discriminant Coefficients*

| | Centroids balanced [0; 1] | LDF coefficients | *F*-statistic *F*(1, 229) | Log. coefficients *beta*, *p* |
|---|---|---|---|---|
| **DBTP** | | | | |
| SWLS | -0.3879; 0.3617 | -1.6843 | 35.65, $p < .0001$ | -0.2741, $p = .523$ |
| PPQ | -0.5125; 0.4412 | 0.01907 | 65.69, $p < .0001$ | 0.0281, $p = .946$ |
| SBI | -0.4358; 0.3411 | -0.04801 | 38.85, $p < .0001$ | 0.0392, $p = .921$ |
| RFS | -0.2866; 0.3067 | -0.07572 | 21.58, $p < .0001$ | 0.5317, $p = .108$ |
| DBTP | 0.8114; -0.8119 | 1.62785 | 338.14, $p < .0001$ | -6.0971, $p < .0001$ |
| **SEM** | | | | |
| SWLS | -0.3820; 0.3618 | -0.5107 | 34.87, $p <. 0001$ | -2.6648, $p = .0001$ |
| PPQ | -0.5137; 0.4412 | 0.01129 | 65.89, $p <. 0001$ | 0.0392, $p = .927$ |
| SBI | -0.4416; 0.3411 | -0.1036 | 39.30, $p <. 0001$ | -0.0856, $p = .839$ |
| RFS | -0.2952; 0.3067 | -0.1024 | 22.45, $p <. 0001$ | 0.4969, $p = .166$ |
| SEM | -0.8061; 0.8051 | 1.91035 | 323.56, $p < .0001$ | 9.1032, $p < .0001$ |

**Table 5**

*Table 5: Cross-validated Accuracy of Predictions*

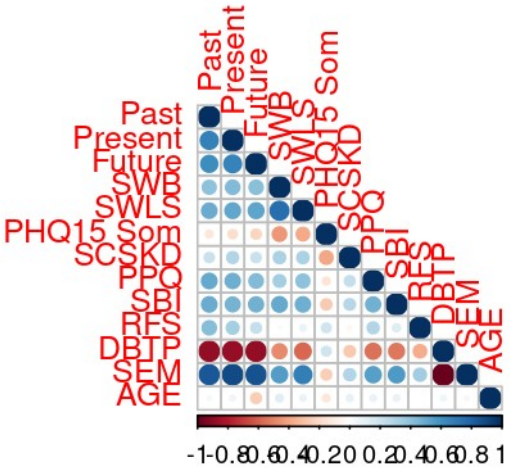
| | **DBTP** | | **SEM** | | | *npv* | *ppv* |
|---|---|---|---|---|---|---|---|
| **predicted observed** | **0** | **1** | **0** | **1** | *margin* | | |
| **0** | 103 | 11 | 102 | 12 | 114 (49.40) | DBTP; SEM .904; .895 | |
| **1** | 8 | 109 | 6 | 111 | 117 (50.60) | | DBTP; SEM .932; .949 |
| *margin* | 110 (47.60) | 121 (52.40) | 108 (46.80) | 123 (53.20) | 231 (100.0) | | |
| *sensitivity* | .936 | | .944 | | | | |
| *specificity* | | .901 | | .902 | | | |

*Note:* balanced [0; 1]; positive predictive value (ppv), negative predictive value (npv)

