Online Supplementary Material

Supplementary Methods

1. Recruitment strategy and comorbid psychiatric disorders in ultra-high risk (UHR) for psychosis individuals

UHR individuals (n = 22) were recruited from the FORYOU clinic of the Green Program for Recognition and Prevention of Early Psychosis (GRAPE) project at Severance Hospital of the Yonsei University Health System in Seoul between March 2012 and March 2017. All participants were assessed for psychiatric disorders using the Structured Clinical Interview for DSM-IV (SCID-I) (First et al., 1996a; First et al., 1996b), and participants were diagnosed as UHR for psychosis based on Structured Interview for Prodromal Syndromes (SIPS) (Miller et al., 2003) criteria by trained psychiatrists. UHR participants had one or more of the following three prodromal syndromes outlined in the SIPS: 1) attenuated psychotic symptoms, 2) brief intermittent psychotic symptoms, or 3) genetic risk and deterioration syndrome.

All participants were youth (15–35 years old) who had more than 9 years of education. Exclusion criteria were current or past neurological illness or traumatic brain injury for both UHR and healthy control (HC) individuals; current or past psychiatric illness for HC individuals; and current or past major psychiatric disorder with psychotic features for UHR individuals.

Comorbid psychiatric disorders in UHR individuals were as follows: depressive disorder not otherwise specified (n = 7), social phobia (n = 3), obsessive-compulsive disorder (n = 1), panic disorder (n = 1), somatoform disorder (n = 1), depersonalization disorder (n = 1), and schizotypal personality disorder (n = 3).

2. *Personality trait adjectives*

Translations of the 40 Korean personality trait adjectives in English are as follow: active, amicable, artistic, attractive, blunt, calm, cold, courageous, critical, decent, excited, fastidious,

foolish, forlorn, gentle, hesitant, independent, irresponsible, lazy, logical, methodical, meticulous, noisy, observant, popular, practical, pretentious, religious, rigid, scrupulous, sensitive, sharp, simple, smart, solemn, solitary, sophisticated, tough, unemotional, and wise.

3. Acquisition, pre-processing, and analysis of functional magnetic resonance imaging (fMRI) data

fMRI data were acquired on a 3T scanner (Intra Achieva; Philips Medical System, Best, Netherlands) using a T2* sensitive gradient-echo-planar imaging sequence (TR = 3,000 ms, TE = 30 ms, flip angle = 90˚, matrix size = 80 × 80, voxel size = 1.72 × 1.72 × 4 mm^3). Interleaved slices were oriented parallel to the AC-PC plane, allowing complete brain coverage. Thirty-four 3.5-mm thick axial slices (FOV = 220 mm) were acquired. Coronal T1-weighted images (TR = 9.7 ms, TE = 4.6 ms, flip angle = 8˚, FOV = 220 mm, matrix size = 256 × 256, voxel size = 0.86 × 1.2 × 0.86 mm^3) using a slice thickness of 1.2 mm were subsequently acquired. Stimuli were displayed on a screen located near the scanner that participants could see through a mirror mounted on the standard head coil.

Data were preprocessed and analyzed using SPM12 software (Wellcome Department of Cognitive Neurology, London UK) implemented in MATLAB (Mathworks Inc., Sherborn, MA). The first five images for each participant were discarded due to MR signal saturation. Functional scans were slice-timed, realigned to the first scan, and coregistered sequentially. They were spatially normalized to the Montreal Neurological Institute (MNI) space (voxel size: 2 × 2 × 2 mm) based on the tissue probability maps obtained by segmenting a skull-stripped T1 image into gray matter, white matter, and cerebrospinal fluid. Data were convolved using a 6-mm Gaussian filter with a full-width at half-maximum. Head motion parameters of each participant were implemented as multiple regressors into the imaging analyses.

Significant clusters were anatomically labeled using the Talairach Daemon (Lancaster et

al., 2000) and Anatomic Automatic Labeling toolbox (Tzourio-Mazoyer et al., 2002). Imaging results were visualized using MRIcroGL (http://www.mccauslandcenter.sc.edu/mricrogl/). Clusters were rendered on the 'ch256' brain template. We extracted contrast estimates of regions of interest constructed by building 5-mm spheres centered on the coordinates of significant clusters using the MarsBaR toolbox (http://marsbar.sourceforge.net).

