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Electrophysiological correlates of visual backward masking in high schizotypic personality traits participants

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ABSTRACT

Visual backward masking is strongly deteriorated in patients with schizophrenia. Masking deficits are associated with strongly reduced amplitudes of the global field power in the EEG. Healthy participants who scored high in cognitive disorganization (a schizotypic trait) were impaired in backward masking compared to participants who scored low. Here, we show that the global field power is also reduced in healthy participants scoring high (n = 25) as compared to low (n = 20) in cognitive disorganization, though quantitatively less pronounced than in patients (n = 10). These results point to similar mechanisms underlying visual backward masking deficits along the schizophrenia spectrum.

1. Introduction

Patients with schizophrenia usually show deficits in behavioral paradigms. Visual processing impairments are of special importance because of their replicability, their relatively well-known neurobiological underpinnings, and their cultural independence (Silverstein et al., 2015). Particularly, visual backward masking (VBM) has been proven to be a powerful tool to understand visual deficits in schizophrenia (Bredgaard and Glenthøj, 2000; Green et al., 2011; Herzog and Brand, 2015; Kéri et al., 2000). For example, in the shine-through masking paradigm, a Vernier target is followed by first an inter-stimulus interval and then a grating mask (Fig. 1; Chkonia et al., 2010; Herzog et al., 2004). The time from the onset of the target to the onset of the mask is called the Stimulus Onset Asynchrony (SOA). Participants indicate whether the lower bar of the Vernier is either offset to the left or to the right. The shine-through paradigm is spatially (small Vernier offset) and temporally (short SOA) challenging. Patients with schizophrenia need on average much longer SOAs compared to controls in order to achieve comparable performance levels (Herzog et al., 2004). In addition, healthy relatives of patients need shorter SOAs compared to patients but longer SOAs compared to controls (Chkonia et al., 2010). This finding is particularly crucial for an endophenotype (Gottesman and Gould, 2003). In an EEG study, patients had on average reduced Global Field Power (GFP) amplitudes compared to controls (Plomp et al., 2013). We suggest that patients are unable to stabilize Vernier related activity across time, which is reflected by the reduced EEG (Herzog et al., 2013).

The schizophrenia continuum ranges from affected patients to healthy schizotypic individuals (Nelson et al., 2013). Importantly, the symptom dimensions observed in patient populations can also be observed in healthy schizotypy, consisting commonly in positive schizotypy, negative schizotypy, and cognitive disorganization (Debbane and Mohr, 2015; Kwapil and Barrantes-Vidal, 2015; Mason, 2015). In line with the fully dimensional model (e.g. Claridge and Beech, 1995), an individual may show personality expressions and cognitive disorganization similar to those observed in patients with schizophrenia, albeit quantitatively milder. Schizotypic personality traits are commonly assessed through self-report questionnaires (e.g., Schizotypal Personality Disorder, SPQ, Raine, 1991; Oxford-Liverpool Inventory of Feelings and Experiences, O-LIFE, Mason et al., 2005). In this tradition, schizotypy allows to study the etiology of schizophrenia by promoting the developmental approach and the identification of the

Abbreviations: CogDis, Cognitive Disorganization; O-LIFE, Oxford-Liverpool Inventory of Feelings and Experiences; GFP, Global Field Power; EEG, Electroencephalography; VBM, Visual Backward Masking; SOA, Stimulus Onset Asynchrony; CSD, Current Source Density

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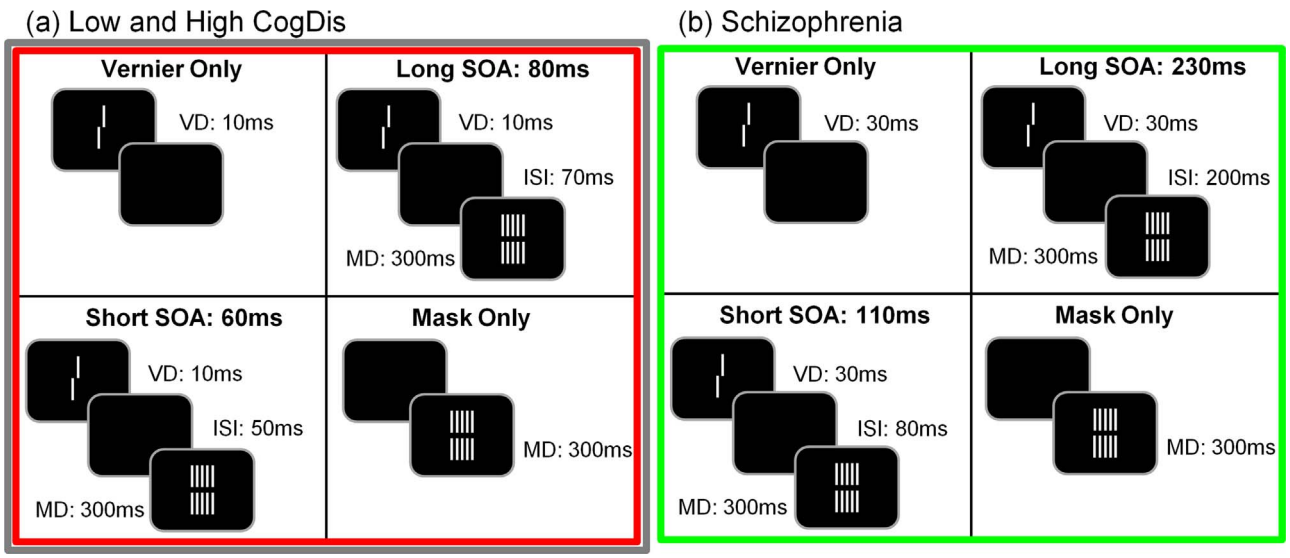

