The Subjective Present and its Modulation in Clinical Contexts

(pre-publication draft)

Wolfgang Tschacher, Fabian Ramseyer and Claudia Bergomi

University Hospital of Psychiatry and Psychotherapy
University of Bern
Laupenstrasse 49
3010 Bern, Switzerland.
phone: +41 31 3876164
fax: +41 31 3829020

please cite as:
Tschacher W, Ramseyer F, & Bergomi C (2013). The subjective present and its modulation in clinical contexts. *Timing & Time Perception, 1,* 239-259.

Abstract

Time is a basic dimension in psychology, underlying behavior and experience. Timing and time perception constitute implicit processes that are often inaccessible to the individual person. Research in this field has shown that timing is involved in many areas of clinical significance. In the projects presented here, we combine timing with seemingly different fields of research, such as psychopathology, perceptual grouping, and embodied cognition. Focusing on the time scale of the subjective present, we report findings from three different clinical studies: (1) We studied perceived causality in schizophrenia patients, finding that perceptual grouping ('binding', 'Gestalt formation'), which leads to visual causality perceptions, did not distinguish between patients and healthy controls. Patients however did integrate context (provided by the temporal distribution of auditory context stimuli) less into perceptions, in significant contrast to controls. This is consistent with reports of higher inaccuracy in schizophrenia patients' temporal processing. (2) In a project on auditory Gestalt perception we investigated auditory perceptual grouping in schizophrenia patients. The mean dwell time was positively related to how much patients were prone to auditory hallucinations. Dwell times of auditory Gestalts may be regarded as operationalizations of the subjective present; findings thus suggested that patients with hallucinations had a shorter present. (3) The movement correlations of interacting individuals were used to study the nonverbal synchrony between therapist and patient in psychotherapy sessions. We operationalized the duration of an embodied 'social present' by the statistical significance of such associations, finding a window of roughly 5.7 seconds in conversing dyads.

We discuss that temporal scales of nowness may be modifiable, e.g. by mindfulness. This yields promising goals for future research on timing in the clinical context: psychotherapeutic techniques may alter binding processes, hence the subjective present of individuals, and may affect the social present in therapeutic interactions.

Keywords: binding; Gestalt perception; psychotherapy; schizophrenia; subjective present

Introduction

The nature of time is in its passing. As a scientific concept, time is likewise elusive. Neurobiological research has shown that no single center is predominantly dedicated to the perception of time in the cortex. Perception of time thus differs from perception of sensory information (Wittmann, 2009). Rather, the interplay of a number of brain regions is involved in temporal tasks. Furthermore, obviously no single sense organ exists for temporal perception: We do not possess eyes or ears for this purpose. When speaking about time and the passage of time, we often use words that relate to locations and journeys, i.e. spatial terms (cf. Bergson, 1922). Thus, in a strict sense, there is no such thing as 'perception of time'. We see, hear, taste and touch directly, but our sense of time is of a secondary nature. This conforms to many accounts in Western philosophy. In early Greek thinking, Parmenides' ontology regarded time altogether as an illusion. Many philosophers in modernity followed Kant in arguing that time is not an entity that can be observed objectively. It may rather be regarded an emergent property of the observing mind, needed as an *a priori* precondition for the perception of reality. Hence time is less an attribute of the world than an attribute of the mind.

Objective time, however, is becoming increasingly focal in modern society. Economics and cultural life seem to revolve around timing in many respects, as illustrated by topics of saving time, being the first, responding in time. In many transactions in modern societies, the delays in feedback systems are being minimized. The velocity of information exchange in self-organizing market systems has become a concern in politics and economy because trading at high rates has tended to destabilize these systems, causing erratic behavior. In contrast to this, and maybe as a response to the high pace of modern society, the concept of *Entschleunigung* (deceleration; Reheis, 2003) has popularized the idea of making people more time-conscious, with the goal of slowing down societal and professional processes as well as private, every-day timing.

Starting in the mid-19th century, psychophysics has accumulated a long tradition of investigating temporal judgments. In this branch of psychological research, subjective temporal estimations are compared to objective temporal measurements, i.e. to physical clocks. Accordingly, the standard models of timing in psychology and neuroscience are variants of the clock model (Vatakis & Papadelis, 2011; cf. Wackermann & Ehm, 2006). Psychophysical findings have supported the philosophical notion that the objective time of physics is not equal to, or coextensive with, the subjective time of humans or animals. Whereas in Newtonian physics no extended 'now' is defined, for the mind several such nows appear to exist, none of which is a point in time. This *subjective present* is not like a knife's edge that separates past from future – rather, any subjective moment possesses some duration (Pöppel, 2009). The term *'specious* present' (James, 1990), often used synonymously to subjective present, derives from this notion that the present in 'objective' physical time should be extensionless.

Perception and cognition, however, demonstrate that this is not true for mental time: Observers report that they are capable of directly perceiving motion, e.g., 'object X is moving at this moment', which is possible only when the positions of X at different points in time are integrated over time to construct a percept of motion. A foundational paradigm of Gestalt psychology is apparent motion (Wertheimer, 1912): if X is flashed alternately at two different locations of visual space, continuous motion of X between the two locations is perceived, i.e. even in the absence of a physically moving stimulus. Apparent motion indicates that events occuring at different points in time can lead to illusory perceptions of motion being presented. The upper limit of non-synchronous presentation, when stimuli are no longer integrated by Gestalt perception (in other terminology, by binding), may correspond to the duration of the subjective present. In auditory perception, as in listening to a metronome, individuals do not just perceive a stream of events (the metronome beats) in isolation – they automatically integrate the consecutive beats into rhythms consisting of several beats, e.g. by accentuating every second, third, fourth,… etc., beat. Previous research found that such Gestalt-like integration may extend over approximately 2-3 s (Wittmann, 2009), which has also been suggested as a duration of the subjective present (Fraisse, 1984; Pöppel, 1997). In addition to such duration findings, the 'velocity' of the passage of subjective time can also vary considerably, depending on a number of psychological and somatic parameters.

In conclusion, minds process information using a hierarchy of circumscribed time scales. All processes of Gestalt formation need a certain time, which may characterize the task and the individual who is forming a Gestalt. It is here where Gestalt psychology and the psychophysics of timing are intrinsically connected. We therefore propose that the temporal range within which Gestalt-like integration occurs can help define the duration of the subjective present. In this sense, Gestalt phenomena can be used as quantitative operationalizations of the implicit mental entity 'subjective present'.

Psychophysical experiments and philosophical theory thus show that timing is a basic aspect of behavior and action. At the same time, most timing occurs implicitly, its psychological attributes are often not accessible to the individual person. Research in this field has nevertheless shown that timing is involved in many processes of high practical significance. Taking these three aspects together, timing issues appear to be of considerable scientific interest in psychology and cognitive science with high foreseeable value for applications. In this paper, we are especially interested in applications to the fields of psychopathology and psychotherapeutic interventions.

Time and psychopathology

Mental timing can be a source, or sign, of dysfunctional adaptation in individuals: In affective disorders, the experienced flow of time is characteristically altered, such that depressive symptoms correlate with a slowed experience of time, manic symptoms with an accelerated experience of time (Mahlberg et al., 2008). Bschor et al. (2004) found analogous temporal experiencing but uniform time overestimation in both groups of patients. Developmental disorders such as dyslexia (Elliott & Shanagher, 2010) were found to be linked to aberrant structuring of temporal events. Greater inaccuracy of temporal judgments was especially observed in patients with schizophrenia (Elvevåg et al., 2003; Giersch et al., 2009), which was correlated with deficits in short-term memory (Lee et al., 2009). Impairments of time judgments may be related to many further neuropsychological processes, all of which are important for everyday functioning (Bonnot et al., 2011). For instance, the perception of temporal order is essential for detecting causal relations between events (van Wassenhowe, 2009). Two studies found that patients with psychosis showed elevated thresholds for simultaneity (Schmidt et al., 2011; Giersch et al., 2009). Many deficits of functioning in psychopathology appear to be associated with deficient timing. Delevoye-Turrell et al. (2012) reported normal clock speed in schizophrenia patients, but impairment of the reafference system resulting in specific deviations of temporal sensory-motor integration. Our own research group found that the temporal binding processes that underlie perceived causality and attributions of causality may be impaired in schizophrenia (Tschacher & Bergomi, 2011a). In a series of studies, we investigated binding processes in schizophrenia using various paradigms (Gestalt perception tasks such as apparent motion and motion-induced blindness). We found strong associations with several dimensions of psychopathology (Tschacher et al., 2006, 2008; Tschacher & Kupper, 2006).

