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Balanced time perspective and its relationship with clinical and cognitive symptoms in schizophrenia

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ABSTRACT

The adaptive function of balanced time perspective is widely acknowledged within positive psychology, yet little is known regarding the expression of time perspective in clinical populations and its relation to clinical features. The current study aimed to examine the nature of time perspective in schizophrenia and to determine whether alterations in balanced time perspective is associated with maladaptive outcomes in terms of clinical and cognitive symptoms. A total of 104 patients with schizophrenia and 93 matched healthy controls participated in this study. Time perspective, negative symptoms, working memory and response inhibition was measured. Results showed that patients with schizophrenia manifested lower balanced time perspective with marginal significance in the context of impaired working memory but intact response inhibition. Correlation analyses revealed that deviation from balanced time perspective in schizophrenia was negatively associated with working memory capacity, as well as positively associated with negative symptoms such as affective blunting and anhedonia. Our findings point to working memory impairments as a candidate cognitive mechanism underpinning the deviation from balanced time perspective in schizophrenia. We further demonstrate a link between deviation from balanced time perspective and clinical symptomatology in schizophrenia, offering potential avenues for remediation strategies.

1. Introduction

A fundamental aspect of human conscious experience is the capacity to apprehend and construct a sense of subjective temporality (Boniwell & Zimbardo, 2004), providing the framework for most, if not all, forms of cognition. Contemporary approaches to the empirical study of subjective temporality have tended to focus on time perspective (TP) (Stolarski, Zajenkowski, Jankowski, & Szymaniak, 2020), that is, the "nonconscious process whereby the continual flows of personal and social experiences are assigned to temporal categories, or time frames, that help to give order, coherence, and meaning to those events" (p. 1271) (Zimbardo & Boyd, 1999). As a multidimensional construct, time perspective encompasses five putative components: Future, Past-Positive, Past-Negative, Present-Hedonistic and Present-Fatalistic time perspective (Zimbardo & Boyd, 1999).

A balanced time perspective has since been proposed as a core component in the realm of positive psychology (Boniwell & Zimbardo, 2004) and central to live a fulfilling life (Boniwell & Zimbardo, 2003), leading to a profusion of research on this topic. Mounting studies demonstrate the adaptive value of a balanced time perspective (Stolarski et al., 2020), such as persistent benefits to well-being (Chen et al., 2020), mental health (Chen et al., 2020), romantic relationships (Stolarski, Wojtkowska, & Kwiecinska, 2016).

The underlying cognitive abilities supporting a balanced time perspective have also received increasing attention (Rönnlund & Carelli, 2018; Witowska & Zajenkowski, 2019; Zajenkowski, Stolarski, Witowska, Maciantowicz, & Łowicki, 2016). Flexible adoption of appropriate time perspectives depending on context is inherently more efficient than

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a habitual reliance on a specific, or fixed, time perspective (Zimbardo & Boyd, 1999). This proposal suggests that processes such as working memory and inhibition of a prepotent response may contribute to balanced time perspective. For example, working memory may facilitate the online maintenance of mental representations of series of events and boost event encoding within a specific time framework. Inhibition, the ability to suppress automatic responses when necessary (Friedman & Miyake, 2017), may enable individuals to override predominant and habitual time perspectives depending on changing contingencies. Accumulating empirical evidence reveals a positive association between balanced time perspective and working memory as well as inhibitory control in healthy adults (Witowska & Zajenkowski, 2019; Zajenkowski, Stolarski, Witowska, et al., 2016). As such, individuals with poorer inhibition may experience difficulties in switching from different perspectives, for example ruminating over past losses rather than adopting a future-positive time perspective across various situations.

Despite clear associations between balanced time perspective and adaptive outcomes in healthy populations, the relationship between alterations in time perspective and functional outcomes in clinical populations remains poorly understood. Schizophrenia is a population of immense interest in this regard, characterised by chronic, severe mental disturbances, accompanied by psychotic symptoms and cognitive impairments (American Psychiatric Association, 2013), such as working memory and inhibition (Türközer et al., 2019; Westerhausen, Kompus, & Hugdahl, 2011). On the neural level, deactivation of regions in the brain's default mode network (DMN) has been observed predominantly in the precuneus and medial frontal gyrus in schizophrenia (Broyd et al., 2009; Garrity et al., 2007). These brain regions have been suggested to play a key role in the maintenance of a balanced time perspective in healthy individuals (Chen et al., 2022; Chen et al., 2022; Guo, Chen, & Feng, 2017). This finding offers a tentative clue that schizophrenia patients may experience difficulty in keeping a balanced time perspective. To date, only one study to date has explored balanced time perspective in schizophrenia relative to healthy controls (Styla, Stolarski, & Szymanowska, 2019), revealing an unbalanced time perspective in a relatively small sample of patients ($N = 45$).

A second issue to consider is the potential underlying cognitive mechanisms driving an imbalanced time perspective in schizophrenia. Increasing attention is being directed towards explicating the cognitive correlates of balanced time perspective in healthy populations (Rönnlund & Carelli, 2018; Zajenkowski, Stolarski, Maciantowicz, Malesza, & Witowska, 2016; Zajenkowski, Stolarski, Witowska, et al., 2016). Key candidate mechanisms in this regard include working memory and inhibition, all of which are impaired in schizophrenia (Türközer et al., 2019; Westerhausen et al., 2011). Together with the preliminary finding that schizophrenia patients also exhibited lower balanced time perspective (Styla et al., 2019), we predict a positive association between balanced time perspective and cognitive ability in schizophrenia.

