Schizophrenia Research

Letter to the Editor

Peripersonal space boundary in schizotypy and schizophrenia

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1. Introduction

Self-disturbances are core features of the phenomenology of schizophrenia, since the prodromal period (Nelson et al., 2012). They are associated with abnormal bodily-self experiences, such as blurred body boundaries. We hypothesized that speci fi cde fi cits of the representation of the space immediately surrounding the body, i.e. the peripersonal space (PPS), affect schizophrenic patients (SCZ). Moreover, according to the idea of a psychosis continuum (Nelson et al., 2013), we thought that early signs of PPS disruption could be find already in individuals at higher risk for psychosis, such as those with high schizotypal traits.

PPS is a multisensory interface that mediates every interaction between the body and the environment (Graziano and Cooke, 2006). Within PPS, auditory, visual and tactile information is more efficiently integrated. Despite the importance of PPS for bodily-self experiences and, thus, for self-disorders, no attempt has been done so far to localize PPS boundary in schizophrenia spectrum conditions.

To fill this gap, we used a well-consolidated PPS task with dynamic approaching sounds (Canzoneri et al., 2012). Participants responded as fast as possible to a tactile stimulus administered on their hand, while task-irrelevant sounds were presented, giving the impression of a sound source either approaching toward their bodies (looming) or being static. Tactile stimuli either preceded the sounds (T0) or were given at five different temporal delays from sound onset, corresponding to five possible distances from the participants (from T1, very far, to T5, very close). It has been shown that close (i.e., within PPS), but not far, sounds boost tactile reaction times (RTs). Hence, looming sounds allowed measuring the boundary of the participant's PPS, as the distance where sounds affected tactile RTs. This distance corresponds to the inflection point (Central Point, CP) of the sigmoid curve that best fits the data (see Supplementary Methods). We compared PPS extension in SCZ and healthy controls (HC; Study 1), as well as in high- and low-schizotypy participants (Study 2). All participants provided written informed consent, and the study protocol was approved by the local ethics committee.

2. Study 1

Twenty SCZ and twenty HC, matched for age and gender, were recruited (see Supplementary Table 1). Data from two SCZ and two HC participants were discarded for bad fitting ($r2 < 0.60$; see Supplementary Table 2). Patients were rated for symptom severity using the positive and negative symptom scale (PANSS). HC completed the Schizotypal Personality Questionnaire, SPQ (Raine, 1991). Their average SPQ score was 11.2 ± 9.4.

An independent sample t-test comparing the CP of SCZ and HC revealed that patients show significantly narrower PPS boundary (1654 ms) relative to controls (1329 ms) ($t(34) = 2.57$, $p = 0.015$, Cohen's $d = 0.86$; Fig. 1a, b). This result seems at odd with previous evidence that patients need relatively larger personal distance (e.g. Park et al., 2009). However, more recent investigation showed that larger personal distance in schizophrenia is specifically induced by social, compared to non-social stimuli (Holt et al., 2015). Another independent sample t-test revealed that the slopes of patients' curves are steeper (– 0.23) than those of controls' (– 0.09) ($t(34) = 2.35$, $p = 0.025$, Cohen's $d = 0.81$; Fig. 1c), suggesting a faster transition between one's own space and the external world in patients. Neither CP nor slope values in SCZ correlated with individual chlorpromazine equivalents.