Time and embodiment

Extending the research in psychopathology, numerous studies showed that the subjective perception of time is influenced by the mental states resulting from valence and arousal, meditation and relaxation, emotion and motivation, and sensory deprivation. Wittmann (2009) termed this increasing focus on non-cognitive modulation of time perception the 'emotive turn' of this field. Droit-Volet & Meck (2007) reviewed the effects of emotion on timing, also mentioning the role of embodied (i.e. bodily expressed) emotionality. Mental states induced by hypnosis, meditation and mindfulness techniques usually alter temporal experiencing in a person: They lead to underestimations of time intervals and to a longer duration of the subjective present (nowness, Sauer et al., 2012). This may again be viewed in the context of embodiment, where various pathologies have been differentiated as being hyper- or disembodied (Fuchs & Schlimme, 2009). Viewing of emotions expressed in faces influences the temporal estimations of the viewers (Effron et al., 2006): The embodiment of emotions and the emotional synchrony in the viewer appears to modulate time perception. The association of embodied cognition and time perception is thus a new development in the field of mental timing research. In the context of theoretical considerations on embodiment (Tschacher & Bergomi, 2011b; Tschacher & Dauwalder, 2003), we conducted a series of empirical projects on social timing, developing a measure of 'nonverbal synchrony' based on video recordings of persons interacting (Ramseyer & Tschacher, 2006; 2010). Applications of the synchrony approach were studied in psychotherapy process (Ramseyer & Tschacher, 2011), human-computer interaction (Reidsma et al., 2010) and schizophrenia research (Kupper et al., 2010). Timing in a social context is the essence of this approach, from which we have started to derive markers of the *social present* (Tschacher, 2012).

The goal of the present paper is to report and aggregate empirical findings from three clinical fields of study. These studies addressed seemingly diverging issues – visually perceived causality in schizophrenia patients, auditory Gestalt perception in schizophrenia patients, and nonverbal synchrony in psychotherapy dyads. On the basis of the above considerations, however, we will argue that the studied phenomena share a focus on timing and on the subjective present. We will then point out the clinical relevance of this timing aspect by discussing possible ways to modify and readjust the perceived present by psychological interventions such as mindfulness-based therapy.

Empirical studies

1. Temporal intersensory integration in schizophrenia

Here we refer to a study of perceived causality in schizophrenia patients (Tschacher & Bergomi, 2011a). Abnormalities in cognitive binding are held responsible for disturbances in causal inferences such as in the phenomenon of 'jumping to conclusions', a cognitive property commonly associated with delusions. In the 1940s, based on Gestalt psychology (Metzger, 1933), Albert Michotte developed an experimental task for the study of the perception of causality: Some geometric object A moves towards object B, which is stationary. After collision, object A is stationary and B moves away from A evoking an immediate perception that the first motion caused the second – 'A pushed B'. Michotte proposed that such phenomenal causality is a spontaneous perceptual Gestalt (in contemporary terminology, a neurocognitive binding or perceptual grouping process), where the feature of movement is transferred from one object to another.

Materials. Here we used a variant of Michotte's task (Sekuler, Sekuler & Lau, 1997) presented on a computer screen (shown schematically in Figure 1). Subjects were instructed to fixate the cross below the center of the display. Two white discs (diameter 0.5 cm, visual angle 0.6°) then appear on both sides above the fixation cross against a black background. Discs are initially separated by 12 cm. Immediately after onset the discs move horizontally towards each other with a constant speed of 10 cm/s, coincide in the screen center, and continue moving until they are again separated by 12 cm; discs then disappear. At around the time of coincidence, a click sound is presented. The timing of the sound defines five conditions, which are slightly distributed: Condition 1, approx. 150 ms before coincidence; Condition 2, approx. 70 ms before coincidence; Condition 3, simultaneous with or minimally after coincidence; Condition 4, approx. 100 ms after coincidence; Condition 5, approx. 200 ms after coincidence. In our study, the exact timing of the click was used as the independent variable ‘Timing condition’.

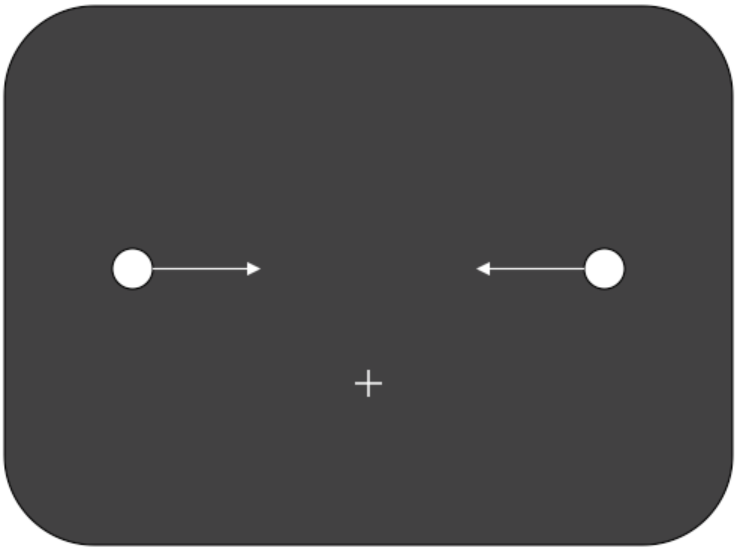

Figure 1. Screen display (schematic) for the perceived causality paradigm. Two discs move horizontally towards each other with constant speed, coincide in the screen center, and continue moving until they are again separated by their initial distance. The auditory 'click' stimulus is presented relative to the time of coincidence

In each participant, up to 60 runs of the paradigm were evaluated. Each run lasted approximately 2.5 s, with a random interval of 1 to 3 s duration between runs. Participants were informed about the bistable character of the stimulus, i.e. that two alternative events could be seen, either bouncing or streaming of the discs. If undecided or ‘in-between’, a third response ("unclear") was allowed. The responses after each run served as the dependent variable in the analysis. For mixed-effects hierarchical analysis, this dependent variable ‘Perceived causality’ was given the values 2 (bouncing), 1 (unclear) or 0 (streaming). We distinguished two types of binding in this perceived causality task: binding type I was operationalized by the occurrence of a bouncing response, i.e. how much movement is perceived as transferred from one disc to the other, generating the perception of causality. Binding type II was operationalized by the integration of additional contextual information, especially the timing of the click sound. Thus, binding type II indicates how strongly acoustic information given at different temporal lags attenuated or supported the perception of causality.

Participants. The study sample consisted of 34 patients of the University Hospital of Psychiatry in Bern, Switzerland (27 men and 7 women) with mean age 27.9 y (SD=7.1) and 34 healthy control subjects (26 men and 8 women; mean age 27.9 y, SD=8.0). 13 inpatients had been admitted to a community-based acute unit and 19 patients were undergoing psychiatric outpatient treatment in two day-hospitals. All patients had been diagnosed as suffering from schizophrenia spectrum disorder (schizophrenia, 27; schizotypal disorder, 1; acute psychotic disorder, 2; schizoaffective disorder, 4). Psychopathology was assessed using the positive and negative syndrome scale (PANSS; Kay, Fiszbein & Opler, 1987), which has five factors: positive symptoms, negative symptoms, excitement, depression, and cognitive disorganization symptoms (Lindenmayer, Grochowski & Hyman, 1995). For some analyses, the patient sample was split into two subgroups with either high (n = 17) or low ratios of positive to cognitive symptoms (n = 14). All participants took part in the study based on prior written informed consent.

Statistical treatment. The complete dataset of all runs of N=68 subjects comprised close to 4,000 observations. This dataset contained statistically dependent data because the paradigm was repeatedly presented to each subject. Our main analysis included all runs by all subjects (patients and controls). We were looking specifically for group differences in type-I or type-II binding.