Finally, the potential relationship between an imbalanced time perspective and psychiatric symptoms (e.g., negative symptoms) in schizophrenia remains unexplored. Negative symptoms, such as blunted affect and anhedonia (e.g., impaired capacity to experience pleasure) are core features of schizophrenia (American Psychiatric Association, 2013; Kirkpatrick, Fenton, Carpenter, & Marder, 2006). Patients with more severe negative symptoms typically have poorer quality of life and social functioning (Lysaker & Davis, 2004; Norman et al., 2000). Despite a paucity of data on this topic, the extant evidence suggests a link between an imbalanced time perspective and negative symptoms in schizophrenia. Negative symptoms are associated with poor performance in working memory and inhibition (Eack, Mesholam-Gately, Greenwald, Hogarty, & Keshavan, 2013; Türközer et al., 2019), cognitive capacities that have been implicated in a balanced time perspective. Given the consensus on the adaptive benefit of a balanced time perspective in healthy individuals, we speculate that a greater imbalance in time perspective may correlate with more severe negative symptoms in schizophrenia.

The available evidence to date converges to suggest an important, yet overlooked, relationship between imbalanced time perspective, cognitive impairment, and negative symptoms in schizophrenia. The objective of this study, therefore, was to characterise the nature of time perspective alterations in a large sample of schizophrenia patients ($n = 104$) and to determine the relationship between an imbalanced time perspective, cognitive function, and negative symptoms. In doing so, we aimed to shed light on the potential underlying cognitive mechanisms and clinical impact of an imbalanced time perspective in schizophrenia, paving the way for refined treatment options for affected individuals.

2. Methods

2.1. Participants

One hundred and four schizophrenia patients were recruited from psychiatric hospitals and local communities in Beijing to participate in this study. Inclusion criteria included: fulfil DSM-IV diagnosis (American Psychiatric Association, 1994) of schizophrenia, aged between 18 and 60 years, estimated IQ $\geq$ 70, and clinically stable. Exclusion criteria included: a history of drug or alcohol abuse/dependence, a history of neurological disorders, received electroconvulsive therapy in the previous three months. All patients were taking atypical antipsychotic medications and did not receive systematic psychotherapy.

Ninety-three healthy controls were recruited from communities in Beijing. Inclusion criteria included: no history of neurological/psychiatric disorders, no drug or alcohol abuse/dependence, no family history of psychiatric disorders. Controls were demographically matched to the schizophrenia group for age, sex ratio, and education.

The study was approved by the Ethics Committee of the Institute of Psychology, Chinese Academy of Sciences. Written informed consent was provided by all participants.

2.2. Measures

2.2.1. Balanced time perspective

The 20-item Chinese brief version of the Zimbardo Time Perspective Inventory (ZTPI), demonstrating good psychometric properties in the Chinese setting, was used to assess time perspective (Wang, Chen, Cui, & Liu, 2015; Zimbardo & Boyd, 1999). The Chinese version of ZTPI includes five dimensions: Past-Positive, Past-Negative, Present-Hedonistic, Present-Fatalistic and Future, with each time perspective comprising four items. Participants rated each item on a 5-point scale (1 = very untrue of me, 5 = very true of me).

Deviation from the Balanced Time Perspective (DBTP) (Stolarski, Bitner, & Zimbardo, 2011) is a continuous indicator of the extent to which an individual's time perspective profile deviates from the optimal time perspective profile. DBTP, calculated from the ZPTI, has previously been confirmed as the optimal indicator of balanced time perspective (Zhang, Howell, & Stolarski, 2013), and thus was adopted in the current study. It was calculated as $DBTP = \sqrt{(oPN - ePN)^2 + (oPP - ePP)^2 + (oPF - ePF)^2 + (oPH - ePH)^2 + (oF - eF)^2}$, in which oPN (1.95), oPP (4.60), oPF (1.50), oPH (3.90), oF (4.00) represents optimal score of Past-Negative, Past-Positive, Present-Fatalistic, Present-Hedonistic, and Future time perspective, respectively. ePN, ePP, ePF, ePH, eF were reported by participants (Stolarski, Wiberg, & Osin, 2015). Lower DBTP values indicate a higher level of balanced time perspective. DBTP has been applied in Chinese setting (Chen, Liu, Cui, Chen, & Wang, 2016). However, this approach to determine the optimal score for each time perspective was suggested to be arbitrary in the calculation of DBTP, Jankowski, Zajenkowski, and Stolarski (2020) recommended the revised DBTP (DBTP-r) based on empirical validation across samples, in which oPN = 1, oPP = 5, oPF =

1, oPH = 3.4, oF = 5. In the current study, we presented the results based on DBTP-r in the main text, and results based on DBTP were also calculated and are provided in the Supplementary Material.

