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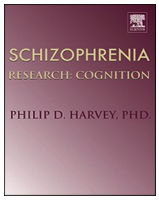

Short Communication

Range adaptation in schizophrenia: A one-year longitudinal study

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ABSTRACT

Range adaptation refers to the representation of a stimulus value based on its relative position in the range of pre-experienced values. Altered range adaptation in value representation may be related to motivation and pleasure (MAP) deficit in schizophrenia (SCZ). This follow-up study examined the relationship between range adaptation performance and MAP symptoms in SCZ patients. We recruited 26 schizophrenia patients and followed them for 1 year. They completed an experimental task for estimating their range adaptation to outcome value (OV) and expected value (EV) at baseline and after 1 year. At baseline, we found a marginally significant and negative correlation between OV adaptation and avolition symptoms in SCZ patients. Moreover, the 1-year change of EV adaptation was significantly and negatively correlated with the change of self-report pleasure experience. Our results suggest that range adaptation may track the variations of MAP symptoms in SCZ.

1. Introduction

Schizophrenia (SCZ) patients exhibit motivation and pleasure (MAP) deficit (Strauss et al., 2019), but its underlying pathophysiology remains unclear. Motivation and pleasure experience relies heavily on the representation of the expected value (EV) and outcome value (OV) of a stimulus (Pool et al., 2016). In human, both EV and OV representations involve range adaptation, which is the process of representing a given value of stimulus, based on its relative position in the range of pre-experienced values, and this process is important for enhancing value discriminability (Rangel and Clithero, 2012) (.

Previous studies reported impaired OV adaptation in SCZ patients at the behavioral and the neural levels (Kaliuzhna et al., 2023; Kirschner et al., 2016, 2018; Wang et al., 2021). However, little research has been conducted to examine EV adaptation in SCZ patients. EV and OV representations are separable processes (Berridge and Kringelbach, 2008), i.e., EV reflects the anticipated value of an action, while OV reflects the experienced value of the outcome (Rangel and Clithero, 2012). Previous studies reported that SCZ patients had more impaired EV representation than OV representation (Barch et al., 2015). It is plausible that different EV and OV adaptation may result in different EV and OV representation in SCZ patients.

Evidence suggested that OV adaptation was negatively correlated with MAP symptoms in both SCZ patients and individuals with schizotypy (Kirschner et al., 2016; Wang et al., 2021). However, prior research on the relationship between range adaptation and MAP symptoms was scarce and cross-sectional. Longitudinal research is needed to examine whether the relationship between range adaptation and MAP symptoms in SCZ patients would change with time.

This study aimed to examine the relationship of range adaptation with MAP symptoms at baseline and after 1 year. Moreover, we aimed to examine the relationship between change of range adaptation and change of MAP symptoms. We hypothesized that baseline range adaptation would be significantly correlated with baseline and 1-year MAP

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symptoms. Moreover, we hypothesized that the change of range adaptation would be correlated with the change of MAP symptoms.

2. Methods

2.1. Participants

At baseline, 26 outpatients with SCZ were recruited at the Shanghai Changning Mental Health Center. The exclusion criteria included a history of head injury, history of illicit substance use and history of alcohol harmful use in the past 12 months. We re-assessed 20 SCZ participants after around 1 year.

2.2. Measures

We administered the Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1989), the Positive and Negative Syndrome Scale (Kay et al., 1987) and the Temporal Experience of Pleasure Scale (TEPS) (Chan et al., 2012; Gard et al., 2006) to SCZ participants at baseline. They also completed the Effort-Expenditure for Reward Task-adaptive version (Wang et al., 2023). This task comprised two phases. During the decision-making phase, SCZ participants chose between low-effort and high-effort tasks. For low-effort tasks, the reward magnitude of was fixed to ¥5(approximately 0.69 USD). For the high-effort tasks, the reward magnitude was randomly" selected within the reward range (¥5.4–¥6.4 (approximately 0.74–0.88 USD) or 5.4–¥9.4 (approximately 0.74–1.29 USD)). After executing the selected task, participants rated their consummatory pleasure after receiving the outcome during the consummatory rating phase.

The baseline and 1-year measurements were identical, except that we did not administered the SANS and the PANSS at follow-up. All participants provided written informed consent. This study was approved by the Ethics Committees of the Shanghai Changning Mental Health Centre (M202155).

2.3. Data analysis

Following our previous method (Wang et al., 2021), we quantified the EV adaption and the OV adaptation by taking the difference between the response slopes of the two ranges for high-effort task during the decision-making phase and the consummatory rating phase respectively. Pearson's correlation analyses were conducted to examine the relationship of EV and OV range adaptation with the MAP symptoms (as measured by the SANS, the PANSS, and the TEPS). In addition, we conducted regression analysis, with EV and OV adaptions and the baseline MAP symptoms as predictors, and the 1-year MAP symptoms as the dependent variable. Lastly, we calculated the 1-year change of range adaptation and MAP symptoms, and then examined the relationship between these variables using Pearson's correlations.

