**SUPPLEMENTARY MATERIALS**

**1. SUPPLEMENTARY METHODS**

**1.1 Participants**

**Study 1.**

Exclusion criteria for all the participants comprised significant medical or neurological illness and substance abuse or dependence in the previous six months; while for the HC group, a personal history of Axis I/II disorders or a history of psychosis in first-degree relatives. Patients were evaluated by the structured clinical interview for DSM-IV Axis I disorders (SCID-I) ([First, Spitzer, Gibbon, & Williams, 1996](#_ENREF_6)) and rated for symptom severity using the scale for assessment of positive symptom (SAPS) ([Andreasen, 1984a](#_ENREF_1)), and the scale for assessment of negative symptom (SANS) ([Andreasen, 1984b](#_ENREF_2)). Chlorpromazine equivalents were calculated ([Woods, 2003](#_ENREF_8)) for antipsychotics.

**Table 1. Demographic information about schizophrenia group (SCZ) and healthy control group (HC).**

|  |  |  |
| --- | --- | --- |
|  | **SCZ****(N=18)** | **HC****(N=18)** |
| **Age (mean ± SD)** | 34.7 ± 8.2 | 35.0 ± 9.1 |
| **Female sex (N)** | 6 | 6 |
| **Handedness** Right, number (%) | 18 (100%) | 18 (100%) |
| **Illness duration (mean ± SD)** | 8.2± 4.7 | n.a. |
| **SAPS (mean ± SD)**Hallucinations Delusions Bizarre Behavior Formal thought disorders  | 2.9 ± 4.79.6 ± 11.20.5 ± 15.3 ± 5.2 | n.a.n.a.n.a.n.a. |
| **SANS (mean ± SD)**Affective flattening AlogiaAvolition - Apathy Anhedonia- AsocialityAttention | 8.1 ± 6.93.3 ± 2.72.5 ± 2.19.2 ± 6.42.7 ± 3.5 | n.a.n.a.n.a.n.a.n.a. |
| **Chlorpromazine Equivalent (mg/die)**Atypical Antipsychotic, N (%) Clozapine Risperidone Quetiapine  Aripiprazole Amisulpride Paliperidone | 448.2 ± 244.518 (100%)6 (33.3%) 3 (16.7%)1 (6.7%)7 (46.7%)1 (6.7%)2 (13.3%) | n.a.n.a. |

**Study 2.**

We screened a total of 172 prospective participants. The average SPQ score in our sample was 19.7±12.2, score range 0-57 (see the frequency distribution of the SPQ scores in Figure 1).



**Figure 1 – Frequency distribution of SPQ scores.**

The distribution of scores was, then, divided into tertiles, with the first tertile representing the participants rated as low schizotypes (score range 0-12), and the third tertile representing the participants rated as high schizotypes (score range 23-57). Twenty participants in the first tertile and twenty-four participants in the third tertile took part in the behavioral study. Data from 2 participants in the in the first tertile and data from 6 participants in the third tertile, whose PPS measures did not conform to a sigmoid function (r2 < .60) were discarded. Therefore, a total of eighteen participants in the low- schizotypal group (average SPQ score 6.6 ± 4.4) and eighteen in the high-schizotypal group (average SPQ score 36.1 ± 6.4) were included in the analyses.

**1.2 Stimuli, Apparatus and Procedure**

The location of participants’ PPS boundary was measured using a well-established procedure ([Canzoneri, Magosso, & Serino, 2012](#_ENREF_3); [Ferri, Costantini, et al., 2015](#_ENREF_4); [Ferri, Tajadura-Jimenez, Valjamae, Vastano, & Costantini, 2015](#_ENREF_5); [Teneggi, Canzoneri, di Pellegrino, & Serino, 2013](#_ENREF_7)). Auditory stimuli were samples of pink noise (or 1/f noise) of 3000 ms duration with flat or increasing (looming) intensity levels. The sounds were sampled at 44.1 kHz. Sound intensity was manipulated using Soundforge 4.5 software (Sonic Foundry) so that “looming sounds” had exponentially rising acoustic intensity from 55 to 70 dB, whereas “flat sounds” had constant 62.5 dB acoustic intensity. Auditory stimuli were presented by two loudspeakers (see below).