2.2.2. Working memory

The Chinese version of the Letter–Number Span Test (CLN) was adopted to assess working memory (Chan et al., 2008). During the CLN test, participants were initially asked to carefully listen to a sequence of Chinese characters (Celestial Trunks, like the alphabet system in western society) combined with random digits (1 to 9) verbalized by the experimenter at a stable rate. After that, participants were required to rearrange the order of the sequence according to a specific rule. Namely, the digits should be verbally reported from small to big, followed by the Chinese characters in sequence. For instance, the correct order of "5 Ding Jia 1" should be given as "1 5 Jia Ding". The length of the sequences increased from 2 to 9 and each length of sequence included four items. The task ended when all four same-length trials were incorrectly repeated by the participant, or all items were completed. The longest span was calculated as the index of working memory ability.

2.2.3. Inhibition

The Sustained Attention to Response Task (SART) (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), a variant of a go/no-go task, was used to measure response inhibition (Carter, Russell, & Helton, 2013; Helton, 2009). In this study, the SART, programmed with *E*-Prime 2.0, consisted of 225 single digits ranging from 1 to 9 with 5 distinct font sizes. Digits were presented at the centre of the screen for 250 ms followed by a 900 ms mask in each trial. Participants were required to press the left button of the mouse as quickly as possible when the digit appeared (go stimulus: digits 1–2, 4–9), but to withhold responses to the digit '3' (no-go stimulus). After the practice session, consisting of 18 go stimulus and 2 no-go stimuli, participants started to perform the 4.3 min formal test. Commission errors (i.e., responses to no-go stimuli) were taken as the index of inhibition.

2.2.4. Negative symptoms

The Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1983) was used to assess negative symptoms. The scale includes five sub-scales: affective blunting, alogia, avolition apathy, anhedonia, and attentional impairment. It consisted of 24 items, with higher scores reflecting greater severity of negative symptoms. Trained psychiatrists rated patients on a 5-point scale (0 = no symptoms, 4 = extremely serious) for each item.

2.2.5. Other measures

IQ was estimated using a shortened form of the Chinese version of the Wechsler Adult Intelligence Scale-Revised (WAIS-R), which assesses Information, Arithmetic, Similarity, and Digit Span (Gong, Jiang, Deng, Dai, & Zhou, 1989).

Medication side effects were assessed by trained psychiatrists using the Abnormal Involuntary Movement Scale (AIMS; Smith, Kucharski, Oswald, & Waterman, 1979) and the Barnes Akathisia Rating Scale (BARS; Barnes, 1989).

2.3. Procedure

Participants were introduced to the purpose of the study following which, they provided written informed consent. After the IQ assessment, participants completed the experimental tasks, followed by the questionnaires and clinical assessments.

2.4. Data analysis

Independent *t*-tests and Chi-square tests were conducted to examine potential group differences in demographic information. A series of analysis of covariance (ANCOVA) were performed to compare group difference in balanced time perspective, working memory and inhibition while controlling for estimated IQ. Pearson correlation analyses and additional partial correlation controlling for estimated IQ were adopted to explore potential associations between balanced time perspective, cognitive functions, and negative symptoms.

3. Results

3.1. Demographic information and clinical characteristics

As presented in Table 1, the two groups were matched in terms of age, years in education, and sex distribution (all *p*s > 0.05). However, patients with schizophrenia demonstrated lower estimated IQ than healthy controls ($p = 0.005$), thus to rule out the confounding effect of IQ from our overall findings, analysis controlling for IQ were performed.

3.2. Comparison of balanced time perspective, working memory and inhibition

As presented in Table 2, schizophrenia patients displayed greater deviation from balanced time perspective in terms of DBTP-r than healthy controls ($F(1,194) = 3.00$, $p = 0.085$, $\eta_p^2 = 0.015$) with marginal significance. On the cognitive battery, schizophrenia patients showed variable impairments relative to controls. First, on the CLN working memory task, schizophrenia patients generated significantly shorter spans relative to controls ($F(1,194) = 4.57$, $p = 0.034$, $\eta_p^2 = 0.023$). Interestingly, no significant differences were observed in terms of sustained attention performance, with schizophrenia patients scoring in line with controls in terms of total number of commission errors on the SART ($F(1,194) = 0.11$, $p = 0.734$, $\eta_p^2 = 0.001$). The group difference on the previous version of DBTP was significant and the results can be found in the Supplementary Material.

3.3. Association between balanced time perspective and cognitive function, negative symptoms in schizophrenia

As presented in Fig. 1, Pearson correlation analysis revealed that DBTP-r significantly negatively correlated with longest span of the CLN ($r = -0.28$, $p = 0.005$). In contrast, no significant correlation was found between DBTP-r and commission errors on the SART ($r = -0.03$, $p = 0.737$). Similarly, after controlling for estimated IQ, the significantly negative relationship between DBTP-r and CLN longest span ($r = -0.32$,

Table 1
Demographic information and clinical characteristics.