4. Statistical analysis of behavioral data

Response times were measured according to participants' durations of choice, and numbers of responses per response type were counted. Reaction times and numbers of responses were separately subjected to analysis of variance (ANOVA). Repeated measures analyses were performed with a between-subjects factor of group (UHR vs. HC) and within-subjects factors of reference target (self vs. other), perspective (1PP vs. 3PP), and response type (1, 2, 3, or 4). Greenhouse-Geisser corrections were applied to compensate for sphericity violation.

Supplementary Results

Behavioral data

Behavioral data were missing from one HC individual due to technical errors during data collection.

A. Reaction times

Mean and standard deviation values of reaction times for the four types of responses in each stimulus condition are presented in Supplementary Table 1. Mauchly's test of sphericity revealed that the assumption of sphericity was violated for the main effect of response type, $\chi^2(5) = 76.4$, $p = 0.0001$, the interaction between perspective and response type, $\chi^2(5) = 31.6$, $p = 0.0001$, the interaction between reference target and response type, $\chi^2(5) = 57.2$, $p = 0.0001$, and the interaction among perspective, reference target, and response type, $\chi^2(5) = 43.8$, $p =$

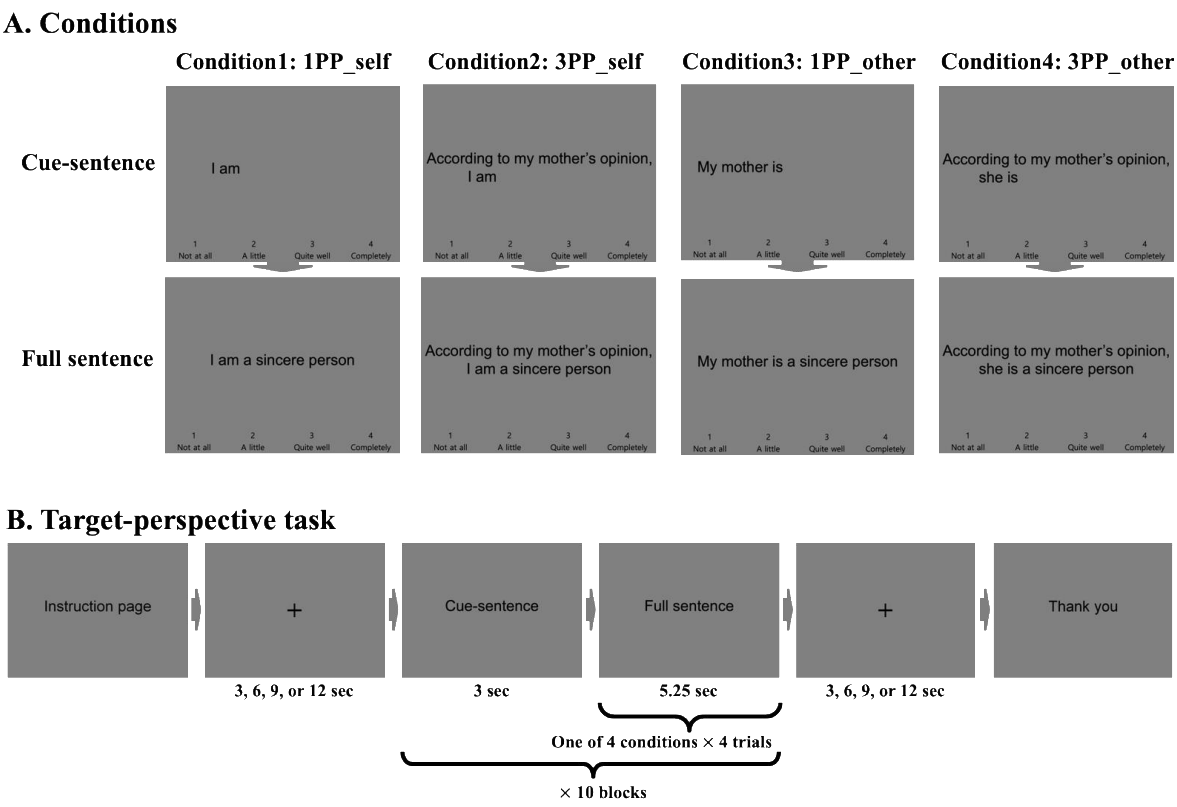
0.0001. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity for the main effect of response type (ε = 0.516), the interaction between perspective and response type (ε = 0.699), the interaction between reference target and response type (ε = 0.576), and the interaction among perspective, reference target, and response type (ε = 0.695). There were main effects of perspective, $F(1,47) = 10.8$, $p = 0.002$, $\eta_p^2 = 0.187$, target, $F(1,47) = 12.6$, $p = 0.001$, $\eta_p^2 = 0.212$, and response type, $F(1.5,72.8) = 33.7$, $p = 0.0001$, $\eta_p^2 = 0.417$, and an interaction between reference target and response type, $F(1.7,81.2) = 6.0$, $p = 0.005$, $\eta_p^2 = 0.114$. No significant effect of group, $F(1,47) = 0.1$, $p = 0.7$, $\eta_p^2 = 0.002$, or other interactions were found. The interaction between reference target and response type is shown in Supplementary Figure 2A.