Tactile stimuli were delivered by means of constant-current electrical stimulators (DS7A; Digitimer) via pairs of neurological electrodes placed on the hairy surface of the index fingers. The electrical stimulus was a single, constant voltage, rectangular monophasic pulse. At the beginning of each session, the intensity of the tactile stimulus was set to be clearly above thresholds individually for each participant ([Canzoneri et al., 2012](#_ENREF_3)). Intensity for the tested participants ranged between 60 and 90 mA. Stimulus duration was equal to 100 μs. The presentation of auditory and tactile stimuli, as well as the recording of participants’ responses, was controlled by custom software implemented in MATLAB (The MathWorks).

During the experiment, participants were blindfolded and comfortably seated beside a table with their right arm resting palm down. The audiotactile apparatus, which was mounted on the table, consisted of two loudspeakers, one placed near to the participants’ right hand and the other at a distance of 100 cm from the near loudspeaker (ie, far from the participant) and a constant-current electrical stimulator controlling a pair of neurological electrodes attached on the participant’s right index finger. During each trial, either a looming or a flat sound was presented. Along with the auditory stimulation, in the 60% of trials, participants were also presented with a tactile stimulus. The remaining trials (40% of total) were catch trials with auditory stimulation only (either looming or flat sounds). The tactile stimulus was delivered at varying temporal delays from the onset of the auditory stimulus. Five different temporal delays were used: -700 ms (T0); 300 ms (T1); 800 ms (T2); 1500 ms (T3); 2200 ms (T4); and 2700 ms (T5). Each trial was followed by an intertrial interval of 1000 ms. Each participant was presented with a random combination of 18 target stimuli for each temporal delay for the looming and flat sounds randomly intermingled with the catch trials. Trials were equally divided into three blocks 120 trials each. Participants were asked to respond as fast as possible to the tactile target, when present, by pressing a button on a response box (Cedrus RB-834) with their left index finger, trying to ignore the auditory stimulus.

**1.2 Data Analysis**

**1.2.1 Central Point Analysis**

To estimate the individual boundary of PPS representation, mean RTs to the tactile targets delivered at the different temporal delays (T1–T5) from the onset of looming sounds were fitted to a sigmoidal function ([Canzoneri et al., 2012](#_ENREF_3); [Ferri, Costantini, et al., 2015](#_ENREF_4); [Ferri, Tajadura-Jimenez, et al., 2015](#_ENREF_5); [Teneggi et al., 2013](#_ENREF_7)) as follows:



Where x represents the independent variable (timing of touch delivery in milliseconds); y the dependent variable (RT); ymin and ymax the lower and upper saturation levels of the sigmoid, respectively; xc the value of the abscissa at the central point (CP) of the sigmoid (value of x at which y = ( ymin + ymax)/2); and b establishes the slope of the sigmoid at the CP. For each participant, values of the parameters ymin and ymax were assigned a priori equal to the minimum and maximum values of individual dataset.

The individual goodness-of-fit values (r^2) of the participants included in the studies are reported below (*Supplementary Table 2*). For each participant, we then took xc, hereafter referred to as the CP of the curve, as an estimation of the individual boundary of PPS representation ([Canzoneri et al., 2012](#_ENREF_3); [Ferri, Costantini, et al., 2015](#_ENREF_4); [Ferri, Tajadura-Jimenez, et al., 2015](#_ENREF_5); [Teneggi et al., 2013](#_ENREF_7)). We performed independent samples t tests to compare CP values between the different groups of participants.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Low SPQ | High SPQ | HC | SCZ |
| 1 | 0,82 | 0,98 | 0,99 | 0,61 |
| 2 | 0,94 | 0,94 | 0,97 | 0,94 |
| 3 | 0,97 | 0,98 | 1,00 | 0,92 |
| 4 | 0,81 | 0,96 | 0,96 | 1,0 |
| 5 | 0,79 | 0,94 | 0,96 | 0,92 |
| 6 | 0,70 | 0,88 | 0,79 | 0,65 |
| 7 | 0,99 | 0,97 | 0,81 | 0,95 |
| 8 | 0,86 | 0,74 | 0,70 | 0,67 |
| 9 | 0,90 | 0,65 | 0,85 | 0,95 |
| 10 | 0,96 | 0,88 | 0,84 | 0,92 |
| 11 | 0,90 | 0,90 | 0,77 | 1,0 |
| 12 | 0,66 | 0,96 | 0,90 | 0,69 |
| 13 | 0,87 | 0,98 | 0,66 | 0,74 |
| 14 | 0,91 | 0,96 | 0,91 | 0,97 |
| 15 | 0,98 | 0,97 | 0,98 | 0,98 |
| 16 | 0,91 | 0,83 | 0,94 | 0,89 |
| 17 | 0,90 | 0,87 | 0,99 | 0,93 |
| 18 | 0,93 | 0,92 | 0,90 | 1,0 |
| **average** | **0,88** | **0,90** | **0,88** | **0,87** |