We applied mixed-effects analysis to explain the variance of the dependent variable ‘Perceived causality’ by the following fixed effects (i.e., predictors): ’Timing condition’, ’Group’ (schizophrenia patients vs. healthy controls), ’Timing condition x Group’. The software package used was JMP8 (SAS Institute Inc., Cary, NC). In all models, 'Subject number' was entered as a random effect, which defined the dependency structure inherent to this hierarchical dataset. In this statistical approach, binding type I is represented by the degree of the dependent variable ‘Perceived causality’. Any group difference here would be marked by a significant fixed effect ‘Group’. Binding type II is represented by the fixed effect ‘Timing condition’; any group difference in this type of binding would result in a significant fixed effect ’Timing condition x Group’.

In a previous study of the same sample, using a different statistical design, Tschacher and Kupper (2006) found that binding type I was associated with psychopathology in the schizophrenia subgroup. Positive symptoms were linked with heightened perceived causality and cognitive disorganization symptoms with reduced perceived causality. Patients however did not significantly differ from healthy controls in the total amount of perceived causality, i.e. binding type I. Our primary hypothesis in the subsequent analysis (Tschacher and Bergomi, 2011a) was that schizophrenia patients would show less type-II binding.

Results. The mixed-effects analysis showed that binding type I was present in many participants. The mean perceived causality levels, irrespective of the timing conditions, were 0.93 in patients and 1.14 in the healthy participants, which was not significantly different. Consistent with this, 'Group' was not a significant predictor of perceived causality – binding type I did not differentiate between the groups, as was already found in the previous analysis.

This finding was however complemented by the results concerning binding type II: Here schizophrenia patients were shown to deviate from control participants, since the ‘Timing condition x Group’ interaction was a significant predictor. This means that the two groups differed with respect to how the timing of context information, spread across a period of about 350 ms, affected the perception of perceived causality.

This is graphically represented by the flatter curve for patients in Figure 2: The group of schizophrenia patients utilize the temporal information of the acoustic stimuli less than members of the control group. This finding, which also generated the best-fitting mixed-effects model in terms of Akaike's information criterion, was consistent with the primary hypothesis. Figure 2 additionally shows that the two symptom subgroups in patients (low vs. high pos/cog symptoms) have different amounts of binding type I, but both still show the flatter curves of attenuated binding type II. Patients with elevated positive symptoms and few cognitive disorganization symptoms showed high levels of perceived causality (i.e. binding type I), yet their binding type II was below that of healthy controls.

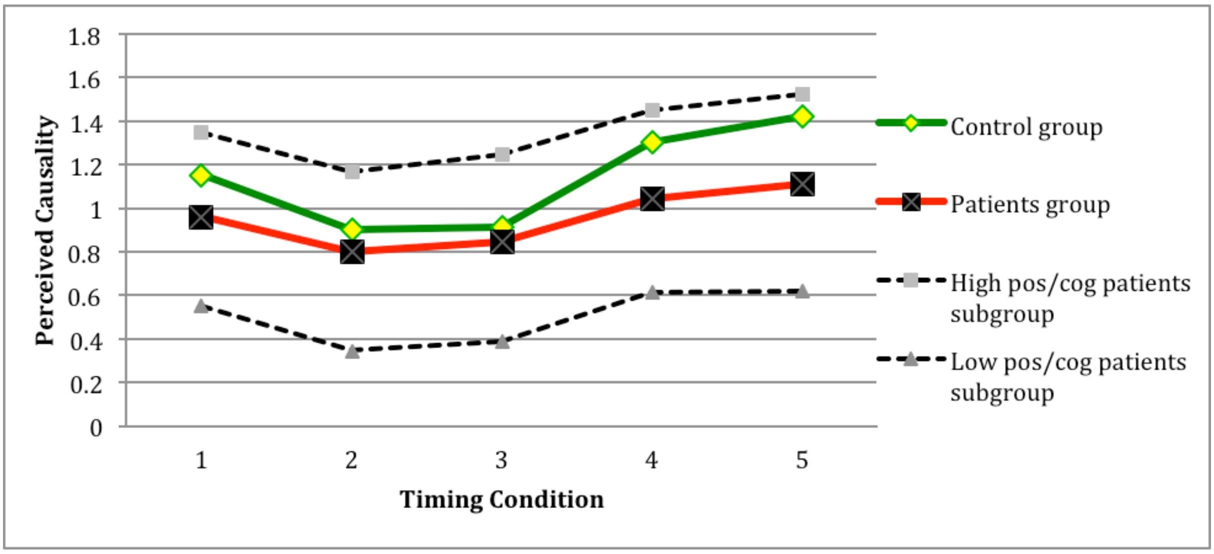

Figure 2. Mean perceived causality by timing conditions of subgroups of the sample. Control group (N=34), Patients group (N=34), High pos/cog patients subgroup (N=17), Low pos/cog patients subgroup (N=14). Abscissa, timing conditions: acoustic stimulus prior to (1 and 2), during (3) and after (4 and 5) coincidence of discs in the Michotte paradigm.

Discussion. Type-II binding is realized when temporal information is processed and becomes instrumental in modulating the more basic Michotte-like perception of causal relationships (type-I binding). In the present study, this further information afforded temporal integration of auditory with visual input. Timing conditions 4 and 5, with presentations of the 'click' sound after the visual contact of the discs, resulted in higher perceived causality.

In this study, we found that type-II binding distinguished between schizophrenia patients and healthy controls, whereas type-I binding did not. This indicates that schizophrenia patients could profit less from the information that was provided by the temporal distribution of acoustic context stimuli. This finding appears consistent with repeated reports of higher inaccuracy in patients' temporal judgments and additionally points to schizophrenia patients' problems in intersensory integration. Our present finding is remarkable because the bulk of results in schizophrenia research is nonspecific, depending on the state of the individual in a heterogeneous population of patients. There is not one schizophrenia, but a spectrum of schizophrenias. The essential aspect of the present finding is, however, that it reveals a promising trait marker of schizophrenia, which is unaffected by the current symptomatic state of a patient.

2. Auditory perceptual binding and schizophrenia

Participants. This study used a different sample as the one studied in Section 1. It consisted of 30 schizophrenia spectrum disorder patients (12 women and 18 men) with mean age 36.9 y (SD=10.8) and 30 healthy people matched in gender and age (M=37.1 y, SD=10.9). In the patients group, mean age at first hospitalization was 26.3 y (SD=8.6) and the mean number of hospitalizations was 4.9 (SD=2.5). The patients group was further subdivided into three subgroups differing in their prevalence of auditory hallucinations: (1) patients with current auditory hallucinations (n=10; women/men=3/7); (2) patients with auditory hallucinations in the past but non currently (n=8; women/men=3/5); (3) patients with no history of auditory hallucinations (n=12; women/men=6/6). These subgroups did not significantly differ in age (M_{cur}=34.8 y, SD_{cur}=11.9; M_{past}=33.9 y, SD_{past}=12.3; M_{no}=40.6 y, SD_{no}=8.4). The present sample was part of an ongoing project on auditory Gestalt perception and psychopathology. Thus, the results reported here are based on interim analyses and must be considered preliminary.
Procedure and materials. The patients were recruited on units of the following psychiatric institutions: the Psychiatric Rehabilitation Centre of the Rudolf-Sophien Stift in Stuttgart, Germany (15 patients); the AMEOS-Clinics in Osnabrück, Germany (7 patients); the University Hospital of Psychiatry in Bern, Switzerland (8 patients). The matched healthy participants were recruited in each case in the corresponding geographical region. All patients had been diagnosed as suffering from schizophrenia spectrum disorder according to the International Classification of Diseases, ICD-10. Participants took part in the study based on prior written informed consent. The study was approved by the Bernese Cantonal Ethics Committee.

All patients participated in a standardized clinical interview (positive and negative syndrome scale, PANSS; Kay, Fiszbein & Opler, 1987) to assess the level of symptoms at the time of testing. Following the model of Lindenmayer, Grochowski & Hyman (1995), the PANSS items were clustered into five factors: positive symptoms, negative symptoms, excitement, depression, and cognitive disorganization symptoms of schizophrenia. Occurrence and frequency of verbal hallucinations in patients was assessed with the Psychotic Symptom Rating Scale (PSYRATS; Haddock et al., 1999), a semi-structured interview measuring the subjective characteristics of hallucinations and delusions. Two trained psychologists performed the interviews.