B. Number of responses

Mean and standard deviation values of the numbers of the four types of responses in each stimulus condition are presented in Supplementary Table 1. Mauchly's test indicated that the assumption of sphericity was violated for the main effect of response type, $\chi^2(5) = 13.6$, $p = 0.02$, the interaction between perspective and response type, $\chi^2(5) = 20.0$, $p = 0.001$, the interaction between reference target and response type, $\chi^2(5) = 31.6$, $p = 0.0001$, and the interaction among perspective, reference target, and response type, $\chi^2(5) = 49.1$, $p = 0.0001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity for the main effect of response type (ε = 0.841), the interaction between perspective and response type (ε = 0.785), the interaction between reference target and response type (ε = 0.760), and the interaction among perspective, reference target, and response type (ε = 0.628). There were significant main effects of group, $F(1,47) = 7.3$, $p = 0.009$, $\eta_p^2 = 0.135$, perspective, $F(1,47) = 7.6$, $p = 0\ .008$, $\eta_p^2 = 0.138$, and response type, $F(2.5,118.6) = 36.4$, $p = 0.0001$, $\eta_p^2 = 0.436$, and significant interactions between perspective and reference target, $F(1,47) = 5.3$, $p = 0.03$, $\eta_p^2 = 0.101$, and among perspective, reference target, and response

type, $F(1.9,88.6) = 72.0$, $p = 0\ .007$, $\eta_p^2 = 0.104$. No significant main effect of reference target, $F(1,47) = 3.0$, $p = 0.09$, $\eta_p^2 = 0.06$, or other interactions ($p \geq 0.052$) were found. The interactions between perspective and reference target and among perspective, reference target, and response type are plotted in Supplementary Figure 2B and 2C.

Supplementary Figure 1. fMRI design for the target-perspective task. (A) Examples of four different sentences within each condition. Cue and full sentences were located in the middle of the screen. Cue sentences consisted of truncated sentences that informed participants about which condition would be presented, followed by the presentation of personality adjectives that formed full sentences. Four types of responses were presented below the screen (1 = not at all, 2 = a little, 3 = quite well, 4 = completely). (B) Schematic representation of the task timeline.



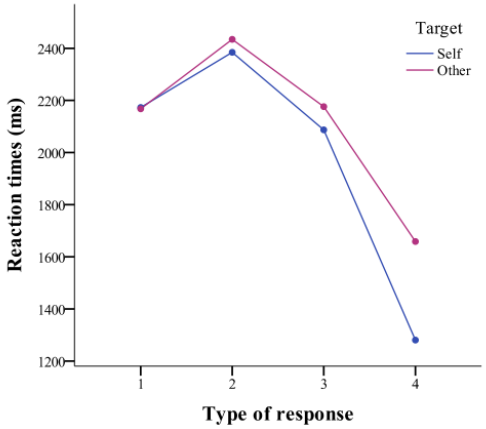
Supplementary Table 1. Mean (SD) values of reaction times (ms) and number of responses for each response type.