***Supplementary Table 2*: individual goodness-of-fit values (r^2).**

**1.2.2 ANOVAs**

We performed ANOVAs on mean reaction times (RT)s to tactile targets to (i) verify the specificity of the effects of approaching, compared to static stimuli on tactile RTs (ii) check the effect of approaching stimuli on tactile RTs at different perceived distances of the dynamic sound, and (iii) measure the multisensory gain (ie, speeded RTs) in the audio-tactile conditions, compared to the unisensory tactile. To investigate all these aspects in each group, we ran 4 separate ANOVAs. For each group (SCZ, HC, High-Schizotypy, Low-Schizotypy), data were entered in an ANOVA with two within-subject factors, sound (looming, flat) and temporal delay (T0, T1, T2, T3, T4, T5). Significant effects found in the ANOVA (αlevel = 0.05) were followed by post-hoc analyses.

**2. SUPPLEMENTARY RESULTS**

**2.1 Study 1: ANOVAs**

*Schizophrenic Patients.*

A total of 86.3±9.7% (±SE) trials from each participant were included in data analyses. Rate of omissions were 4.3% and 3.8% for flat and looming trials, respectively. Responses longer than 2 SDs from the individual mean were treated as outliers and not considered further (1.3% for flat and 1.0% for looming trials). ANOVA results showed significance of the critical two-way interaction (F5,85=5.998, p<.001, η2=.261). This entailed specific modulation of RTs due to the perceived position of approaching compared with flat sounds (*Supplementary Figure 2a*). (i) RTs (±SE) were slower for looming compared to flat sounds at T1 (423±28 ms vs 385±26 ms, respectively), while faster at T5 (352±24 ms vs 388±23, respectively; all ps<.005). (ii) Looming stimuli induced significant modulation of tactile RTs from T4 to T5 (380±25 vs 352±24, p<.05), ie, very close to patients’ body. (iii) RTs at T0 were significantly slower compared to T4-T5 for looming sounds (all ps<.001), while slower than all the other conditions (T1-T5) for flat sounds (all ps<.01). Neither individual chlorpromazine equivalents nor the number of psychotic episodes correlated with RTs to tactile targets at any experimental condition.

*Healthy Controls.*

A total of 94.3±0.05 % (±SE) trials from each participant were included in data analyses. Rate of omissions were 2.8% and 2.2% for flat and looming trials, respectively. Responses longer than 2 SDs from the individual mean were treated as outliers and not considered further (5.1% for flat and 4.8% for looming trials). ANOVA results showed significance of the critical two-way interaction (F5,85=7.584, p<.001, η2=.308), due to specific modulation of RTs as a function of the perceived position of approaching compared to flat sounds (*Supplementary Figure 2b*). (i) RTs (±SE) were slower for looming compared to flat sounds at T1 (363±17 ms vs 338±16 ms, respectively, p=.001), whereas faster at T4 (308±14 ms vs 328±14, respectively, p<.005) and T5 (296±13 ms vs 326±15, respectively, p<.005). (ii) Looming stimuli induced significant modulation of tactile RTs from T2 to T3 (352±16 vs 320±13; p<.001) and from T3 to T4 (320±13vs 308±14; p=.01). (iii) RTs (±SE) in the unimodal conditions (T0) were significantly slower compared to T2-T5 for looming sounds (all ps<.005), while slower than all the other conditions (T1-T5) for flat sounds (all ps<.005).