Auditory perceptual grouping (i.e., formation of auditory Gestalts) was tested using two tasks: The Galloping Stream Segregation task (GSS) and the Verbal Transformation Effect task (VTE). In the GSS, participants listen to a sequence of tones, which can give rise to the perception of a galloping rhythm. Figure 3 gives a schematic representation of the acoustic stimuli: Two tones (A and B) alternate in a short ABA sequence, which is followed by a pause (P). Similar tasks based on perceptual grouping and stream segregation within the auditory modality have been extensively studied (Bregman, 1990; Deutsch, 1999; van Noorden, 1975). Tone B was fixed to the note A3 (220 Hz) while tone B varied between the notes A3 and G4 (392 Hz) in half-tone steps (eleven possible pitch levels). Participants listened to six tracks with ascending and descending pitch intervals. Three different velocities were used for the tracks (two tracks per velocity). Depending on the track's tempo, each ABAP-sequence lasted 400 to 600 ms and was repeated for 35 to 53 seconds. A higher pitch difference between A and B increases the probability that the two tones are not integrated into a Gestalt and thus no galloping rhythm is heard. Depending on the pitch difference between the tones A and B (d_{tones}) three ranges of stimuli can be discerned: 1) conform galloping: Stimuli in which participants are expected to hear a galloping rhythm (d_{tones} =0-4 halftones); 2) ambiguous galloping: Stimuli in which either a galloping or non-galloping rhythm may be heard (d_{tones} =5-7 halftones); 3) nonconform galloping: Stimuli in which participants are expected not to perceive a galloping rhythm (d_{tones} =8-12 halftones) (Stroh, 2000). Participants were asked to press a key each time they heard a galloping rhythm and to keep it pressed until the percept disappeared. Gestalt perception was operationalized as the time during which galloping was heard during the conform, ambiguous, and nonconform ranges. Perceiving a galloping rhythm during nonconform ranges is an index of excessive Gestalt formation, whereas not perceiving it during conform ranges points to a lack of Gestalt formation.

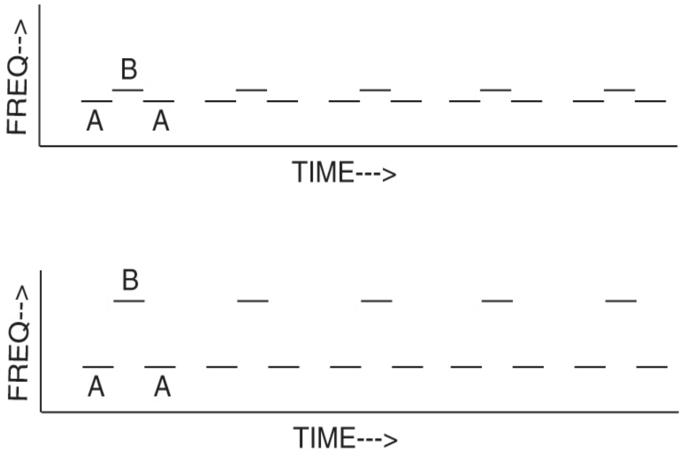

Figure 3. Illustration of acoustic stimuli in the Galloping Stream Segregation Task (GSS). The vertical dimension depicts the size of the pitch difference between the two tones A and B; in the upper condition, perception of galloping (i.e. Gestalt formation) is expected, in the lower condition Gestalt formation is not expected. FREQ, frequency

In the Verbal Transformation Effect task (VTE) participants listen to the acoustic presentation of a word that is constantly repeated with zero interstimulus intervals. The presentation lasts for a fixed period of time, such as one minute. In this situation, auditory percepts cannot be confirmed by a context (i.e. a grammatical and semantic environment) that would stabilize it (Pitt & Shoaf, 2002; Warren, 1968). This leads to different successive Gestalt formations, by which the perceiver attempts to give meaning to the out-of-context stimulus that is being presented. Perceivers accordingly report hearing several different words (Warren, 1968).

In the present task, four German stimulus words were used: "Hase", "leise", "rosa", "rennen" (in English: hare, quiet, rose, to run). Each word lasted 380 ms and was repeated 200 times; thus the presentation lasted 76 s. Participants were asked to press a key each time they heard a new percept, word or non-word. After each presentation, they were prompted by the experimenter to mention all percepts they had just heard, which were then documented by the experimenter. The presence of auditory hallucinations was not recorded during the experiment. Gestalt formation in VTE was operationalized by the following variables: 1) mean dwell time per percept (calculated over all percepts except the last one, as dwell time on the last percept is artificially cut by the presentation limit of 76 s); 2) latency to first word switch. In accordance with previous studies addressing multistable perception, we considered mean dwell time as an operationalization of the duration of the subjective present (Franck & Atmanspacher, 2009; Pöppel, 1997; Wittmann, 2011). Mean dwell times for the VTE were expected to scale with the duration of each word, the number of repetitions and the resulting duration of each word's repetition presentation. For example, according to results in a healthy population utilizing tracks lasting 180 s, mean dwell times for words varying in duration between 405 ms to 432 ms can vary between 5.4 and 10.9 s (Warren, 1968). This study also suggested that mean dwell time remains constant across the first, second and third minute of the word's presentation. A more recent study, however, provided evidence of shorter mean dwell times ranging from 1.6 to 2.0 s in healthy controls and from 1.4 to 3.5 s in patients with schizophrenia (Haddock, Slade, & Bentall, 1995).

In both GSS and VTE, participants listened to the acoustic stimuli via headphones connected to a computer. Instructions were given through the computer screen and participants were asked to close their eyes while listening to the stimuli. Participants indicated each percept switch by pressing a key.

Statistical analyses. As the assumptions for parametric tests were only partly given (non-normal distributions, small patient subgroups), all analyses applied non-parametric tests (Spearman's correlation ρ, Mann-Whitney test, Kruskal-Wallis test). The VTE analyses comprised 25 patients and 28 controls due to errors in response behavior. For the same reason, in GSS only data from 19 patients and 29 controls were analyzed.

The following hypothesis was tested: Auditory hallucinations are positively related with a more unstable verbal Gestalt formation in VTE (i.e. shorter mean dwell times, shorter latencies to first percept). We did not expected to find group differences between healthy controls and schizophrenia spectrum disorder patients with respect to the amount of Gestalt formation in both tasks. As secondary goals, the study aimed at exploring the relationships between auditory Gestalt formation in both GSS and VTE and symptom dimensions of schizophrenia.

Results. The average symptom level of patients in the study was moderate. The patient subgroups with and without auditory hallucinations significantly differed on the PANSS depression and cognitive subscales (Table 1). As expected, none of the assessed Gestalt formation variables were significantly different in the control group and schizophrenia group (Table 2).