3. Results

3.1. Demographic information

Our sample comprised 26 SCZ patients (14 male) with a mean age of 43.27 years (SD = 9.04). SCZ participants had normal range of IQ (mean = 97.42. SD = 18.67) and education level (mean = 11.42 years, SD = 3.06), but relatively long duration of illness (mean = 19.19 years, SD = 8.25, Table 1).

Table 1
Demographic information of patients with schizophrenia.

	SCZ patients (n = 26)
Age (year)	43.27 (9.04)
Gender (male:female)	14:12
IQ estimates	97.42 (18.67)
Length of education (year)	11.42 (3.06)
Duration of illness (year)	19.19 (8.25)
BL_SANS_affectiveflattening	1.57 (2.56)
BL_SANS_alogia	1.52 (2.09)
BL_SANS_avolition	3.22 (1.76)
BL_SANS_anhedonia	2.26 (2.28)
BL_SANS_total	9.39 (8.25)
BL_SANS_attention	0.83 (1.59)
BL_PANSS_Positive	8.83 (3.21)
BL_PANSS_negative	8.17 (1.97)
BL_PANSS_general	20.37 (3.09)
BL_TEPS_total	83.42 (20.88)

Note. SANS = Scale for the Assessment of Negative Symptoms; PANSS = Positive and Negative Syndrome Scale; MAP = Motivation and Pleasure Experience; EXP = Expressivity; SCZ = Schizophrenia; TEPS = Temporal Experience of Pleasure Scale; BL = Baseline.

3.2. Cross-sectional relationship between range adaptation and MAP symptoms at baseline

We found a trend of correlation between OV adaptation and SANS anhedonia symptoms ($r_{22} = -0.37$, $p = .09$) (Fig. 1a), and between EV adaptation and SANS avolition symptoms ($r_{22} = 0.31$, $p = .17$) (Fig. 1b).

3.3. Longitudinal relationship between baseline range adaptation and MAP symptoms

Baseline EV adaptation predicted the endpoint TEPS scores, after controlling for the effects of baseline TEPS scores (beta = 0.163, t = 2.08, $p = .05$). Moreover, the change of EV adaptation was negatively correlated with the change of TEPS scores ($r_{17} = -0.51$., $p = .04$, see Fig. 1c).

4. Discussion

This study examined the relationship between range adaptation and MAP symptoms, both cross-sectionally and longitudinally. Consistent with our hypothesis, we found that baseline EV adaptation and OV adaptation were correlated with MAP symptoms, though the results were only marginal significant or not significant. After controlling for the baseline TEPS scores, the baseline EV adaptation significantly predicted the end-point TEPS scores.

Our findings indicated that range adaptation in SCZ patients was associated with anhedonia and amotivation symptoms. Notably, given the small sample size, more large-scale studies are required. However, the current findings did consist with previous results that OV adaptation was correlated with the MAP symptoms in both clinical SCZ patients and subclinical individuals (Kirschner et al., 2016, 2018; Wang et al., 2021, 2023). Our study further investigated the EV adaptation in SCZ patients and supported the notion that both EV adaptation and OV adaptation were linked to MAP symptoms. Although the results did not reach statistical significance because of our small sample size, EV adaptation seemed to be positively correlated with MAP symptoms, whilst OV adaptation seemed to be negatively correlated with MAP symptoms. The finding of opposite direction of correlations suggested that OV and EV adaptation may have different role in MAP symptoms formation or maintenance. Indeed, over-adaptation to OV could improve the discriminability of medium low values (Kobayashi et al., 2010), thus allowing SCZ patients to appreciate more the small rewardsand to compensate for the deprived environment that they often encounter (Mallett et al., 2002). On the other hand, excessive EV adaptation may lead to less accurate representation of higher values (Kirschner et al., 2016), resulting in SCZ patients' under-motivation to pursue higher rewards.

This study was one of the first few longitudinal study to example the relationship between range adaptation and MAP symptoms (Kirschner et al., 2016; Wang et al., 2021, 2023). The results indicated that baseline EV adaptation could predict 1-year end-point TEPS scores. However,