	Schizophrenia ($N = 104$)	Healthy control ($N = 93$)		
	Mean (SD)	Mean (SD)	t/x^2	p
Male: female	50:54	46:47	0.04	0.846
Age (years)	40.48 (9.89)	39.41 (11.33)	0.71	0.479
Education (years)	12.58 (2.88)	12.73 (2.45)	−0.40	0.687
IQ	104.51 (16.11)	110.90 (15.20)	−2.86	0.005
Illness duration (years)	14.63 (9.67)	–		
SANS_affective [24]	6.67 (4.39)			
SANS_alogia [20]	3.91 (3.73)			
SANS_avolition [20]	5.52 (3.62)			
SANS_anhedonia [20]	5.73 (3.72)			
SANS_attention [12]	1.00 (1.73)			
SANS_total [96]	22.84 (14.32)	–		
AIMS [42]	0.74 (1.49)	–		
BARS [14]	0.85 (1.58)	–		
Medication[a]	302.27 (255.78)	–		

SANS = Scale for the Assessment of Negative Symptoms, where higher scores denote greater symptom severity; AIMS = Abnormal Involuntary Movement Scale; BARS = Barnes Akathisia Rating Scale. Maximum test scores are provided in square brackets, where appropriate.

[a] Chlorpromazine equivalence mg/day.

Table 2
Comparison of balanced time perspective, working memory and inhibition between the two groups (controlled for IQ).

	Schizophrenia ($N = 104$)	Healthy control ($N = 93$)			
	Mean (SD)	Mean (SD)	F	p	η_p^2
DBTP-r	3.96 (0.86)	3.74 (0.83)	3.00	0.085	0.015
CLN_lg	5.07 (1.02)	5.67 (1.46)	4.57	0.034	0.023
SART_ce	0.55 (0.21)	0.56 (0.24)	0.11	0.734	0.001

DBTP-r = Deviation from the Balanced Time Perspective revised; CLN_corr = total number of correct span; CLN_lg = the longest span; SART_ce = Sustained Attention to Response Task Commission error.

$p = 0.001$) remained, and we also find no significant correlation between DBTP-r and commission errors on the SART ($r = -0.04$, $p = 0.702$).

Turning our attention to clinical symptoms, DBTP-r was found significantly positively associated with the SANS total score ($r = 0.24$, $p = 0.016$), affective blunting subscale score of SANS ($r = 0.24$, $p = 0.015$) and anhedonia subscale score of SANS ($r = 0.23$, $p = 0.017$) suggesting that the greater the deviation from balanced time perspective, the greater severity of negative symptoms (particularly affective blunting and anhedonia). When we controlled for estimated IQ, the results remained stable, with significant correlations between DBTP-r and SANS total score ($r = 0.23$, $p = 0.017$), affective blunting subscale ($r = 0.24$, $p = 0.016$) and anhedonia subscale ($r = 0.23$, $p = 0.017$).

Moreover, the results in the above Pearson correlation analysis survived FDR-correction ($q < 0.05$) for multiple comparisons.

Further information about the Pearson correlations between DBTP-r, cognitive functions and negative symptoms are shown in Fig. 2.

4. Discussion

This study aimed to explore whether schizophrenia patients demonstrate alterations in balanced time perspective, and possible associations of such changes with canonical negative symptoms of this syndrome. We further sought to illustrate the association between cognitive abilities that are known to be impaired in schizophrenia and balanced time perspective, to establish candidate mechanisms of balanced time perspective disruption.

Overall, our preliminary results showed that schizophrenia patients manifested a less balanced time perspective relative to controls with marginal significance based on DBTP-r and with significance based on DBTP. The findings are generally in line with the previous study demonstrating alterations in balanced time perspective in schizophrenia based on the previous version of DBTP (Styla et al., 2019), which suggested that negative life experiences (e.g., childhood adversity) might disrupt the capacity to maintain a balanced time perspective in schizophrenia. We replicated Styla et al.'s (2019) findings with DBTP, and also examined group difference with the new validated DBTP-r scores. However, future studies recruiting larger samples are needed to further examine whether schizophrenia patients would show less balanced time perspective based on DBTP-r.

One of the key aims of this study was to explore potential cognitive mechanisms of imbalanced time perspective in schizophrenia. To that end, we employed validated measures of working memory and response inhibition, two cognitive processes that are consistently affected in schizophrenia (Türközer et al., 2019; Westerhausen et al., 2011). Consistent with previous findings, we found working memory difficulties in schizophrenia (Türközer et al., 2019; Wang et al., 2008), which in turn were found to significantly correlate with deviations from