Table 1. PANSS scores of patient groups

PANSS Subscale	Schizophrenia Patients (N=30)		Patient Subgroup with current AH (n=10)		Patient Subgroup with AH in the past (n=8)		Patient Subgroup with no AH (n=12)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Positive symptoms	2.64	0.91	3.12	1.03	2.63	1.02	2.25	0.51
Negative symptoms	2.25	0.72	2.17	0.75	2.03	0.67	2.46	0.72
Excitement	2.21	0.74	2.48	0.85	2.34	0.77	1.90	0.53
Depression	2.63	0.65	2.98**	0.51	2.65**	0.61	2.08**	0.51
Cognitive symptoms	2.21	0.83	2.74*	0.87	1.73*	0.61	2.08*	0.70

significance levels *p<.05, **p<.01 (Kruskal-Wallis Test). AH, auditory hallucinations

Table 2. Results on acoustic Gestalt variables in the patient and control groups

	Control Group Mean (SD)	Schizophrenia Patients Group Mean (SD)
VTE	N=28	N=25
Mean dwell time	6.3 (7.1)	6.7 (8.5)
Latency to first switch (ms)	60’850 (50’382)	54’705 (59’041)
GSS	N=29	N=19
Conform galloping time	42.0 (11.2)	34.0 (13.7)
Ambiguous galloping time	12.1 (11.4)	12.2 (11.9)
Nonconform galloping time	7.2 (6.9)	8.6 (11.3)

no significant differences (Mann-Whitney Test). VTE, Verbal Transformation Effect Task; GSS, Galloping Stream Segregation Task

With reference to the study hypothesis, results showed the expected direction but levels did not reach significance in all variables (Table 3). Only the VTE mean dwell time significantly differentiated between patient subgroups: Patients with current auditory hallucinations showed significantly shorter dwell times than both patients with auditory hallucinations in the past (Mann-Whitney-U=10.5, p<.05) and patients without auditory hallucinations (U=12.5, p<.05). Patients with auditory hallucinations in the past and patients without auditory hallucinations did not differ significantly. Although latency times in patients with current auditory hallucinations were nearly halved, this difference failed to reach significance. Thus the occurrence of auditory hallucinations was significantly related to a shorter dwell time on each word percept. Interestingly, no GSS variable showed significant differences between groups, which suggests a specific association of auditory hallucinations to verbal Gestalt formation, but possibly not to auditory Gestalt formation in general. The limited statistical power, however, must be considered in the interpretation of significant and insignificant results.

Table 3. Results on acoustic Gestalt variables in patient subgroups with differing occurrence of auditory hallucinations

	Patient subgroup with current AH Mean (SD)	Patient subgroup with AH in the past Mean (SD)	Patient subgroup with no AH Mean (SD)
VTE	n=8	n=7	n=10
Mean dwell time	2.1* (0.9)	9.4* (10.9)	8.5* (9.1)
Latency to first switch (ms)	32’696 (33’221)	61’250 (72’485)	67’732 (65’438)
GSS	n=6	n=5	n=8
Conform galloping time	29.6 (16.4)	35.3 (14.0)	36.6 (12.3)
Ambiguous galloping time	10.2 (10.9)	7.8 (8.8)	16.6 (13.9)
Nonconform galloping time	6.9 (12.3)	2.7 (2.5)	13.5 (12.6)

Significance levels: *p<.05, Kruskal-Wallis-Test (χ^2=7.0). AH, auditory hallucinations; VTE, Verbal Transformation Effect Task; GSS, Galloping Stream Segregation Task

None of the three VTE variables was significantly correlated with any of the five PANSS dimensions. On the other hand, GSS ambiguous galloping time was significantly correlated with cognitive symptoms ($\rho=-.49$, $p<.05$) and GSS nonconform galloping time was correlated with cognitive symptoms ($\rho=-.63$, $p<.01$) and positive symptoms ($\rho=-.63$, $p<.01$). In other words, cognitive disorganization and positive symptoms were both associated with less Gestalt formation.

Discussion. The present study provided preliminary evidence for specific associations between Gestalt formation in the auditory domain and symptom dimensions of schizophrenia. As an interim analysis in ongoing projects, the reported results relied on relatively small samples. In both auditory Gestalt tasks, VTE and GSS, acoustic stimuli were presented over a time interval giving rise to subsequent reorganizations of the percept. In VTE, verbal material (one spoken word) was repeated over and over. In human language, words are usually embedded in a context (e.g. a sentence) that generates expectations and thus helps disambiguating their meaning. In VTE such a context is not given and thus, over time, percepts get saturated and successive reorganizations occur. In GSS, a tone sequence is repeated and gradually modified over time. The pitch differences and the time pattern of the tone sequence can give rise to the perception of a Gestalt in the shape of a galloping rhythm. Changes at the level of the single notes can disrupt this Gestalt even if the time pattern is unaltered.

Consistent with our expectations, healthy controls and schizophrenia spectrum disorder patients did not show significant average differences in the measures of auditory Gestalt formation. Thus, in line with previous findings utilizing VTE (Slade, 1976; Haddock et al., 1995) or other Gestalt paradigms (see Section 1; Tschacher & Kupper, 2006; Tschacher, Dubouloz, Meier, & Junghan, 2008), no significant differences were found when schizophrenia spectrum disorder patients were pooled and compared to controls. This implies that it is essential to consider patient subgroups and the single symptom dimensions.

The study hypothesis was partially confirmed. Results in all VTE variables pointed in the theoretically expected direction, yet only the mean dwell time was related to auditory hallucinations. Dwell times may be regarded as possible operationalizations of the subjective present; our findings hence indicate that patients with hallucinations may have a shorter present (about 2 s) than other patients (8 to 10 s). These numbers have to be considered as preliminary estimates due to the small sample sizes. In addition, dwell time is merely one possible approach to quantify an aspect of the subjective present of an individual.

Interestingly, the association between auditory hallucinations and Gestalt formation was specific to VTE, the verbal task. Only the GSS was significantly associated to other symptom dimensions of schizophrenia, namely positive symptoms and cognitive disorganization. In fact, patients with higher levels of positive and cognitive symptoms appeared to be less prone to integrate the acoustic stimuli into a Gestalt. In a previous study, cognitive disorganization and positive symptoms were both related to more Gestalt transitions in multistable visual tasks (Tschacher et al., 2008). Taken together, these results point to a relationship between symptoms (positive symptoms, cognitive disorganization and auditory hallucinations) and instability of Gestalt formation over time. Moreover, this relationship seems to be specific for verbal material but does not hold for non-verbal acoustic stimuli. Further studies with bigger samples sizes are needed to corroborate these hypotheses.

3. Temporal windows of social synchrony

In a project designed to investigate the nonverbal interplay between therapist and patient in psychotherapy sessions, we developed the methodology of Motion energy analysis (MEA: Ramseyer & Tschacher, 2011), which is based on video recordings of two persons interacting, such as therapist and patient. Motion energy is defined as differences in grey-scale pixels between consecutive video-frames (Grammer et al., 1999). Detection of frame-by-frame change allows quantification of movement in pre-defined regions of interest in a video. Provided that recordings are obtained with a fixed camera position, static background, and constant lighting conditions, frame-by-frame change indicates body motion of the respective participant. After filtering of the data for video-noise and signal-distortion, MEA provides objective quantitative measures of the movement characteristics displayed by therapist and patient. Cross-correlation analyses with time-lags of up to five seconds are then applied to these time-series of movement quantification, such that a dyadic index of movement coordination is generated for each therapist-patient dyad. This measure of movement coordination is called nonverbal synchrony, which captures simultaneous as well as time-lagged associations of body movements. Based on previous observations (Ramseyer & Tschacher, 2006), cross-correlations were calculated in segments of one minute duration, taking into account that movement coordination appears to be a non-stationary process.

Using automated surrogate testing algorithms (Ramseyer & Tschacher, 2010), surrogate datasets (n = 100 out of each genuine dataset) were produced by segment-wise shuffling of the original data, thus aligning therapist’s and patient’s movement segments that never actually occurred at the same time. This procedure kept the individual temporal structure inside the segments of data intact. Pseudosynchrony in shuffled datasets was calculated identically to the synchrony of the original data as described above. For the statistical comparison of nonverbal synchrony versus pseudosynchrony, the mean value of surrogate datasets was computed (i.e. the base-level of pseudosynchrony) and compared with the value of genuine synchrony.

The complex datasets that originate from MEA can be used to assess not only the degree, but also the duration of nonverbal synchrony. This duration can be defined as the time window within which the nonverbal synchrony of two persons exceeds chance levels. Chance levels may be computed on the basis of the surrogate data that are generated by shuffling procedures. Synchrony duration may be considered a moving window of the *nonverbal present*, which is based on two people's nonverbal interaction (Figure 4).