**Figure 2 - Plots of mean RTs to tactile targets in Schizophrenic Patients (SCZ) and Healthy Controls (HC).** Tactile targets were delivered at different temporal distances (T0, -700 ms; T1, 300 ms; T2, 800 ms; T3, 1500 ms; T4, 2200 ms; and T5, 2700 ms) from the onset of either looming (dark colour) or flat (light colour) sounds. b) Plots of mean RTs from the SCZ group (blue); b) plots of mean RTs from the HC group (green). Data averaged across 18 participants for each group are reported.

*Schizophrenic Patients vs. Healthy Controls*

Group (SCZ vs HC) by Distance (T0-T5) ANOVA was run to support results from fitting analysis reported in the main text, showing a difference in the CP between the two groups. ANOVA results showed significance of the critical two-way interaction (F1,34=2.897, p<.05, η2=.326), due to significant between group differences at T2 and T3 (all ps<.05).

**2.2 Study 2: ANOVAs**

*High-Schizotypy.*

A total of 92.9±4.5% (±SE) trials from each participant were included in data analyses. Rate of omissions were 1.5% and 1.9% for flat and looming trials, respectively. Responses longer than 2 SDs from the individual mean were treated as outliers and not considered further (2.5% for flat and 2.3% for looming trials). ANOVA results showed significance of the critical two-way interaction (F5,85=15.612, p<.001, η2=.527), explained by specific modulation of RTs by approaching compared to flat sounds (*Supplementary Figure 3a*). (i) RTs (±SE) were slower for looming compared to the flat sounds at T1 (321±12 ms vs 314±14 ms, respectively), while faster at T4 (274±10 ms vs 304±11, respectively) and T5 (257±10 ms vs 306±8, respectively; all ps<.001). (ii) Looming stimuli induced significant modulation of tactile RTs from T2 to T3 (311±10 vs 293±10; p<.001), from T3 to T4 (293±10 vs 274±10; p=.001) and from T4 to T5 (274±10vs 257±8; p<.005). (iii) RTs (±SE) in the unimodal conditions (T0) were significantly slower compared to T1-T5 in case of both looming sounds and flat sounds (all ps<.005).

*Low-Schizotypy.*

A total of 90.6±8.5 % (±SE) from each participant were included in data analyses. Rate of omissions were 2.3% and 2.6% for flat and looming trials, respectively. Responses longer than 2 SDs from the individual mean were treated as outliers and not considered further (2.9% for flat and 2.6% for looming trials). ANOVA results showed significance of the critical two-way interaction (F5,85=7.466, p<.005, η2=.772), due to different of approaching compared to static sounds on RTs (*Supplementary Figure 3b*). (i) RTs (±SE) were significantly slower for looming compared to flat sounds at T1 (366±15 ms vs 340±13 ms, respectively, p<.001), while faster at T4 (309±12 ms vs 328±14, respectively, p<.001) and T5 (303±12 ms vs 317±11, respectively, p=.005). (ii) Looming stimuli induced significant modulation of tactile RTs from T2 to T3 (346±14 vs 325±12; p<.005), from T3 to T4 (325±12 vs 309±12; p<.001). (iii) RTs (±SE) in the unimodal conditions (T0) were significantly slower compared to T3-T5 for looming sounds, while slower than all the other conditions (T1-T5) for flat sounds (all ps<.001).

**Figure 3 - Plots of mean RTs to tactile targets in High-Schizotypy and Low-Schizotypy individuals.** Tactile targets were delivered at different temporal distances (T0, -700 ms; T1, 300 ms; T2, 800 ms; T3, 1500 ms; T4, 2200 ms; and T5, 2700 ms) from the onset of either looming (dark colour) or flat (light colour) sounds. b) Plots of mean RTs from the High-Schizotypy group (red); b) plots of mean RTs from the Low-Schizotypy group (green). Data averaged across 18 participants for each group are reported.

*High-Schizotypy vs. Low Schizotypy*

Group (High-Schizotypy vs Low-Schizotypy) by Distance (T0-T5) ANOVA was run to support results from fitting analysis reported in the main text, showing a difference in the CP between the two groups. ANOVA results showed significance of the critical two-way interaction (F1,34=2.777, p<.05, η2=.357), due to significant between group differences at T1 and T5 (all ps<.05).

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