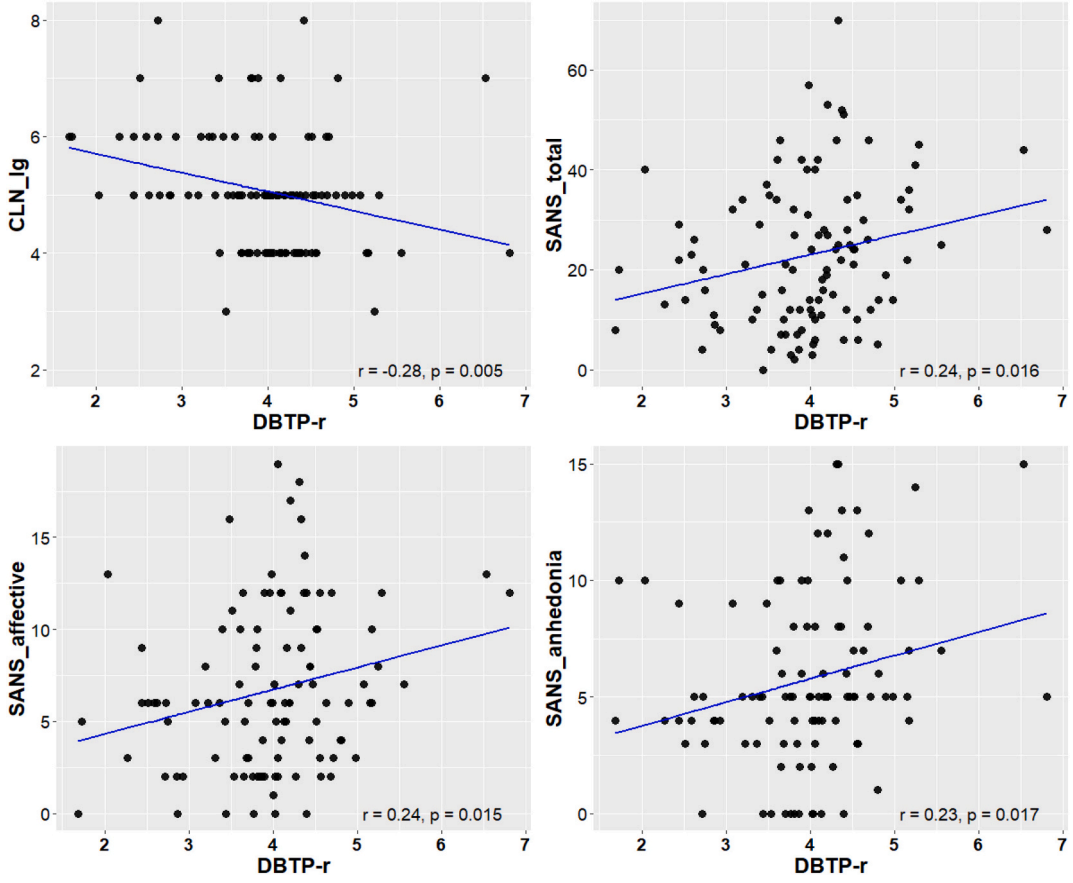

Fig. 1. Pearson correlations between balanced time perspective and working memory, and negative symptoms in schizophrenia patients ($N = 104$). DBTP-r = Deviation from the Balanced Time Perspective revised; CLN_lg = the longest span; SANS = Scale for the Assessment of Negative Symptoms.

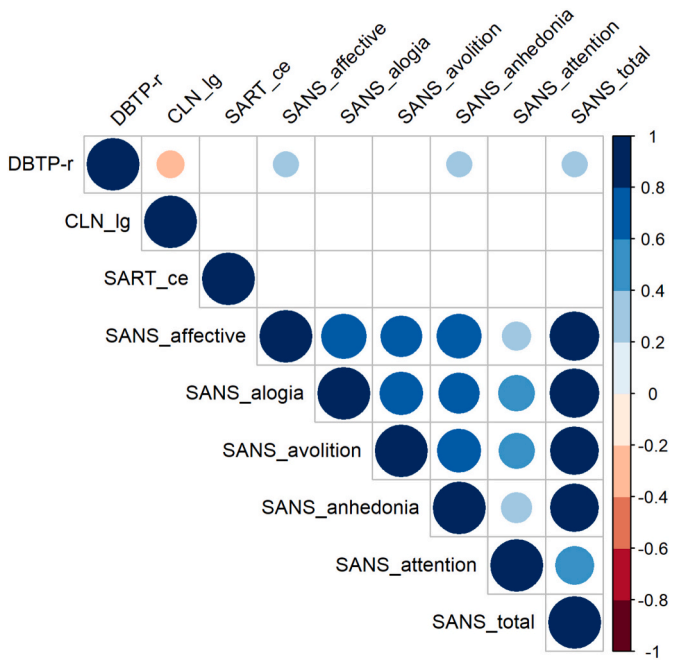

Fig. 2. Pearson correlations between balanced time perspective, cognitive functions, and negative symptoms in schizophrenia patients ($N = 104$). DBTP-r = Deviation from the Balanced Time Perspective revised; CLN_lg = the longest span; SART_ce = Sustained Attention to Response Task commission errors; SANS = Scale for the Assessment of Negative Symptoms. More saturated and larger circles represent stronger associations between two variables. Blue colour represents positive correlation while red colour represents negative correlation. The blank squares indicate no significant correlation ($p < 0.05$). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