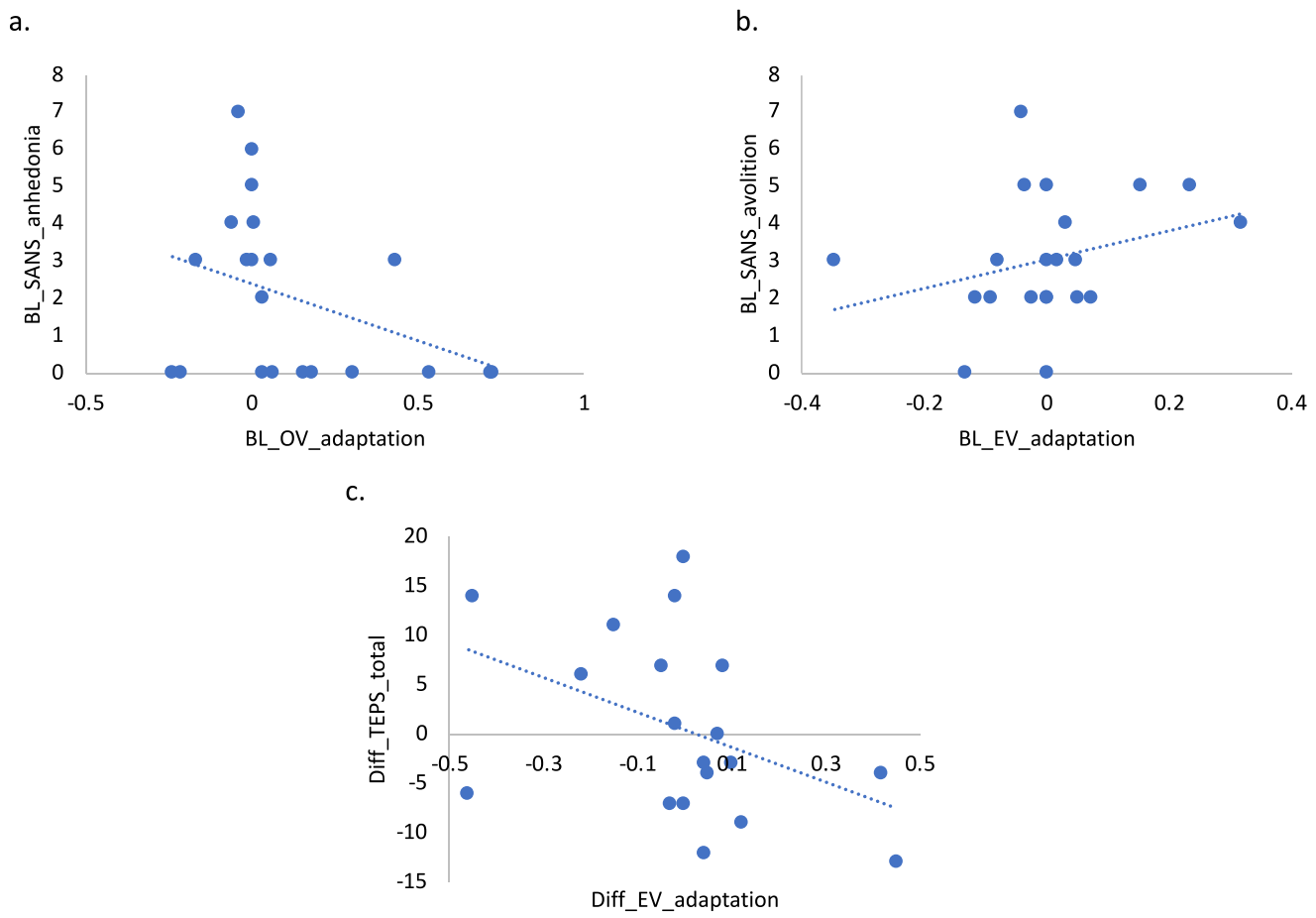

Fig. 1. Relationship between range adaptation with MAP symptoms in SCZ patients
Note. SANS = Scale for the Assessment of Negative Symptoms; SCZ = Schizophrenia; TEPS = Temporal Experience of Pleasure Scale; BL = Baseline; EV = Expected value; OV = Outcome value.

given our mall sample size, no conclusion regarding the causal effect of range adaptation and MAP symptoms can be made.

Several limitations should be mentioned. First, our sample size was small, and a considerable proportion of baseline participants were not re-assessed. Second, we only used the SANS and the PANSS at baseline, and the TEPS at end-point to measure MAP symptoms. There are other valuable tools that can be utilized to measure MAP symptoms, including the Clinical Assessment Interview for Negative Symptoms of Schizophrenia (CAINS) (Kring et al., 2013) and the Brief Negative Symptom Scale (BNSS) (Kirkpatrick et al., 2011). Given that we did not administer the PANSS at end-point, we could not examine whether range adaptation variation may be associated with positive symptoms. Moreover, the medication dosage information were not collected from these patients.

Notwithstanding these limitations, our findings suggest that range adaptation is involved in anhedonia and amotivation symptoms in SCZ patients. Intervening range adaptation may be a viable strategy to minimize anhedonia and amotivation symptoms.

CRediT authorship contribution statement

Ling-ling Wang: Data curation, Methodology, Project administration, Writing – original draft, Formal analysis. **Jing-bo Gong:** Project administration, Supervision. **Yi-hang Huang:** Data curation, Project administration, Writing – review & editing. **Shu-hong Shi:** Data curation, Writing – review & editing. **Chao Yan:** Supervision, Writing – review & editing. **Hui-xin Hu:** Data curation, Writing – review & editing. **Yi Wang:** Writing – review & editing. **Simon S.Y. Lui:** Writing – review & editing. **Kang Ju:** Funding acquisition, Writing – review & editing. **Raymond C.K. Chan:** Conceptualization, Funding acquisition, Methodology, Writing – review & editing.

Declaration of competing interest

None to be declared.

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