## Figures

### Figure 1

*Figure 1: Bivariate Associations Among Feature Variables*




### Figure 2

*Figure 2: AUC: Balancedness ~ SWLS+PPQ+SBI+RFS+DBTP*

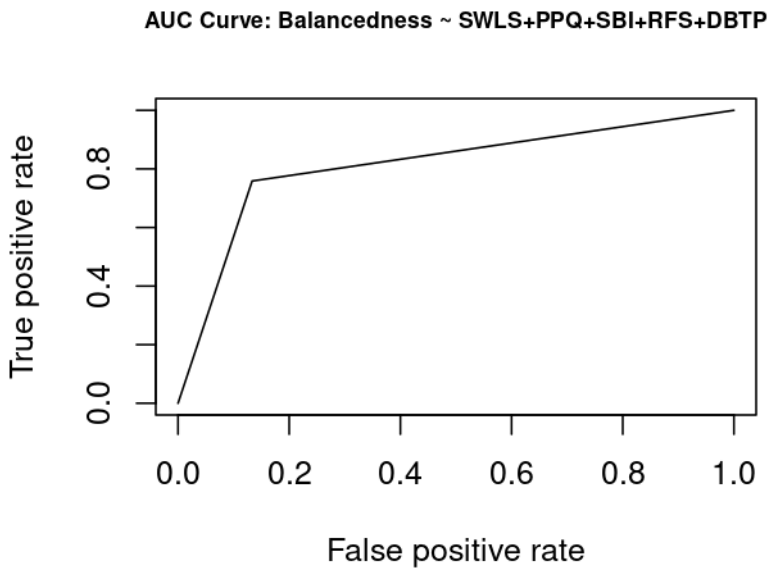
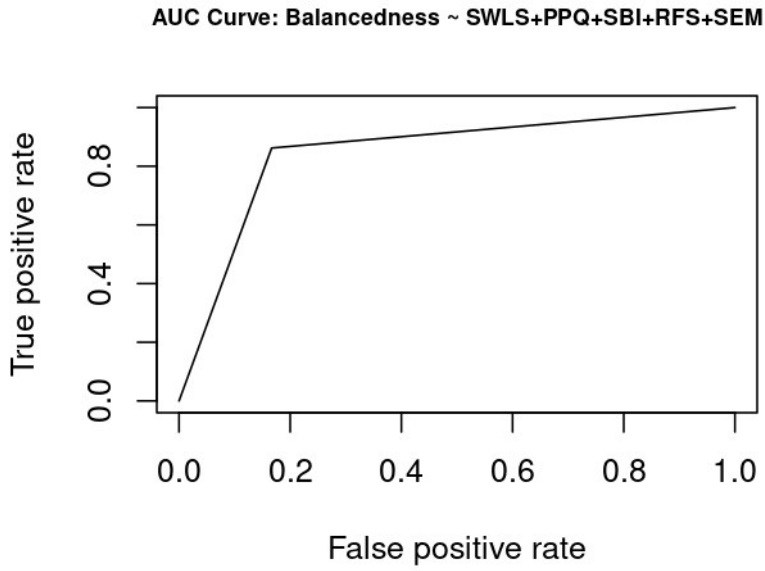


**Figure 3**

*Figure 3: AUC: Balancedness ~ SWLS+PPQ+SBI+RFS+SEM*



## Supplementary Materials

*Table S1: Equal Distribution of Age and Sex*

| | Sex | | | | | |
|---|---|---|---|---|---|---|
| | male | | female | | divers | |
| Age Group | *n* | % | *n* | % | *n* | % |
| 18-30 | 13 | 26.0 | 36 | 72.0 | 1 | 2.0 |
| 31-40 | 21 | 42.0 | 29 | 58.0 | 0 | 0.0 |
| 41-50 | 25 | 50.0 | 25 | 50.0 | 0 | 0.0 |
| 51-60 | 31 | 62.0 | 19 | 38.0 | 0 | 0.0 |
| 61-70 | 32 | 64.0 | 18 | 36.0 | 0 | 0.0 |
| 71+ | 28 | 53.8 | 24 | 46.2 | 0 | 0.0 |
| Σ | 150 | 49.7 | 151 | 50.0 | 1 | 0.3 |

*Note:* Age × Sex [ $\chi^2(5) = 19.18$, $p = .002$ ]

*Table S2: Distributional Parameters of Normalized Feature Variables*

| Feature variables | n | *X*~*N*( ) | mean | sd | median | trimmed | min | max | range | skew | kurtosis | se |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Past | 302 | yes | 0.00 | 1.00 | 0.08 | 0.04 | -2.95 | 2.42 | 5.37 | -0.46 | 0.51 | 0.06 |
| Present | 302 | yes | 0.00 | 1.00 | 0.09 | -0.01 | -2.71 | 2.96 | 5.68 | -0.02 | 0.36 | 0.06 |
| Future | 302 | yes | 0.00 | 1.00 | 0.02 | 0.00 | -2.72 | 2.94 | 5.65 | -0.01 | -0.12 | 0.06 |
| SWB | 302 | yes | 0.00 | 0.99 | 0.05 | 0.00 | -2.93 | 2.57 | 5.50 | -0.02 | -0.12 | 0.06 |
| SWLS | 302 | yes | 0.00 | 1.00 | -0.03 | 0.00 | -2.58 | 2.58 | 5.16 | -0.01 | -0.17 | 0.06 |
| PHQ15 Somatoform | 302 | yes | 0.01 | 0.96 | -0.03 | -0.01 | -1.57 | 2.94 | 4.51 | 0.19 | -0.41 | 0.06 |
| SCSKD, onedimensional | 302 | yes | 0.00 | 1.00 | 0.02 | 0.00 | -2.94 | 2.94 | 5.87 | 0.00 | -0.09 | 0.06 |
| PPQ, onedimensional | 302 | yes | 0.00 | 1.00 | 0.04 | 0.00 | -2.94 | 2.72 | 5.65 | -0.01 | -0.11 | 0.06 |
| RFS, general factor | 302 | yes | 0.00 | 1.00 | -0.02 | 0.00 | -2.58 | 2.94 | 5.52 | 0.01 | -0.13 | 0.06 |
| SBI, general factor | 302 | yes | 0.00 | 1.00 | -0.01 | 0.00 | -2.94 | 2.94 | 5.87 | 0.00 | -0.09 | 0.06 |
| DBTP | 302 | no | 0.00 | 1.00 | 0.00 | 0.00 | -2.94 | 2.94 | 5.87 | 0.00 | -0.09 | 0.06 |
| SEM | 302 | yes | 0.00 | 1.00 | 0.00 | 0.00 | -2.94 | 2.94 | 5.87 | 0.00 | -0.09 | 0.06 |
| AGE | 302 | yes | 0.00 | 1.00 | 0.00 | 0.00 | -2.94 | 2.94 | 5.87 | -0.01 | -0.13 | 0.06 |