balanced time perspective. While we cannot speak to the direction of this relationship, we suggest that working memory represents a candidate mechanism of interest for future studies to explore. This finding builds on that of previous studies revealing a meaningfully significant positive correlation between balanced time perspective and working memory in healthy adults (Rönnlund, Del Missier, Mäntylä, & Carelli, 2019; Witowska & Zajenkowski, 2019), and extends this association to the clinical syndrome of schizophrenia. In contrast, we failed to find significant differences in response inhibition between our schizophrenia cohort and healthy controls as evidenced by comparable levels of commission errors on the SART. Task difficulty may have played a confounding role in this case, as both groups were observed to display high levels of commission errors (~50 % of no-go trials) obscuring potential performance difficulties in schizophrenia. Notably, one study adopting the SART in schizophrenia underscored the importance of task difficulty on inhibition performance by demonstrating that schizophrenia patients showed more commission errors only in the fixed (e.g., the number stimuli were displayed serially in a fixed numerical order) but not the random (e.g., the number stimuli were presented in a random numerical order) SART condition (O'Gráda et al., 2009). Interestingly, previous studies using a go/no-go task (Zajenkowski, Stolarski, Witowska, et al., 2016) and the Stroop task (Witowska, Zajenkowski, & Wittmann, 2020) as indices of response inhibition, have failed to show significant correlations between inhibition and balanced time perspective in healthy adults. However, an anti-saccade task, used to measure inhibition, was positively related to balanced time perspective (Zajenkowski, Stolarski, Witowska, et al., 2016), again suggesting the importance of task differences when assessing these complex processes.

The third aim of this study was to explore the possible relationship between altered time perspective in schizophrenia and maladaptive outcomes. This line of enquiry was motivated by mounting evidence that a balanced time perspective is associated with numerous positive outcomes in healthy populations, such as well-being (Chen et al., 2020). Here, we demonstrate for the first time that deviation from a balanced time perspective is associated with negative symptoms in schizophrenia, whereby the greater the deviation from a balanced time perspective, the more severe the negative symptoms. Notably, deviation from a balanced time perspective was associated with blunted affect and anhedonia, resonating with a previous study in which schizophrenia patients were shown to experience impaired anticipatory pleasure (Frost & Strauss, 2016). This is the first linking of alterations in balanced time perspective to clinical symptomatology in schizophrenia, although we caution that the direction of these relationships is unclear. In view of the pervasive detrimental effects of negative symptoms (Norman et al., 2000), and the dearth of effective antipsychotic treatments (Aleman et al., 2017), we propose that it is beneficial and pressing to adopt non-pharmacological interventions for negative symptoms. Such strategies might include coaching practice (Boniwell & Osin, 2015) and time perspective based therapy (Sword, Sword, Brunskill, & Zimbardo, 2014) to boost the ability to manage the temporal focus of schizophrenia, with the ultimate aim of alleviating negative symptoms.

A number of limitations should be noted here. Firstly, as mentioned above, the cross-sectional design prevents us from drawing any causal conclusions, and we note that future studies incorporating longitudinal data will prove important in this regard. In addition, from a theoretical perspective, the capacity to seamlessly switch between different time perspectives likely relies upon cognitive flexibility processes, not unlike the process of 'flexible temporal switching' (Boniwell & Zimbardo, 2004). Therefore, future studies are needed to ascertain the relationship between cognitive flexibility and balanced time perspective in schizophrenia, given characteristic impairments in cognitive flexibility in this disorder (Eşsizoğlu, Kösger, Akarsu, Özaydin, & Güleç, 2017).

Notwithstanding these limitations, we have provided important data on balanced time perspective in patients with schizophrenia. The deviation from balanced time perspective was further linked with negative symptoms, and impaired working memory capacity. As such, our findings point to candidate cognitive mechanisms potentially modulating deviation from balanced time perspective in schizophrenia and open the door to potential remediation strategies to improve quality of life in these patients.

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CRediT authorship contribution statement

Tao Chen: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Writing – original draft, Visualization. **Xiao-jing Qin:** Methodology. **Ji-fang Cui:** Writing – review & editing. **Ming-yuan Gan:** Resources, Investigation. **Shu-ping Tan:** Resources, Investigation. **Ya Wang:** Conceptualization, Investigation, Resources, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Muireann Irish:** Conceptualization, Methodology, Visualization, Investigation, Writing – review & editing, Supervision.

Declaration of competing interest

All authors declare no conflicts of interest.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2022.112003.

References

Aleman, A., Lincoln, T. M., Bruggeman, R., Melle, I., Arends, J., Arango, C., & Knegtering, H. (2017). Treatment of negative symptoms: Where do we stand, and where do we go? *Schizophrenia Research, 186*, 55–62. https://doi.org/10.1016/j.schres.2016.05.015

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5™* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Andreasen, N. C. (1983). *The scale for the assessment of negative symptoms (SANS)*. Iowa City, Iowa: University of Iowa.

Barnes, T. R. (1989). A rating scale for drug-induced akathisia. *The British Journal of Psychiatry, 154*(5), 672–676. https://doi.org/10.1192/bjp.154.5.672

Boniwell, I., & Osin, E. (2015). Time perspective coaching. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory; review, research and application: Essays in honor of Philip G. Zimbardo* (pp. 451–469). Cham: Springer International Publishing.

Boniwell, I., & Zimbardo, P. G. (2003). Time to find the right balance. *Psychologist, 16*(3), 129–131.

Boniwell, I., & Zimbardo, P. G. (2004). Balancing time perspective in pursuit of optimal functioning. In *Positive psychology in practice* (pp. 165–178). John Wiley & Sons Inc.