Perspective	Reference target	Response type	Reaction time, mean (SD)		Number of responses, mean (SD)	
			HC	UHR	HC	UHR
1PP	Self	1	2053.5 (698.4)	2186.2 (773.2)	2053.5 (698.4)	2186.2 (773.2)
		2	2270.6 (506.2)	2439.1 (366.9)	2270.6 (506.2)	2439.1 (366.9)
		3	2045.8 (520.9)	2047.4 (816.6)	2045.6 (520.9)	2047.4 (816.6)
		4	1183.0 (1091.4)	1258.0 (1052.9)	1183.0 (1091.4)	1258.0 (1052.9)
	Other	1	2134.1 (660.4)	2057.1 (463.7)	2134.1 (660.4)	2057.1 (463.7)
		2	2310.1 (611.5)	2423.8 (381.2)	2310.1 (611.5)	2423.8 (381.2)
		3	2224.0 (499.9)	2055.1 (643.9)	2224.0 (499.9)	2055.1 (643.9)
		4	1729.7 (873.8)	1565.8 (1096.1)	1729.7 (873.8)	1565.8 (1096.1)
3PP	Self	1	2314.6 (601.1)	2137.5 (477.3)	2314.6 (601.1)	2137.5 (477.3)
		2	2317.2 (589.9)	2510.8 (457.4)	2317.2 (589.9)	2510.8 (457.4)
		3	2068.1 (642.9)	2187.2 (658.3)	2068.1 (642.9)	2187.2 (658.3)
		4	1217.4 (1127.4)	1464.1 (1086.4)	1217.4 (1127.4)	1464.1 (1086.4)
	Other	1	2133.2 (707.7)	2347.0 (450.7)	2133.2 (707.7)	2347.0 (450.7)
		2	2395.1 (579.6)	2608.1 (404.7)	2395.1 (579.6)	2608.1 (404.7)
		3	2268.0 (437.4)	2158.3 (608.4)	2268.0 (437.4)	2158.3 (608.4)
		4	1723.9 (1052.3)	1614.4 (957.6)	1723.9 (1052.3)	1614.4 (957.6)

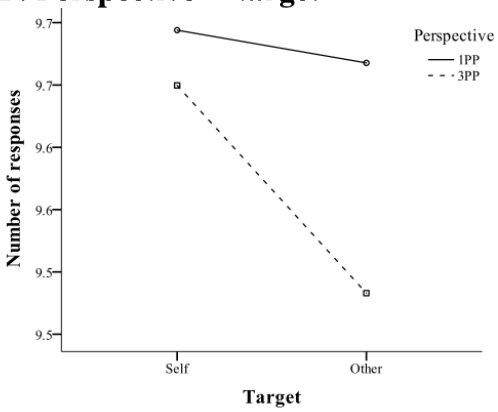
1PP, first-person perspective; 3PP, third-person perspective; SD, standard deviation; UHR, ultra-high risk; HC, healthy control

Supplementary Figure 2. Repeated measures ANOVA interactions on reaction time (A) and numbers of responses (B, C). (A) Interaction between reference target and response type. (B) Interaction between perspective and reference target. (C) Interaction among perspective, reference target, and response type. 1PP, first-person perspective; 3PP, third-person perspective; UHR, ultra-high risk; HC, healthy control.