*Note*: *X*~*N*( ). See supplementary materials for data before normalizing transformation

*Table S3: Distributional Parameters, Raw Data*

| Feature variables | n | *X~N*( ) | mean | sd | median | trimmed | min | max | range | skew | kurtosis | se |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Past (1) | 302 | yes | 3.71 | 0.92 | 3.79 | 3.75 | 1.00 | 5.93 | 4.93 | -0.46 | 0.51 | 0.05 |
| Present | 302 | yes | 3.87 | 0.84 | 4.00 | 3.91 | 1.00 | 6.00 | 5.00 | -0.53 | 0.95 | 0.05 |
| Future | 302 | yes | 3.85 | 1.01 | 4.00 | 3.91 | 1.00 | 6.00 | 5.00 | -0.64 | 0.48 | 0.06 |
| SWB01 (2) | 302 | yes | 69.78 | 19.76 | 75.00 | 72.03 | 0.00 | 100.00 | 100.00 | -1.05 | 0.97 | 1.14 |
| SWB01 (3) | 294 | yes | 69.83 | 19.93 | 75.00 | 72.11 | 0.00 | 100.00 | 100.00 | -1.05 | 0.95 | 1.16 |
| SWLS | 302 | yes | 4.42 | 1.22 | 4.40 | 4.48 | 1.00 | 7.00 | 6.00 | -0.40 | -0.05 | 0.07 |
| PHQ4 | 302 | no | 0.78 | 0.69 | 0.75 | 0.69 | 0.00 | 3.00 | 3.00 | 1.00 | 0.86 | 0.04 |
| PHQ4 Anxiety | 302 | no | 0.76 | 0.74 | 0.50 | 0.65 | 0.00 | 3.00 | 3.00 | 0.99 | 0.65 | 0.04 |
| PHQ4 Depression | 302 | no | 0.81 | 0.74 | 1.00 | 0.71 | 0.00 | 3.00 | 3.00 | 0.92 | 0.61 | 0.04 |
| PHQ15 | 302 | no | 0.50 | 0.36 | 0.40 | 0.47 | 0.00 | 1.67 | 1.67 | 0.69 | -0.31 | 0.02 |
| PHQ15 Somatic | 302 | yes | 0.40 | 0.32 | 0.31 | 0.37 | 0.00 | 1.50 | 1.50 | 0.85 | 0.07 | 0.02 |
| PHQ15 Depression | 302 | no | 1.13 | 0.83 | 1.00 | 1.07 | 0.00 | 3.00 | 3.00 | 0.61 | -0.37 | 0.05 |
| ADNM | 162 | no | 3.04 | 0.71 | 3.12 | 3.06 | 1.50 | 5.12 | 3.62 | -0.10 | -0.47 | 0.06 |
| ADNM Preoccupation | 62 | no | 3.34 | 0.59 | 3.50 | 3.39 | 1.75 | 4.25 | 2.50 | -0.71 | -0.32 | 0.05 |
| ADNM Maladaptation | 162 | yes | 2.75 | 1.01 | 2.75 | 2.72 | 1.00 | 6.50 | 5.50 | 0.55 | 0.83 | 0.08 |
| SCSKD | 302 | yes | 4.57 | 0.87 | 4.54 | 4.55 | 0.90 | 2.46 | 6.92 | 4.46 | 0.20 | -0.30 |
| GQ5 | 301 | no | 4.92 | 1.08 | 5.00 | 4.96 | 1.19 | 1.00 | 7.00 | 6.00 | -0.34 | 0.09 |
| PPQ | 302 | yes | 6.05 | 1.38 | 6.17 | 6.12 | 1.46 | 1.00 | 9.00 | 8.00 | -0.54 | 0.46 |
| RFS | 302 | yes | 3.44 | 0.89 | 3.45 | 3.46 | 0.82 | 1.00 | 6.00 | 5.00 | -0.18 | 0.16 |
| RFS Identity | 302 | no | 3.86 | 0.99 | 4.00 | 3.92 | 0.99 | 1.00 | 6.00 | 5.00 | -0.59 | 0.36 |
| RFS Problem Solving | 302 | no | 4.02 | 0.97 | 4.25 | 4.09 | 0.74 | 1.00 | 6.00 | 5.00 | -0.70 | 0.63 |
| RFS Death Preparation | 302 | no | 2.55 | 1.22 | 2.29 | 2.46 | 1.42 | 1.00 | 6.00 | 5.00 | 0.51 | -0.66 |
| SBI | 302 | yes | 4.78 | 0.84 | 4.71 | 4.76 | 0.93 | 2.04 | 6.83 | 4.79 | 0.08 | -0.24 |
| SBI Anticipating | 302 | yes | 4.76 | 0.91 | 4.75 | 4.73 | 1.11 | 2.12 | 6.88 | 4.76 | 0.18 | -0.29 |
| SBI Savoring | 302 | no | 4.70 | 0.99 | 4.62 | 4.69 | 0.93 | 1.88 | 6.88 | 5.00 | 0.10 | -0.32 |
| SBI Reminiscing | 302 | yes | 4.89 | 0.90 | 4.88 | 4.88 | 1.10 | 2.12 | 7.00 | 4.88 | -0.06 | -0.23 |
| DBTP | 302 | no | 3.87 | 1.40 | 3.67 | 3.82 | 0.19 | 8.66 | 8.47 | 0.50 | 1.03 | 0.08 |
| SEM | 302 | yes | 0.00 | 0.70 | 0.10 | 0.03 | -2.46 | 1.77 | 4.22 | -0.59 | 1.25 | 0.04 |
| AGE | 302 | yes | 50.54 | 17.49 | 51.00 | 50.73 | 18.00 | 81.00 | 63.00 | -0.06 | -1.20 | 1.01 |