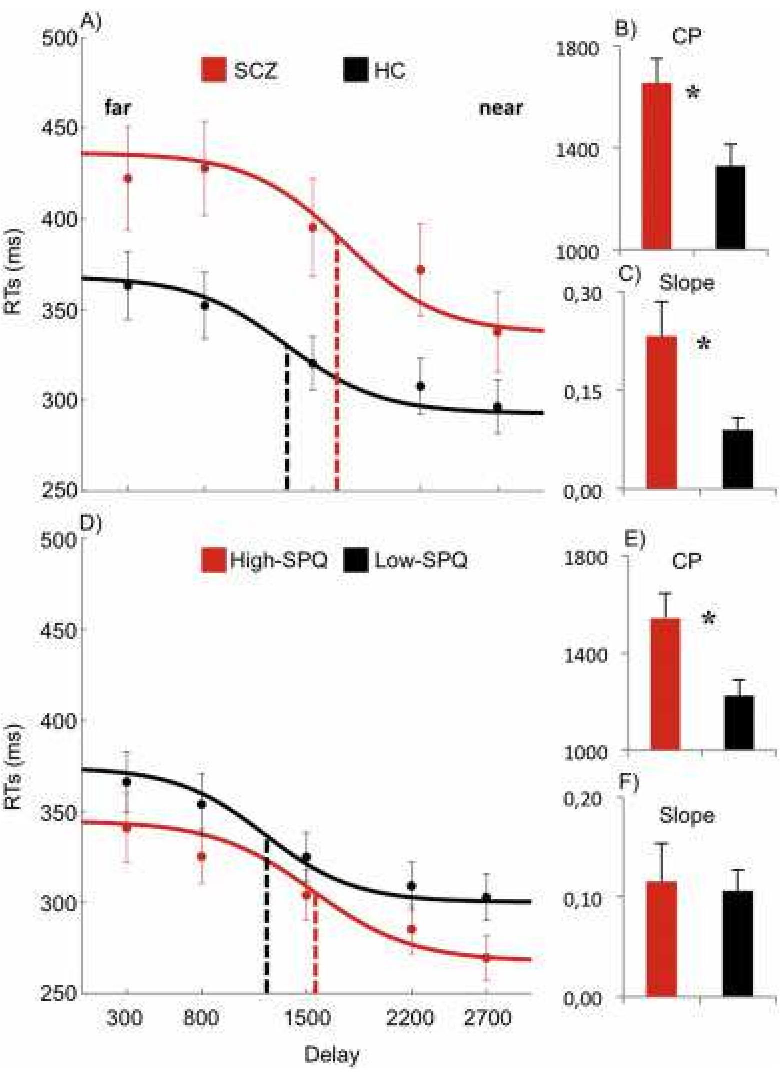

Fig. 1. PPS representation: comparisons of a–c) schizophrenic patients (SCZ) with healthy controls (HC), and d–f) high-schizotypy individuals (High-SPQ) with low-schizotypy individuals (Low-SPQ).

Tactile RTs plotted as a function of tactile stimulus delays from looming-sound onset a) for SCZ (red dots and curve) and HC (black dots and curve) groups, and d) for High-SPQ (red dots and curve) and Low-SPQ (black dots and curve) groups. The curves represent the sigmoid fit determining (b & e) the central point (CP) - i.e. the location of the PPS boundary that corresponds to the critical distance at which sound affected the participant's tactile RTs – and (c & f) the slope – i.e. the steepness of the curve that describes the transition between one's own space and the external world. Between-group differences in the effects of approaching sounds on tactile RTs have been tested also using ANOVA (see Supplementary Results). Separate ANOVAs tested the effects of approaching, compared to static, sounds on tactile RTs, in each group (see Supplementary Results). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Finally, according to prior studies (e.g. Holt et al., 2015; Park et al., 2009), we found evidence of PPS extension (CP) being linked to negative symptoms ($r = -0.48$, two-tailed p-value = 0.04, 95% CI [– 0.78–0.02]) and to the ratio between positive and negative symptoms ($r = -0.49$, two-tailed p-value = 0.04, 95% CI [– 0.76–0.08]), but not to positive symptoms ($p = 0.67$).

3. Study 2

We screened 172 healthy volunteers for schizotypal traits (range 0–57) using the SPQ. Twenty individuals falling within the first tertile (low-schizotypy, average score 6.6 ± 4.4) and twenty-four in the third tertile (high-schizotypy, average score 36.1 ± 6.4) volunteered to perform the PPS task. Two low-schizotypy and six high-schizotypy participants were excluded for bad fitting (see Supplementary Table 2).

In agreement with the idea of a psychosis continuum, the independent sample t-test comparing the CP of low- and high-schizotypy groups revealed that high-schizotypy individuals, similarly to patients, show a significantly narrower PPS boundary (1542 ms) relative to low-schizotypy participants (1224 ms) ($t(34) = 2.59$, $p = 0.014$, Cohen's $d = 0.86$; Fig. 1d, e) There was no significant between-group difference in the slopes (Fig. 1f).

This is the first study to localize the boundary of PPS, across the continuum from low-schizotypy to schizophrenia. Our work, however, has some limitations. First, our sample of schizophrenic patients was small. Second, possible between-group differences in looming sound processing (Bach et al., 2011), leading to different perception of distances, may affect multisensory contributions to PPS representation. Third, we did not measure the boundary of PPS in all directions. Despite these limitations, this was a proof-of-concept study, and future investigations should: 1) use sound localization tasks to confirm the multisensory nature of PPS abnormalities in schizophrenia spectrum; 2) test the efficacy of multisensory training (e.g. (Serino et al., 2015)) aimed at extending PPS boundary in schizotypy and schizophrenia, by possibly reducing neural response variability in far space (Ferri et al., 2015).

Contributors

GDC collected the data; MC & FF designed the study, wrote the protocol and managed the analyses; FF wrote the first draft of the manuscript; AS, GM, GDI, MDG recruited and performed the clinical assessment of patients. All authors contributed to and have approved the final manuscript.

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No funders had a role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Conflict of interest

All the authors have no conflict of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2017.12.003.

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