Broyd, S. J., Demanuele, C., Debener, S., Helps, S. K., James, C. J., & Sonuga-Barke, E. J. S. (2009). Default-mode brain dysfunction in mental disorders: A systematic review. *Neuroscience & Biobehavioral Reviews, 33*(3), 279–296. https://doi.org/10.1016/j.neubiorev.2008.09.002

Carter, L., Russell, P. N., & Helton, W. S. (2013). Target predictability, sustained attention, and response inhibition. *Brain and Cognition, 82*(1), 35–42. https://doi.org/10.1016/j.bandc.2013.02.002

Chan, R. C., Wang, Y., Deng, Y., Zhang, Y., Yiao, X., & Zhang, C. (2008). The development of a Chinese equivalence version of letter-number span test. *The Clinical Neuropsychologist, 22*(1), 112–121. https://doi.org/10.1080/13825580601025957

Chen, T., Huang, J., Cui, J.-F., Li, Z., Wang, Y., Irish, M., & Chan, R. C. K. (2022). In *, 12 (9). Functional coupling between the fronto-parietal network and default mode network is associated with balanced time perspective* (p. 1201).

Chen, T., Li, Z., Cui, J.-F., Huang, J., Irish, M., Wang, Y., & Chan, R. C. K. (2022). The neural substrates of sex differences in balanced time perspective: A unique role for the precuneus. *Brain Imaging and Behavior*. https://doi.org/10.1007/s11682-022-00694-x

Chen, T., Liu, L.-L., Cui, J.-F., Chen, X.-J., & Wang, Y. (2016). Developmental trajectory of time perspective: From children to older adults. *PsyCh Journal, 5*(4), 245–255. https://doi.org/10.1002/pchj.140

Chen, T., Liu, L.-L., Cui, J.-F., Qin, X.-J., Shi, H.-S., Irish, M., & Wang, Y. (2020). Balanced time perspective and life satisfaction: The mediating role of "Temporal Negative Affect". *Journal of Happiness Studies*. https://doi.org/10.1007/s10902-020-00330-9

Eack, S. M., Mesholam-Gately, R. I., Greenwald, D. P., Hogarty, S. S., & Keshavan, M. S. (2013). Negative symptom improvement during cognitive rehabilitation: Results from a 2-year trial of Cognitive Enhancement Therapy. *Psychiatry Research, 209*(1), 21–26. https://doi.org/10.1016/j.psychres.2013.03.020

Eşsizoğlu, A., Köşger, F., Akarsu, F., Özaydin, Ö., & Güleç, G. (2017). Theory of mind and selective attention, response inhibition, cognitive flexibility in patients with schizophrenia. *Noro Psikiyatri Arsivi, 54*(2), 162–167. https://doi.org/10.5152/npa.2016.12750

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex, 86*, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023

Frost, K. H., & Strauss, G. P. (2016). A review of anticipatory pleasure in schizophrenia. *Current Behavioral Neuroscience Reports, 3*(3), 232–247. https://doi.org/10.1007/s40473-016-0082-5

Garrity, A. G., Pearlson, G. D., McKiernan, K., Lloyd, D., Kiehl, K. A., & Calhoun, V. D. (2007). Aberrant "default mode" functional connectivity in schizophrenia. *The American Journal of Psychiatry, 164*(3), 450–457. https://doi.org/10.1176/ajp.2007.164.3.450

Gong, Y.-X., Jiang, D.-W., Deng, J.-L., Dai, Z.-S., & Zhou, Q.-Z. (1989). *Manual of Wechsler memory scale-Chinese version*. Changsha: Hunan Medical College Press.

Guo, Y., Chen, Z., & Feng, T. (2017). Neural substrates underlying balanced time perspective: A combined voxel-based morphometry and resting-state functional connectivity study. *Behavioural Brain Research, 332*(Supplement C), 237–242. https://doi.org/10.1016/j.bbr.2017.06.005

Helton, W. S. (2009). Impulsive responding and the sustained attention to response task. *Journal of Clinical and Experimental Neuropsychology, 31*(1), 39–47. https://doi.org/10.1080/13803390801978856

Jankowski, K. S., Zajenkowski, M., & Stolarski, M. J. P. B. (2020). In *, 60(1). What are the optimal levels of time perspectives? Deviation from the balanced time perspective-revisited (DBTP-r)* (p. 164).

Kirkpatrick, B., Fenton, W. S., Carpenter, W. T., Jr., & Marder, S. R. (2006). The NIMH-MATRICS consensus statement on negative symptoms. *Schizophrenia Bulletin, 32*(2), 214–219. https://doi.org/10.1093/schbul/sbj053

Lysaker, P. H., & Davis, L. W. (2004). Social function in schizophrenia and schizoaffective disorder: Associations with personality, symptoms and neurocognition. *Health and Quality of Life Outcomes, 2*. https://doi.org/10.1186/1477-7525-2-15, 15-15.

Norman, R. M., Malla, A. K., McLean, T., Voruganti, L. P., Cortese, L., McIntosh, E., & Rickwood, A. (2000). The relationship of symptoms and level of functioning in schizophrenia to general wellbeing and the quality of life scale. *Acta Psychiatrica Scandinavica, 102*(4), 303–309. https://doi.org/10.1034/j.1600-0447.2000.102004303.x

O'Gráda, C., Barry, S., McGlade, N., Behan, C., Haq, F., Hayden, J., & Donohoe, G. (2009). Does the ability to sustain attention underlie symptom severity in schizophrenia? *Schizophrenia Research, 107*(2), 319–323. https://doi.org/10.1016/j.schres.2008.07.013

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). 'Oops!': Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologia, 35*(6), 747–758. https://doi.org/10.1016/s0028-3932(97)00015-8

Rönnlund, M., & Carelli, M. G. (2018). Deviations from a balanced time perspective in late adulthood: Associations with current g and g in youth. *Intelligence, 71*, 8–16.