*Note: X~N*( ) succeeding normalizing data transformation; (1) past TP: excluding n = 14 outliers; (2) MCAR: $\chi^2$ (1) = 0.122, $p$ = .727; (3) 8 cases NA

*Table S4: Multicollinearity of Feature Variables*

| | excluding DBTP, SEM | | all predictors | | DBTP only | | SEM only | |
|---|---|---|---|---|---|---|---|---|
| Measure/ Scale(s) | vif | tol. | vif | tol. | vif | tol. | vif | tol. |
| Past | 2.480 | 0.403 | 11.331 | 0.088 | 10.890 | 0.092 | 8.497 | 0.118 |
| Present | 2.550 | 0.393 | 13.411 | 0.075 | 6.898 | 0.145 | 13.371 | 0.075 |
| Future | 2.710 | 0.369 | 11.381 | 0.088 | 9.975 | 0.100 | 10.003 | 0.091 |
| SWB | 2.672 | 0.374 | 2.721 | 0.368 | 2.677 | 0.374 | 2.712 | 0.369 |
| SWLS | 2.904 | 0.344 | 5.517 | 0.182 | 2.911 | 0.344 | 4.170 | 0.240 |
| PHQ15 general factor | 1.390 | 0.720 | 1.393 | 0.728 | 1.392 | 0.718 | 1.393 | 0.718 |
| SCSKD | 1.147 | 0.872 | 1.147 | 0.872 | 1.147 | 0.072 | 1.147 | 0.072 |
| PPQ | 1.650 | 0.606 | 1.722 | 0.581 | 1.722 | 0.581 | 1.688 | 0.593 |
| RFS, general factor | 1.490 | 0.673 | 1.525 | 0.656 | 1.523 | 0.656 | 1.497 | 0.668 |
| SBI, general factor | 1.720 | 0.583 | 1.877 | 0.533 | 1.832 | 0.550 | 1.722 | 0.581 |
| DBTP | NA | NA | 83.454 | 0.012 | 44.965 | 0.022 | NA | NA |
| SEM | NA | NA | 128.651 | 0.008 | NA | NA | 69.318 | 0.014 |
| AGE | 1.285 | 0.778 | 1.310 | 0.764 | 1.294 | 0.773 | 1.310 | 0.764 |