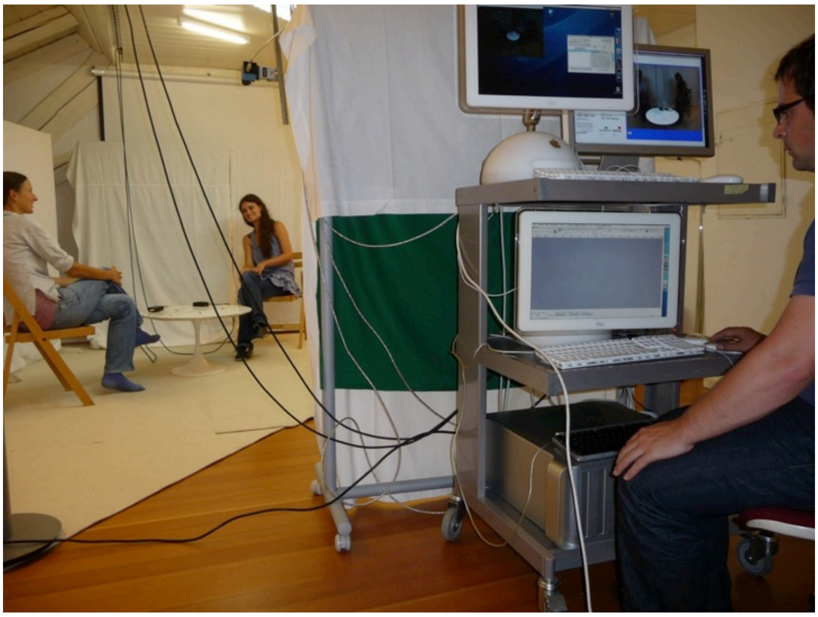

Figure 4. Laboratory setup for the measurement of nonverbal synchrony

The nonverbal interplay between therapist and patient was previously studied using recordings of a randomized sample of 104 psychotherapy sessions. Only sessions from same-sex dyads were selected. This dataset came from a sample consisting of 70 patients treated at the outpatient psychotherapy clinic of the University of Bern, Switzerland. Thirty-seven participants were women and 33 men (mean age 36.5 y, SD = 10.2). Patients belonged to the following main diagnostic groups: 34% anxiety disorders, 29% affective disorders, 37% other diagnoses (e.g. adjustment disorders and personality disorders). The analysis (Ramseyer & Tschacher, 2011) showed that i) nonverbal synchrony was significantly higher in comparison to pseudosynchrony (effect size Cohen's d ≈ 0.6), ii) nonverbal synchrony was positively associated with patient's post-session assessments of relationship quality and self-efficacy (Pearson correlations of r ≈ .30) , and iii) nonverbal synchrony predicted positive therapy outcome assessed by a battery of outcome measures administered at termination of therapy (r ≈ .30).

Based on these associations between nonverbal synchrony and measures of therapy process and outcome, we became interested in the temporal characteristics of social coordination. An exemplary analysis of this property was conducted in a different sample recruited at Stanford University, California. The goal of this exploratory analysis was to use the established MEA methodology in order to estimate the duration of the nonverbal social present.

Participants and design. The Stanford sample consisted of 102 (56 women and 46 men) students and freely recruited persons at Stanford University (mean age = 22.3 y, range: 17-54). They identified themselves as having 37.5% white, 27% asian, 16% latino, 15.5% black, 4% multi-ethnic backgrounds; 81% were native speakers of English. They participated for payment (13 $) or course credits. Dyads served as the main units of observation in this study, and participants were randomly grouped into previously unacquainted dyads. Of the 51 same-sex dyads, 28 were female and 23 male. Dyads completed three prescribed verbal tasks, each with six minutes duration, in identical order. Participants were told that the aim of the experiment was the assessment of processes occurring during conversations where previously unacquainted persons are getting acquainted. In order to not influence participants' nonverbal behavior, the assessment of nonverbal synchrony was not disclosed until the completion of the study. The tasks consisted of conversations on topics that would get them more acquainted

with each other: In the first task, participants were instructed to compile a menu with foods both of them disliked; in the second conversation, participants were encouraged to tell each other a close-call situation; and in the last task, participants were told to try to find at least ten commonalities that they shared. In order to evaluate the duration of the nonverbal social present of the 51 dyads, the segment-wise calculations of time-lagged cross-correlations were aggregated and tested against pseudosynchrony. The hypothesis of this statistical exploration was that the cross-correlation values for movement synchrony should exceed those of pseudosynchrony. With increasing distances from simultaneous (time-lag zero) cross-correlation of movement streams, this difference to pseudosynchrony should vanish, i.e. at higher time-lags movement synchrony should become indistinguishable from pseudosynchrony.
Results. Figure 5 shows the mean values of nonverbal synchrony of 51 dyads, for time-lags ranging from -5 to +5 s. The data again show that the observed synchrony was higher than pseudosynchrony. The peak nonverbal synchrony was found around a lag of 0, i.e. in proximity to simultaneous movement of the verbally interacting members of the dyads. The crossing of lines (dashed vertical segments) indicates where nonverbal synchrony becomes indistinguishable from pseudosynchrony: For the data presented here, this occurred at lags of -3 s and +2.7 s, which indicates that within a window of roughly 5.7 seconds, meaningful associations between two person's movements were found. Beyond this duration of a nonverbal 'social present', associations were at levels that would be expected by chance.

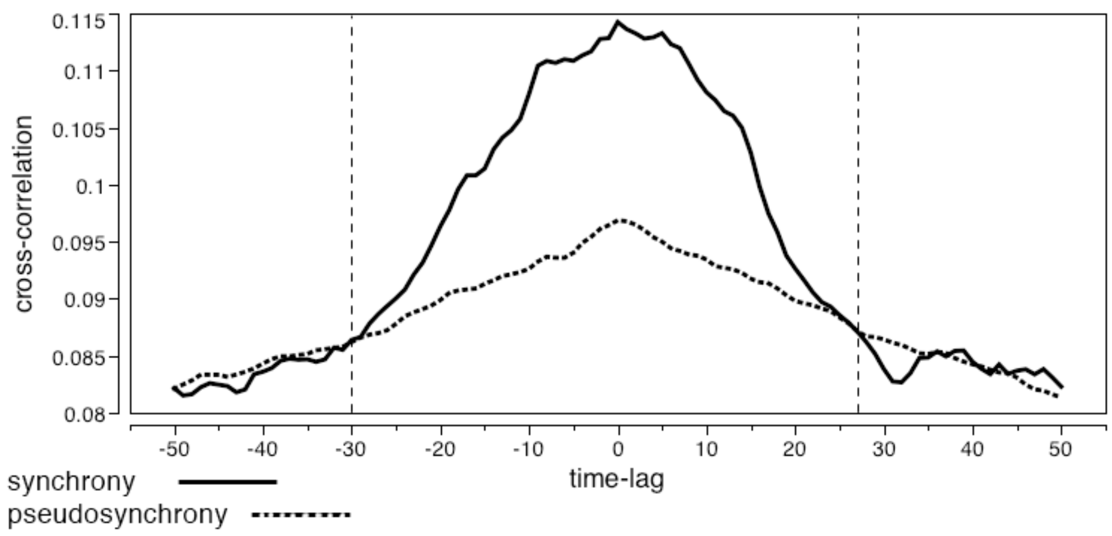

Figure 5. Temporal window of nonverbal synchrony as a measure of the social present, computed in 51 dyads interacting verbally. Dashed vertical segments, crossing of nonverbal synchrony and pseudosynchrony. The duration of nonverbal presence thus defined was roughly 5.7 s

Discussion. Studies addressing nonverbal synchrony in dyadic interactions, such as prominently given in psychotherapy sessions, allow estimating the duration of time within which significant coordination is found. We propose that this procedure yields a duration measure of the nonverbal social present, which may serve as a complement to the time-scales of subjective present that have been discussed for the individual person. We consider this approach, of which we have reported an exemplary result based on a students sample, a promising extension of the idea of temporal scales (Pöppel, 1997; Atmanspacher & Filk, 2010) from the individual to the interpersonal domain.

Conclusion and outlook

The studies reported above illuminate the role of temporality in clinical populations from different angles. We focused on individuals and dyads, on schizophrenia spectrum patients and psychotherapy outpatients with non-psychotic disorders. Experimental tasks addressed the temporal integration of stimuli of individuals and the temporal coordination of two individuals' body movement. The common denominator of these various research approaches can be seen in that they all investigated cognitive binding processes. How are single stimuli of different sensory modalities integrated in the minds of participants? How well can they be integrated by individuals suffering from mental disorders? What are the temporal bounds within which elements are integrated to form a novel entity (a Gestalt perception or, in a dyad, social synchrony)?