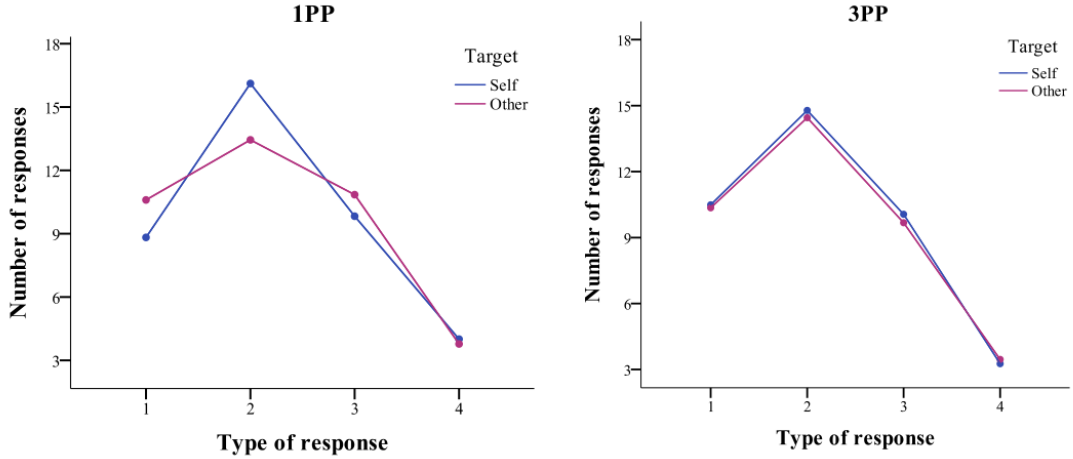
A. Target × type of response



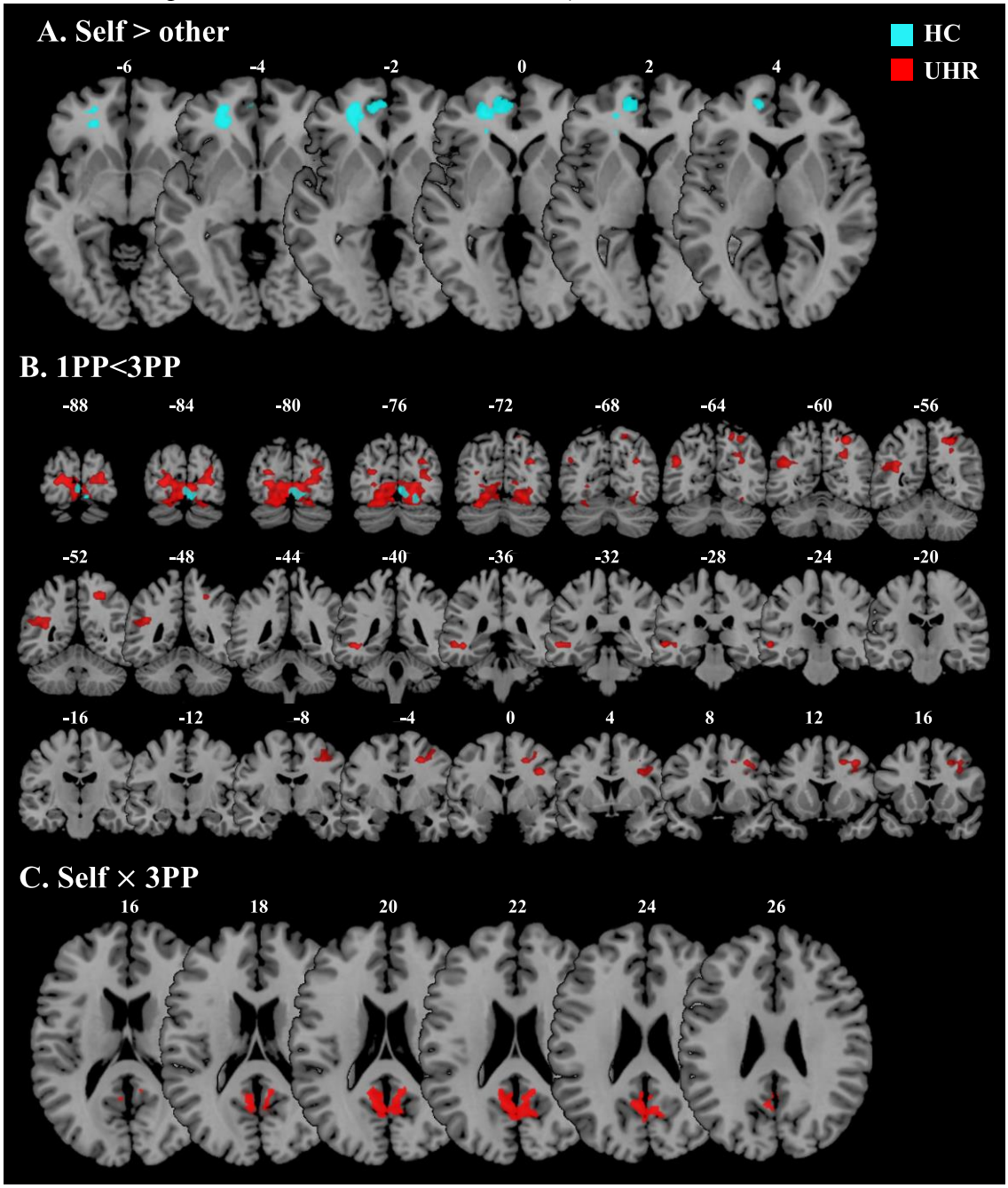
B. Perspective × target



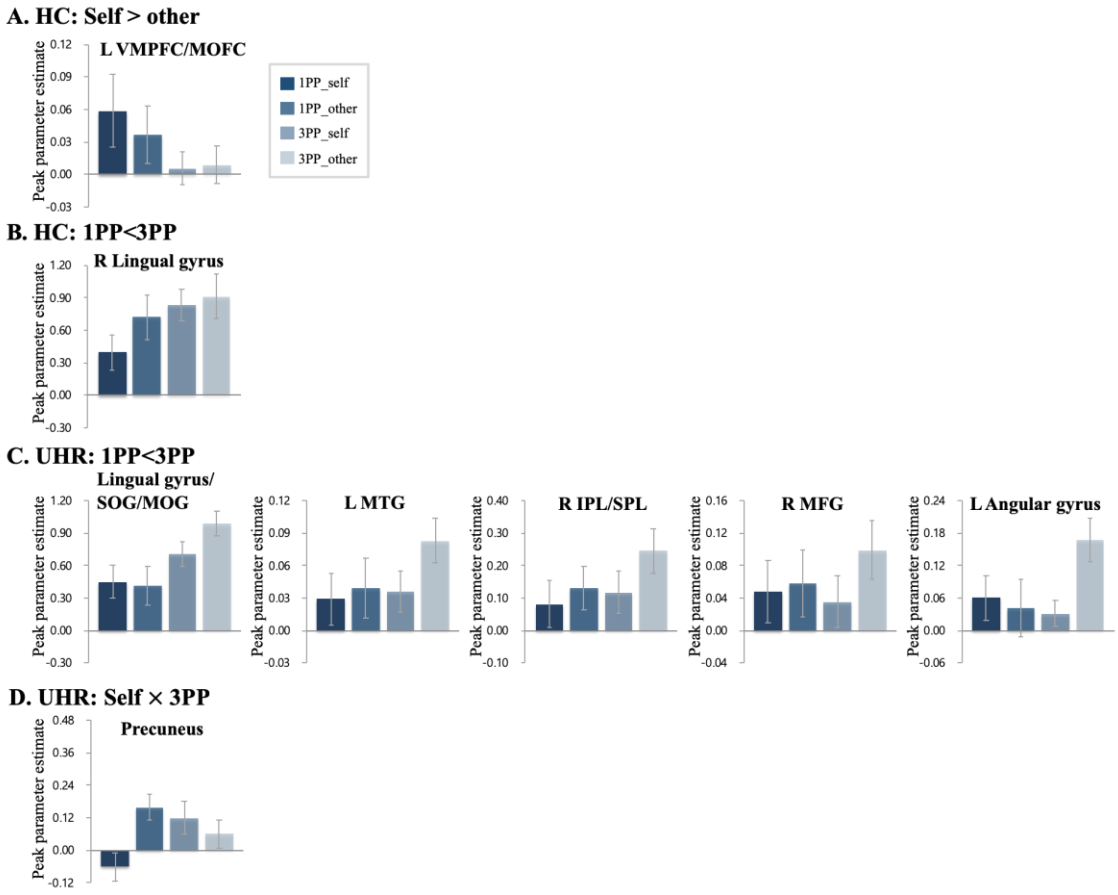
C. Perspective × target × type of response



Supplementary Figure 3. Within-group differences in neural activity for healthy control (HC) and ultra-high risk (UHR) for psychosis individuals. (A) Self-as-target vs. other-as-target in HC individuals. (B) 3PP vs. 1PP in UHR individuals. (C) Specific effect of taking a 3PP for self-as-target in UHR individuals. Images are depicted on a standard MNI template (threshold of uncorrected $p < .005$; minimum voxel size, 224).



Supplementary Figure 4. Contrast estimates (means and standard errors of the mean) within spherical regions of interest around the principally activated voxel for each within-subject effect. (A) For self-as-target (vs. other-as-target), MNI coordinates were -26, 38, -4 in HC individuals. (B–C) For 3PP (vs. 1PP), MNI coordinates were 6, -78, -6 in HC individuals and -12, -88, 4; -44, -38, -6; 26, -52, 52; 38, 0, 30; and -44, -48, 26 in UHR individuals. (D) For taking a 3PP for self-as-target, MNI coordinates were -8, -56, 22 in UHR individuals. L, left hemisphere; R, right hemisphere; VMPFC, ventromedial prefrontal cortex; MOFC, medial orbitofrontal cortex; SOG, superior occipital gyrus; MOG, middle occipital gyrus; MTG, middle temporal gyrus; IPL, inferior parietal lobe; SPL, superior parietal lobe; MFG, middle frontal gyrus; 1PP, first-person perspective; 3PP, third-person perspective; UHR, ultra-high risk; HC, healthy controls.



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