*Table S5: Scale Analyses*

| | Cronbachs Alpha | McDonalds Omega | | multiple $R^2$: factor scores | |
|---|---|---|---|---|---|
| Measure/ Scale(s) | | general | subscales | general | subscales |
| Past | .95 | .95 | | .95 | |
| Present | .91 | .92 | | .92 | |
| Future | .96 | .98 | | .96 | |
| mBTPS/ BTPS: past; present; future | .97 | .77 | .57; .58; .65 | .78 | .69; .67; .55 |
| SWLS | .91 | .91 | | .92 | |
| PHQ4: gen., Anxiety, Depression | .88; .80; .84 | .84 | .70; .75 | .84 | .19; .20 |
| PHQ15: gen., Somatoform, Depression | .83; .80; .75 | .45 | .38; .28 | .48 | .54; .39 |
| ADNM: gen., Preoccupation, Maladaptation | .80; .72; .78 | .62 | .47; .49 | .64 | .42; .44 |
| SCSKD | .82 | .82 | | .84 | |
| GQ5 | .82 | .85 | | .85 | |
| PPQ | .82 | .82 | | .84 | |
| RFS: gen.; Identity, Prbl. Solving, Death Prep. | .89 | .69 | .69; .23; .73 | .82 | .53; .84; .16 |
| SBI: gen., 1st factor, 2nd factor, 3rd factor | .93 | .62 | .33; .65; .36 | .70 | .77; .31; .71 |

*Note*: To assess scales consistency, Cronbachs α and Mc Donalds ω were performed. While the former index points towards an overall good up to excellent reliability, so does the latter picture more details. To begin with, exploratory factor analyses contradict a simple structure for some of the measures, i.e. RFS and SBI for which subscales have crossloadings. Hence, to infer meaningful factors was either impossible or additional inconsistencies occurred, for instance a one-item factor, where the originating scale is constructed by four items loading on it (RFS, subscale Problem Solving). Consequently, a general factor model of these scales has bad fit (RFS: SRMR .17, RMSEA .199 90% CI [.185;.214], BIC 317.83; SBI: SRMR .17, RMSEA .138 90% CI [.132;.144], BIC 258.61). PHQ15: only the Somatoform subscale has sufficient reliability, but not a general factor model.

*Table S6: Inferential Statistics of the Discriminant Coefficients, DBTP modeled*

| | Centroids balanced [0; 1] | LDF coefficients | *F*-statistic *F*(1, 229) | Log. coefficients beta, *p* |
|---|---|---|---|---|
| **DBTP** | | | | |
| **Past (1)** | -0.6692; 0.6751 | 0.8656 | 182.17, $p < .001$ | 3.4647, $p < .0001$ |
| **Future (1)** | -0.6756; 0.6543 | 0.6381 | 152.53, $p < .001$ | 2.1615, $p < .0001$ |
| **Past (2)** | -06692; 0.6751 | 0.4983 | 182.17, p< .001 | 3.9983, $p < .0001$ |
| **Present (2)** | -0.7544; 0.7541 | 0.8447 | 253.20, $p < .001$ | 5.2173, $p < .0001$ |
| **Future (2)** | -0.6756;0.6543 | 0.2840 | 152.53, $p < .001$ | 2.7463, < .0001 |
| **SWB (3)** | -0.2981; 0.2610 | 0.0167 | 19.66, $p < .001$ | 0.0145, $p = .9469$ |
| **SWLS (3)** | -0.3879; 0.3617 | 1.0357 | 35.65, $p < .001$ | 0.81141, $p < .0001$ |
| **PHQ15 (4)** | 0.0932; -0.1259 | 1.0436 | 3.020, $p = .0836$ | -0.2402, $p = .0846$ |
| **SCSKD (5)** | 0.1132; 0.1206 | -0.2543 | 3.075, $p = .0809$ | -0.3835, $p = .0241$ |
| **PPQ (5)** | -0.5125; 0.4413 | 0.7187 | 65.686, $p < .001$ | 0.9484, $p < .001$ |
| **SBI (5)** | -0.4358; 0.3411 | 0.3679 | 38.845, $p < .001$ | 0.4659, $p = .0162$ |
| **RFS (5)** | -0.2866; 0.3067 | 0.3438 | 21.582, $p < .001$ | 0.5237, $p = .0041$ |
| **DBTP (6)** | 0.8114; -0.8119 | 1.491 | 338.10, $p < .001$ | -5.712, $p < .001$ |
| **SEM (7)** | NA | NA | NA | NA |
| **AGE (8)** | -0.0162; -0.0384 | 1.0033 | 0.029, $p = .8660$ | -0.0225, $p = .8650$ |

*Note:* Prevalence by mediansplit. Parentheses: identical numbers indicate same model. LDF coefficients: imply relevance of feature variables; scaled in units of the discriminant value (metric LDF outcome).