These are rather fundamental questions in cognitive science as well as, whenever such integrative processes include the bodies of participants, embodiment research. In all these investigations the common denominator 'binding' indicates that some sort of structural commonality is involved. In the history of psychology, the Gestalt approach has proposed such a core idea, namely that a macroscopic phenomenon, a Gestalt pattern, arises from the interaction of elements. Gestalt psychology has defined the conditions under which such pattern formation occurs; the emergence of Gestalts may even follow 'laws' (Helson, 1933; Köhler, 1947). A similar structural science, dynamical systems theory, has developed a terminology for such processes that was not confined to psychology. Yet, during recent decades dynamical systems theory has become fruitful for many psychological applications (Tschacher, 1997). In systems-theoretical terms, elements of (any) complex micro level may develop organized behavior spontaneously, which is then described by order parameters (Haken, 1977).

Our results consistently showed that and how temporality is altered in schizophrenia patients. If one accepts dwell time as an approximation to the perceived present of an individual, we find little difference between patients and healthy persons in general (mean dwell times of about 6.5 s). However, these times scales vary significantly with the psychopathological status of schizophrenia patients. Additionally, the integration of temporally distributed contextual cues into the causality perception paradigm was impaired in schizophrenia patients, whatever their psychopathological status.

The dyadic data of Section 3 pointed to an unobtrusive method by which the temporal window of the 'social present' may be assessed. Social interaction is embodied by the nonverbal coordination of interactants. We found that this coordination, nonverbal synchrony, is an important correlate of effective psychotherapeutic interventions (Ramseyer & Tschacher, 2011). We have recently begun to investigate the temporal attributes of such synchrony, finding durations of around 6 s in interacting dyads. This measure of the social present is expected to yield further insights into the temporal processes of clinical-psychological interventions.

It was our goal to operationalize and quantify the durations of the 'present'. It must be considered, however, that there is no single such entity, with a magical number attached to it: Measuring *the* subjective present is unwarranted. Any reification of subjective temporal scales would be troublesome because they are not singular physical entities but mental processes that are defined by our psychophysical measurement and statistical procedures. The validity of these operationalizations still has to be shown, not least by the usefulness in clinical applications.

Outlook – Time and mindfulness. A growing field of research in psychology addresses mindfulness, a cognitive state of non-judgmental awareness (Ludwig & Kabat-Zinn, 2008; Bergomi et al., 2013) that originates from Buddhist philosophy (Varela, Thompson & Rosch, 1991). When focusing on a subject's awareness of the 'here-and-now', mindful states are by definition closely linked with the experienced present. Mindfulness has generated much interest especially in the field of clinical psychology because it was found to act as a change mechanism that several psychotherapy techniques appear to have in common (Pfammatter & Tschacher, 2012). In the last two decades, cognitive-behavioral treatment approaches have implemented mindfulness exercises into their repertoires of techniques (e.g. dialectical behavior therapy: Linehan, 1993). Entirely new cognitive-behavioral therapies have been developed with a focus on mindfulness, so-called third-wave behavior therapies (Hayes, 2004; Teasdale et al., 2003). Examples of third-wave therapy approaches are mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT). The preventive and curative effects of mindfulness have been supported by a growing number of efficacy studies; our intuition is that this may be realized through a modulation of time scales. Yet, the causal role of timing is completely unresearched territory. Is the subjective present a causal mechanism, a mediator, or a correlational by-product of clinical change? If causally active, it is completely unclear which properties of the subjective present may be responsible for such effects: Is the mechanism quantitative and durational, such as an extension of the subjective present allowing a person to invest more time in processes of acceptance, exposure to stimuli, and subsequent coping? Or alternatively, is some altered quality of the subjective present an essential factor, such as the increase of positive affect that goes along with mindfulness?

We foresee that research on fundamental time scales will generate new information on the mechanisms by which mindfulness becomes instrumental in psychological therapy. Both aspects of the studies reported in this chapter may help to elucidate the mechanisms of action of mindfulness and related techniques: mindfulness may alter the binding processes of patients, and may also affect the way in which synchrony in therapy sessions is established. These assumptions would be valuable goals of future research on timing in the clinical context.

Acknowledgements. We thank Georg Rees and Janina von Schlippe for their contributions in these projects. This work was partly conducted with the help of grants by the Swiss Federal Department of Home Affairs (SER project number C07.0036) and the Swiss National Science Foundation (SNSF project number PBBEP1_133532).

References

Atmanspacher, H., & Filk, T. (2010). A proposed test of temporal nonlocality in bistable perception. Journal of Mathematical Psychology, 54, 314-321.

Bergomi, C., Tschacher, W., & Kupper, Z. (2013). Measuring mindfulness: First steps towards a comprehensive mindfulness scale. Mindfulness, 4, 18-32.

Bergson, H. (1922). Durée et simultanéité. A propos de la théorie d'Einstein. Paris: Alcan.

Bonnot, O., Montalembert, M. D., Kermarrec, S., Botbol, M., Walter, M., & Coulon, N. (2011). Are impairments of time perception in schizophrenia a neglected phenomenon? Journal of Physiology - Paris, 105, 164-169.

Borkenau, P., & Ostendorf, F. (1991). Ein Fragebogen zur Erfassung fünf robuster

Persönlichkeitsfaktoren. Diagnostica, 37, 29-41.
Bregman, A. S. (1990). Auditory scene analysis. Cambridge: MIT Press.
Bschor, T., Ising, M., Bauer, M., Lewitzka, U., Skerstupeit, M., Müller-Oerlinghausen, B., et al. (2004). Time experience and time judgment in major depression, mania and healthy subjects. A controlled study of 93 subjects. Acta Psychiatrica Scandinavica, 109, 222-229.
Delevoye-Turrell, Y., Wilquin, H., & Giersch, A. (2012). A ticking clock for the production of sequential actions: Where does the problem lie in schizophrenia? Schizophrenia Research, 135, 51-54.
Deutsch, D. (2003). Phantom words, and other curiosities [CD]. La Jolla, CA: Philomel Records.
Deutsch, D. (1999). Grouping mechanisms in music. The psychology of music, 28, 184-248.
Droit-Volet, S., & Meck, W. H. (2007). How emotions colour our perception of time. Trends in Cognitive Sciences, 11, 504-513.
Effron, D. A., Niedenthal, P. M., Gil, S., & Droit-Volet, S. (2006). Embodied temporal perception of emotion. Emotion, 6, 1-9.
Elliott, M. A., & Shanagher, L. (2010). Temporal event-structure coding in developmental dyslexia: Evidence from explicit and implicit temporal processing. Psihologija, 43, 373-387.
Elvevåg, B., McCormack, T., Gilbert, A., Brown, G. D., Weinberger, D. R., & Goldberg, T. E. (2003). Duration judgments in patients with schizophrenia. Psychological Medicine, 33, 1249-61.
Faul, F., Erdfelder, E., Lang, A.-G. & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191.
Fraisse, P. (1984). Perception and estimation of time. Annual Review of Psychology, 35, 1-36.
Franck, G., & Atmanspacher, H. (2009). A proposed relation between intensity of presence and duration of nowness. In: Atmanspacher H. & Primas H. (eds.) Recasting Reality (pp. 211-225). Berlin: Springer.
Franke, G. (1994). SCL-90-R. Die Symptom-Checkliste von Derogatis -deutsche Version. Weinheim: Beltz.
Friston, K. J. (2011). Embodied Inference: or "I think therefore I am, if I am what I think". In: Tschacher W & Bergomi C (eds.) The implications of embodiment: Cognition and communication (pp. 89-125). Exeter: Imprint Academic.
Fuchs, T., & Schlimme, J. E. (2009). Embodiment and psychopathology: A phenomenological perspective. Current Opinion in Psychiatry, 22, 570-5.
Giersch, A., Lalanne, L., Corves, C., Seubert, J., Shi, Z., Foucher, J., et al. (2009). Extended visual simultaneity thresholds in patients with schizophrenia. Schizophrenia Bulletin, 35, 816-825.
Grammer, K., Kruck, K. B., & Magnusson, M. S. (1998). The courtship dance: Patterns of nonverbal synchronization in opposite-sex encounters. Journal of Nonverbal Behavior, 22, 3-29.
Haddock, G., McCarron, J., Tarrier, N., Faragher, E.B., 1999. Scales to measure dimensions of hallucinations and delusions: the Psychotic Symptom Rating Scales (PSYRATS). Psychological Medicine, 29, 879-889.
Haddock, G., Slade, P. D., & Bentall, R. P. (1995). Auditory hallucinations and the verbal transformation effect: The role of suggestions. Personality and Individual Differences, 19, 301-306.