Rönnlund, M., Del Missier, F., Mäntylä, T., & Carelli, M. G. (2019). The fatalistic decision maker: Time perspective, working memory, and older adults' decision-making competence. *Frontiers in Psychology, 10*(2038). https://doi.org/10.3389/fpsyg.2019.02038

Smith, J. M., Kucharski, L. T., Oswald, W. T., & Waterman, L. J. (1979). A systematic investigation of tardive dyskinesia in inpatients. *The American Journal of Psychiatry, 136*(7), 918–922. https://doi.org/10.1176/ajp.136.7.918

Stolarski, M., Bitner, J., & Zimbardo, P. G. (2011). Time perspective, emotional intelligence and discounting of delayed awards. *Time & Society, 20*(3), 346–363. https://doi.org/10.1177/0961463x11414296

Stolarski, M., Wiberg, B., & Osin, E. (2015). Assessing temporal harmony: The issue of a balanced time perspective. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory; review, research and application: Essays in honor of Philip G. Zimbardo* (pp. 57–71). Cham: Springer International Publishing.

Stolarski, M., Wojtkowska, K., & Kwiecinska, M. (2016). Time for love: Partners' time perspectives predict relationship satisfaction in romantic heterosexual couples. *Time & Society, 25*(3), 552–574.

Stolarski, M., Zajenkowski, M., Jankowski, K. S., & Szymaniak, K. (2020). Deviation from the balanced time perspective: A systematic review of empirical relationships with psychological variables. *Personality and Individual Differences, 156*, Article 109772. https://doi.org/10.1016/j.paid.2019.109772

Styla, R., Stolarski, M., & Szymanowska, A. (2019). Linking childhood adversities with schizophrenia: A mediating role of the balanced time perspective. *Schizophrenia Research, 209*, 281–283.

Sword, R. M., Sword, R. K. M., Brunskill, S. R., & Zimbardo, P. G. (2014). Time perspective therapy: A new time-based metaphor therapy for PTSD. *Journal of Loss and Trauma, 19*(3), 197–201. https://doi.org/10.1080/15325024.2013.763632

Türközer, H. B., Hasoğlu, T., Chen, Y., Norris, L. A., Brown, M., Delaney-Busch, N., & Öngür, D. (2019). Integrated assessment of visual perception abnormalities in psychotic disorders and relationship with clinical characteristics. *Psychological Medicine, 49*(10), 1740–1748. https://doi.org/10.1017/s0033291718002477

Wang, Y., Chan, R. C. K., Hong, X., Ma, Z., Yang, T., Guo, L., & Shum, D. (2008). Prospective memory in schizophrenia: Further clarification of nature of impairment. *Schizophrenia Research, 105*(1), 114–124. https://doi.org/10.1016/j.schres.2008.07.002

Wang, Y., Chen, X.-J., Cui, J.-F., & Liu, L.-L. (2015). Testing the Zimbardo time perspective inventory in the Chinese context. *PsyCh Journal, 4*(3), 166–175. https://doi.org/10.1002/pchj.103

Westerhausen, R., Kompus, K., & Hugdahl, K. (2011). Impaired cognitive inhibition in schizophrenia: A meta-analysis of the Stroop interference effect. *Schizophrenia Research, 133*(1–3), 172–181. https://doi.org/10.1016/j.schres.2011.08.025

Witowska, J., & Zajenkowski, M. (2019). Cognitive consequences of timeframe bias. On the link between working memory, cognitive switching, and time perspective. *Current Psychology*, 1–14.

Witowska, J., Zajenkowski, M., & Wittmann, M. (2020). Integration of balanced time perspective and time perception: The role of executive control and neuroticism. *Personality and Individual Differences, 163*, 1–5.

Zajenkowski, M., Stolarski, M., Maciantowicz, O., Malesza, M., & Witowska, J. (2016). Time to be smart: Uncovering a complex interplay between intelligence and time perspectives. *Intelligence, 58*, 1–9.

Zajenkowski, M., Stolarski, M., Witowska, J., Maciantowicz, O., & Łowicki, P. (2016). Fluid intelligence as a mediator of the relationship between executive control and balanced time perspective. *Frontiers in Psychology, 7*(1844). https://doi.org/10.3389/fpsyg.2016.01844

Zhang, J. W., Howell, R. T., & Stolarski, M. (2013). Comparing three methods to measure a balanced time perspective: The relationship between a balanced time perspective and subjective well-being. *Journal of Happiness Studies, 14*(1), 169–184. https://doi.org/10.1007/s10902-012-9322-x

Zimbardo, P. G., & Boyd, J. N. (1999). Putting time in perspective: A valid, reliable individual-differences metric. *Journal of Personality and Social Psychology, 77*(6), 1271–1288. https://doi.org/10.1037/0022-3514.77.6.1271