*Table S7: Inferential Statistics of the Discriminant Coefficients, SEM modeled*

| | Centroids balanced [0; 1] | LDF coefficients | *F*-statistic *F*(1, 229) | Log. coefficients beta, *p* |
|---|---|---|---|---|
| **SEM** | | | | |
| **Past (1)** | -0.6630; 0.6751 | 0.8673 | 179.74, $p < .001$ | 3.3276, $p < .001$ |
| **Future (1)** | -0.6695; 0.6543 | 0.6278 | 149.22, $p < .001$ | 2.006, $p < .001$ |
| **Past (2)** | -0.6630; 06751 | 0.4922 | 179.74, p< .001 | 3.9322; $p < .0001$ |
| **Present (2)** | -0.7533; 0.7541 | 0.8573 | 252.64, $p < .001$ | 5.2847, p < .001 |
| **Future (2)** | -0.6695; 0.6543 | 0.2712 | 149.22, $p < .001$ | 2.4863; $p < .0001$ |
| **SWB (3)** | -0.2996; 0.2610 | 0.0374 | 19.80, $p < .001$ | 0.031, $p = .8885$ |
| **SWLS (3)** | -0.3820; 0.3618 | 1.0169 | 34.87, $p < .001$ | 0.7874, $p < .0004$ |
| **PHQ15 (4)** | 0.079; -0.1259 | 1.0436 | 2.654, $p = .1047$ | -0.2253, $p = .1050$ |
| **SCSKD (5)** | 0.0959; 0.1206 | -0.2360 | 2.6561, $p = .1045$ | -0.3580, $p = .0035$ |
| **PPQ (5)** | -0.5137; 0.4413 | 0.7110 | 65.893, $p < .001$ | 0.9385, $p < .001$ |
| **SBI (5)** | -0.4416; 0.3411 | 0.3771 | 39.303, $p < .001$ | 0.4802, $p = .0128$ |
| **RFS (5)** | -0.2952; 0.3067 | 0.3517 | 22.452, $p < .001$ | 0.5358, $p = .0036$ |
| **DBTP (6)** | NA | NA | NA | NA |
| **SEM (7)** | -0.8061; 0.8051 | 1.4692 | 323.60, $p < .001$ | 5.019, $p < .001$ |
| **AGE (8)** | -0.0205; -0.0385 | 1.0022 | 0.019, $p = .8920$ | -0.0181, $p = .8910$ |

*Note:* Prevalence by mediansplit. Parentheses: identical numbers indicate same model. LDF coefficients: imply relevance of feature variables; scaled in units of the discriminant value (metric LDF outcome).

*Table S8: Multivariate Statistics of the LDF Equations*

| | *r* | *Wilks λ, $\chi^2$(df)* | *F-Statistic* | *AIC* | *r* | *Wilks λ, $\chi^2$ (df)* | *F-Statistic* | *AIC* |
|---|---|---|---|---|---|---|---|---|
| ***Mediansplit*** | **DBTP** | | | | **SEM** | | | |
| **BTPS** Past, Future | 0.5040 | λ = 0.4959 $\chi^2$(2) = 159.92 *p* < .001 | *F*(2, 228) = 116.38 *p* < .0001 | 130.86 | 0.4989 | λ = 0.5010 $\chi^2$(2) = 157.58 *p* < .001 | | 135.33 |
| **mBTPS** Past, Present, Future | 0.5751 | λ = 0.4249 $\chi^2$ (3) = 194.72 *p* < .001 | *F*(3, 227) = 102.85 *p* < .0001 | 73.348 | 0.5726 | λ = 0.4274 $\chi^2$ (3) = 193.38 *p* < .001 | | 75.96 |
| **Well-being** SWB, SWLS | 0.1342 | λ = 0.8658 $\chi^2$ (2) = 32.86 *p* < .001 | *F*(2, 228) = 17.75 *p* < .0001 | 292.96 | 0.1317 | λ = 0.8683 $\chi^2$ (2) = 32.20 *p* < .001 | *F*(2, 228) = 17.37 *p* < .0001 | 293.63 |
| **PHQ15 (4)** | 0.0129 | λ = 0.9870 $\chi^2$ (1) = 2.989 *ns* | *F*(1, 229) =3.020 *p* = .0836 | 321.17 | 0.0114 | λ = 0.9886 $\chi^2$ (1) = 2.619 *ns* | *F*(1, 229) = 2.654 *p* = .1047 | 321.54 |
| **Traits** SCSKD, PPQ, SBI, RFS | 0.2768 | λ = 0.7232 $\chi^2$ (4) = 73.56 *p* < .001 | *F*(4, 226) =21.72 *p* < .0001 | 252.30 | 0.2775 | λ = 0.7225 $\chi^2$ (4) = 73.78, *p* < .001 | *F*(4, 226) =21.79 *p* < .0001 | 252.08 |
| **DBTP (6)** | .5952 | λ = 0.4048 $\chi^2$ (1) = 206.65 *p* < .001 | *F*(1, 229) =338.10 *p* < .0001 | 97.56 | NA | NA | NA | NA |
| **SEM (7)** | NA | NA | NA | NA | .5845 | λ = 0.4155 $\chi^2$ (1) = 200.69 *p* < .001 | *F*(1, 229) =323.60 *p* < .0001 | 107.90 |
| **AGE (8)** | 0.0001 | λ = **0.9999** $\chi^2$ (1) = 0.0223 *ns* | *F*(1, 229) = 0.029 *p* = .8660 | 324.17 | **0.00008** | λ = **0.9999** $\chi^2$ (1) = 0.0223 *ns* | *F*(1, 229) = 0.019 *p* = .8920 | 324.18 |
| **HCA2** | **DBTP** | | | | **SEM** | | | |
| **mBTPS** Past, Present, Future | 0.6014 | λ = 0.3986 $\chi^2$ (3) = 120.03 *p* < .001 | *F*(3, 132) = 66.87 *p* < .0001 | 45.873 | 0.6386 | λ = 0.3614 $\chi^2$ (3) = 132.82 *p* < .001 | *F*(3, 132) = 78.34 *p* < .0001 | 25.285 |
| **DBTP Coefficient** | 0.6397 | λ = 0.3603 $\chi^2$ (1) = 134.24 *p* < .001 | *F*(1, 134) = 239.64 *p* < .0001 | 42.45 | NA | NA | NA | NA |
| **SEM Coefficient** | NA | *NA* | NA | NA | 0.6131 | λ = 0.3869 $\chi^2$ (1) = 124.87 *p* < .001 | *F*(1, 134) = 252.90 *p* < .0001 | 36.35 |