Haken, H. (1977). Synergetics — An Introduction. Nonequilibrium Phase-Transitions and Self-Organization in Physics, Chemistry and Biology. Berlin: Springer.
Hayes, S. C. (2004). Acceptance and commitment therapy, relational frame theory, and the third wave of behavior therapy. Behavior Therapy, 35, 639-665.
Helson, H. (1933). The Fundamental Propositions of Gestalt Psychology. Psychological Review, 40, 13-32.
James, W. (1890). Principles of Psychology. New York: Holt.
Kay, S. R., Fiszbein, A., & Opler, L. A. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. Schizophrenia Bulletin, 13, 261.
Köhler, W. (1947). Gestalt Psychology: An Introduction to New Concepts in Modern Psychology. New York: Liveright.
Kupper, Z., Ramseyer, F., Hoffmann, H., Kalbermatten, S., & Tschacher, W. (2010). Video-Based quantification of body movement during social interaction indicates the severity of negative symptoms in patients with schizophrenia. Schizophrenia Research, 121, 90-100.
Lee, K. H., Bhaker, R. S., Mysore, A., Parks, R. W., Birkett, P. B., & Woodruff, P. W. (2009). Time perception and its neuropsychological correlates in patients with schizophrenia and in healthy volunteers. Psychiatry Research, 166, 174-183.
Lindenmayer, J. P., Grochowski, S., & Hyman, R. B. (1995). Five factor model of schizophrenia: replication across samples. Schizophrenia Research, 14, 229-234.
Linehan, M. (1993). Cognitive-Behavioral treatment of borderline personality disorder. New York: The Guilford Press.
Ludwig, D. S., & Kabat-Zinn, J. (2008). Mindfulness in medicine. JAMA, 300, 1350-1352.
Mahlberg, R., Kienast, T., Bschor, T., & Adli, M. (2008). Evaluation of time memory in acutely depressed patients, manic patients, and healthy controls using a time reproduction task. European Psychiatry, 23, 430-3.
Pfammatter, M., & Tschacher, W. (2012). Wirkfaktoren der Psychotherapie – eine Übersicht und Standortbestimmung. Schizophrenia Bulletin, 60, 17-31.
Pitt, M. A., & Shoaf, L. (2002). Linking verbal transformations to their causes. Journal of Experimental Psychology: Human Perception and Performance, 28, 150.
Pöppel, E. (1997). A hierarchical model of temporal perception. Trends in Cognitive Science, 1, 56-61.
Pöppel, E. (2009). Pre-Semantically defined temporal windows for cognitive processing. Philosophical Transactions of the Royal Society B, 364, 1887-1896.
Ramseyer, F., & Tschacher, W. (2006). Synchrony: A core concept for a constructivist approach to psychotherapy. Constructivism in the Human Sciences, 11, 150-171.
Ramseyer, F., & Tschacher, W. (2010). Nonverbal synchrony or random coincidence? How to tell the difference. In A. Esposito, N. Campbell, C. Vogel, A. Hussain, & A. Nijholt (Eds.), Development of multimodal interfaces: Active listening and synchrony (pp. 182-96). Berlin: Springer.
Ramseyer, F., & Tschacher, W. (2011). Nonverbal synchrony in psychotherapy: Coordinated body movement reflects relationship quality and outcome. Journal of Consulting and Clinical Psychology, 79, 284-295.
Reheis, F. (2003). Entschleunigung: Abschied vom Turbokapitalismus. München: Riemann.
Reidsma, D., Nijholt, A., Tschacher, W., & Ramseyer, F. (2010). Measuring multimodal synchrony for human-computer interaction. In A. Sourin (Ed.), Proceedings CYBERWORLDS 2010. (pp. 67-71). IEEE Computer Society Press.
Sauer, S., Lemke, J., Wittmann, M., Kohls, N., Mochty, U., & ,Walach, H. (2012). How

long is now for mindfulness meditators? Personality and Individual Differences, 52, 750-754.
Schmidt, H., McFarland, J., Ahmed, M., McDonald, C., & Elliott, M. A. (2011). Low-Level temporal coding impairments in psychosis: Preliminary findings and recommendations for further studies. Journal of Abnormal Psychology, 120, 476-482.
Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. In J. Weinmann, S. Wright, & M. Johnston (Eds.), Measures in health psychology: A user’s portfolio. Causal and control beliefs (pp. 35-7). Windsor: NFER-NELSON.
Slade, P. D. (1976). An investigation of psychological factors involved in the predisposition to auditory hallucinations. Psychological Medicine, 6, 123-132.
Stroh, W. M. (1999). Musikalische Grenzerfahrungen durch Midifiles? Hörpsychologische Experimente im Musikunterricht. Praxis Musikunterricht, 36-43.
Szelag, E., von Steinbüchel, N., Reiser, M., de Langen, E. G., & Pöppel, E. (1996). Temporal constraints in processing of nonverbal rhythmic patterns. Acta Neurobiologiae Experimentalis, 56, 215-225.
Teasdale, J. D., Segal, Z. V., & Williams, J. M. G. (2003). Mindfulness training and problem formulation. Clinical Psychology: Science and Practice, 10, 157-160.
Tschacher, W. (2012). Implicit temporal processes in cognition and behavior. Presentation held at the COST action TIMELY training school "Temporal processing in clinical populations". Thessaloniki, Greece.
Tschacher, W., & Bergomi, C. (2011a). Cognitive binding in schizophrenia: Weakened integration of temporal intersensory information. Schizophrenia Bulletin, 37, S13-22.
Tschacher, W., & Bergomi, C. (Eds.) (2011b). The implications of embodiment: Cognition and communication. Exeter: Imprint Academic.
Tschacher, W., & Dauwalder, J. -P. (Eds.) (2003). The dynamical systems approach to cognition. Singapore: World Scientific.
Tschacher, W., & Kupper, Z. (2006). Perception of causality in schizophrenia spectrum disorder. Schizophrenia Bulletin, 32, S106-S112.
Tschacher, W., Dubouloz, P., Meier, R., & Junghan, U. (2008). Altered perception of apparent motion in schizophrenia spectrum disorder. Psychiatry Research, 159, 290-299.
Tschacher, W., Schuler, D., & Junghan, U. (2006). Reduced perception of the motion-induced blindness illusion in schizophrenia. Schizophrenia Research, 81, 261-267.
van Noorden, L.P.A.S. (1975). Temporal coherence in the perception of tone sequences. Eindhoven University of Technology, doctoral dissertation.
van Wassenhove, V. (2009). Minding time in an amodal representational space. Philosophical Transactions of the Royal Society B, 364, 1815-30.
Varela, F., Thompson, E., & Rosch, E. (1991). The embodied mind. Cambridge: MIT Press.
Vatakis, A., & Papadelis, G. (2011). Time in mental activity: Theoretical, behavioral, bioimaging, and clinical perspectives. In Esposito, A. M. Esposito, R. Martone, V. C. Muller, & G. Scarpetta (Eds.), Toward autonomous, adaptive, and context-aware multimodal interfaces: Theoretical and practical issues. Berlin: Springer.
Wackermann, J. (2008). Measure of time: A meeting point of psychophysics and fundamental physics. Mind & Matter, 6, 9-50.
Wackermann, J., & Ehm, W. (2006). The dual klepsydra model of internal time representation and time reproduction. Journal of Theoretical Biology, 239, 482-493.

Warren, R. M. (1968). Verbal transformation effect and auditory perceptual mechanisms. Psychological Bulletin, 70, 261.
Wittmann, M. (2009). The inner experience of time. Philosophical Transactions of the Royal Society B, 364, 1955-67.
Wittmann, M. (2011). Moments in time. Frontiers in Integrative Neuroscience, 5, 66.