*Note:* Prevalence by mediansplit, for some models compared to binary clustering (HCA2). Gamma: Standardized eigenvalue of the LDF, expresses explained variance.

*Table S9: Area Under the Curve: Balancedness ~ SWLS + DBTP*

| AUC | n | n_pos | n_neg |
|---|---|---|---|
| 0.9181 | 231 | 120 | 111 |

| Optimal cutpoint | youden | acc | sensitivity | specificity | tp | fn | fp | tn |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.8363 | 0.9177 | 0.9083 | 0.9279 | 109 | 11 | 8 | 103 |

Predictor summary:

| Data | Min. | 5% | 1st Qu. | Median | Mean | 3rd Qu. | 95% | Max. | SD | NAs |
|---|---|---|---|---|---|---|---|---|---|---|
| Overall | 0 | 0 | 0 | 1 | 0.50649351 | 1 | 1 | 1 | 0.5010435 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0.07207207 | 0 | 1 | 1 | 0.2597800 | 0 |
| 2 | 0 | 0 | 1 | 1 | 0.90833333 | 1 | 1 | 1 | 0.2897647 | 0 |

*Table S10: Area Under the Curve: Balancedness ~ SWLS + SEM*

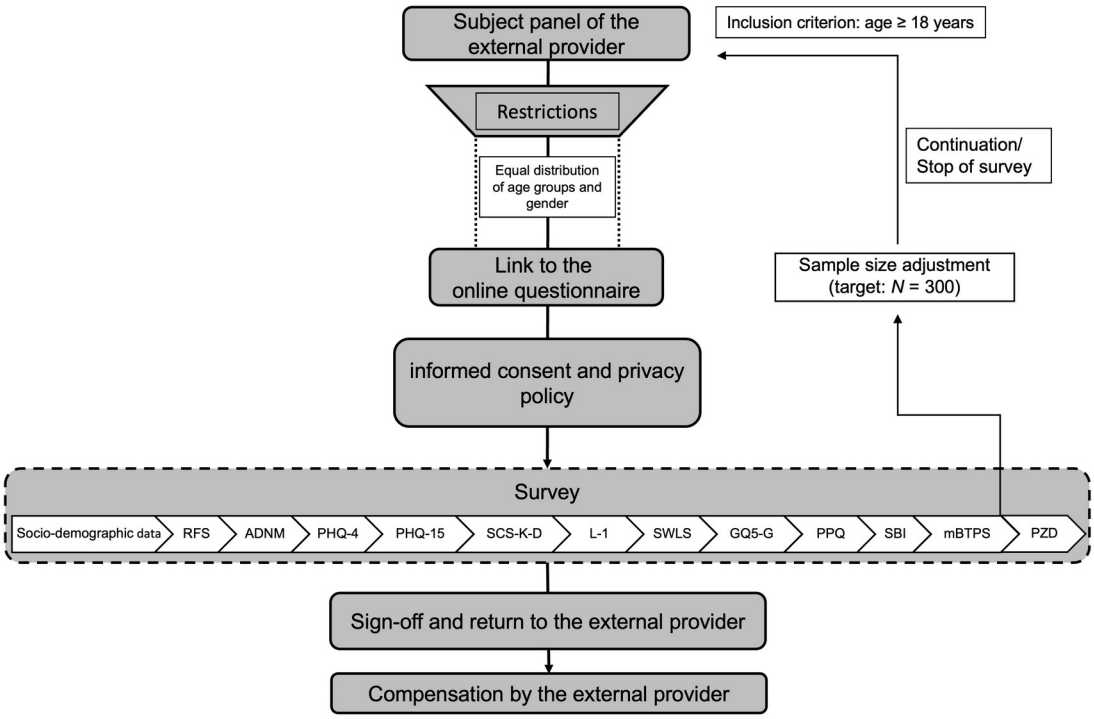
| AUC | n | n_pos | n_neg |
|---|---|---|---|
| 0.9274 | 231 | 122 | 109 |

| optimal cutpoint | youden | acc | sensitivity | specificity | tp | fn | fp | tn |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.8548 | 0.9264 | 0.9098 | 0.945 | 111 | 11 | 6 | 103 |

Predictor summary:

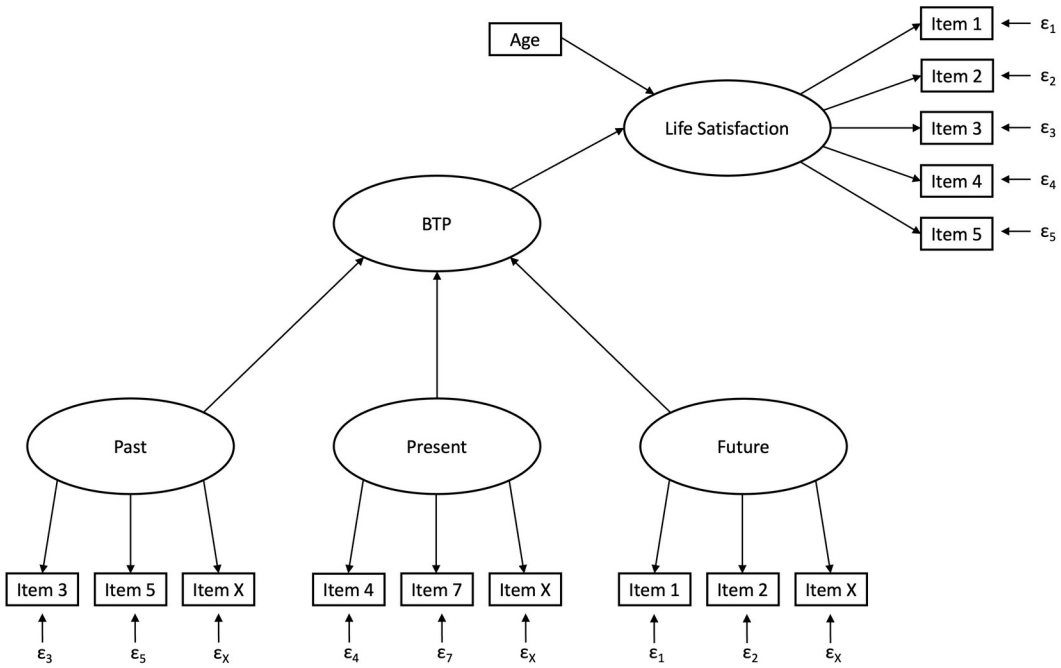
| Data | Min. | 5% | 1st Qu. | Median | Mean | 3rd Qu. | 95% | Max. | SD | NAs |
|---|---|---|---|---|---|---|---|---|---|---|
| Overall | 0 | 0 | 0 | 1 | 0.50649351 | 1 | 1 | 1 | 0.5010435 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0.05504587 | 0 | 0.6 | 1 | 0.2291232 | 0 |
| 2 | 0 | 0 | 1 | 1 | 0.90983607 | 1 | 1.0 | 1 | 0.2875976 | 0 |

*Figure S1: Procedure*




*Note*. RFS = Reminiscence Function Scale; ADNM = short form of the Adjustment Disorder New Model; PHQ-4 = Patient Health Questionnaire-4; PHQ-15 = Patient Health Questionnaire-15; SCS-K-D = short form of the Self-Control Scale; L-1 = one item scale to measure life satisfaction; SWLS = Satisfaction with Life Scale; GQ5-G = German adaptation of the Gratitude Questionnaire-Six Item Form; PPQ = Prioritizing Positivity Questionnaire; SBI = Savoring Beliefs Inventory; mBTPS = modified Balanced Time Perspective Scale; PZD = psychological temporal distance.

*Figure S2: BTP coefficient based on structural equation model (SEM)*




*Note:* BTP = Balanced Time Perspective, Life Satisfaction = SWLS.

The manifest variables (items) are first defined as indicators of the latent variables. In order to give the latent variables a metric, the loading of the first indicator was fixed at 1 in each case. In a second step (structural model), the relationship between BTP and life satisfaction was defined. The measure of BTP estimated based on this SEM was then extracted from the model and represents the SEM coefficient.