Fig. 1. In the Vernier Only condition, the Vernier was presented for 10 ms for both, the low and high CogDis groups (a) and for 30 ms for the patients (b). In the Short and Long SOA conditions, the Vernier was followed by a mask of 60 and 80 ms for the low and high CogDis groups, respectively, and of 110 and 230 ms, respectively for the patients. The task was to indicate whether the lower bar of the Vernier was offset either to the left or to the right. In the Mask Only condition, the mask was presented for 300 ms in both experiments. Abbreviations: VD = Vernier Duration, ISI = Inter-Stimulus Interval, SOA = Stimulus Onset Asynchrony, MD = Mask Duration. SOA = VD + ISI.

multidimensional heterogeneous structure (Ettinger et al., 2014; Kwapil and Barrantes-Vidal, 2015) as well as the assessment of individual differences in healthy cognition (Cohen et al., 2015; Mohr and Claridge, 2015; Schofield and Claridge, 2007).

Further evidence that VBM is a promising endophenotypic candidate comes from studies on healthy participants varying in the degree of self-reported schizotypy (Cappe et al., 2012; Shaqiri et al., 2015). University students scoring high in the schizotypy dimension cognitive disorganization (CogDis) needed longer SOAs than those who scored lower. More precisely, high CogDis students needed 80 ms on average to reach 75% of correct responses whereas low CogDis students needed 60 ms to reach the same performance level.

Here, we tested whether VBM deficits in healthy individuals with high scores of CogDis are reflected in lower EEG amplitudes compared to lower scoring people.

2. Methods

2.1. Healthy participants pre-selected for high and low cognitive disorganization

Fifty-three healthy students from either the University of Lausanne (UNIL) or the Swiss Federal Institute of Technology (EPFL) volunteered. Participants had normal or corrected to normal vision as determined with the Freiburg visual acuity test (FrAct). Participants reached a value ≥ 1.0 for at least one eye (Bach, 1996). In addition, participants were tested for ocular dominance and completed a standardized handedness questionnaire (Oldfield, 1971). All participants provided written informed consent prior to participation after having received detailed written information. Participants obtained financial compensation for their time. All procedures complied with the Declaration of Helsinki and were approved by the local ethics committee.

Schizotypy scores were determined by the O-LIFE short questionnaire (French version, Sierro et al., 2015) assessing the three schizotypy dimensions Cognitive Disorganization (CogDis, n = 11 items), Unusual Experience (UnEx, n = 12), and Introvertive Anhedonia (IntAn, n = 10). Over three years, participants were selected from a large set of first year students from the UNIL/EPFL (n = 1048, Sierro et al., 2016). From these data sets, we randomly selected the participants. The CogDis subscale varied from the lowest (0 point) to the highest (11 points) score. The two other subscales (UnEx and IntAn) were kept as low as possible, UnEx ≤ 4 and IntAn ≤ 3, except for a few participants at the beginning of the study (N = 9). The experimenter was blind to whether participants belonged to the low or high CogDis group until after the experiment. Three subjects were excluded for poor behavioral performance (< 70% of correct responses) in the Vernier Only condition. Five subjects were excluded for bad EEG data (see Section 2.6).

The 45 remaining participants (Table 1a) were separated into two groups depending on the CogDis scores by a median split (median = 6). Participants scoring from 0 to 5 were considered as low (N = 20) and

Table 1
Demographic measures of (a) the low/high CogDis participants and (b) the patients with schizophrenia.

(a)	**Schizotypy**	**Low CogDis**	**High CogDis**	**Statistics**
	N	20	25	
	Age (years) ± SD	21.0 ± 2.73	20.8 ± 2.65	
	Gender (F/M)	15/5	18/7	
	Handedness (L/R)	2/18	4/21	
	Ocular Dominance (L/R)	5/15	8/17	
	CogDis[a] **± SD**	2.45 ± 1.15	8.00 ± 1.61	$t_{43} = -13.01$, $p < 0.001$*
	UnEx[b] **± SD**	2.55 ± 2.19	2.84 ± 2.41	$t_{43} = -0.42$, $p = 0.678$
	IntAn[c] **± SD**	0.95 ± 0.89	1.56 ± 1.12	$t_{43} = -1.98$, $p = 0.054$
(b)	**Schizophrenia**		**Patients**	
	N		10	
	Age (years) ± SD		39.5 ± 7.4	
	Gender (F/M)		1/9	
	Handedness (L/R)		1/9	
	Education level (years) ± SD		14.4 ± 1.35	
	Duration of illness (years) ± SD		16 ± 6.2	
	SANS[d] **± SD**		7 ± 5.5	
	SAPS[e] **± SD**		6 ± 1.9	
	CPZ[f] **± SD**		501 ± 474	

Average statistics: SD = standard deviation, F = Female, M = Male, L = left, R = right
*As aimed for, the two groups differed in the CogDis subscore only.
[a] Cognitive Disorganization.
[b] Unusual Experience.
[c] Introvertive Anhedonia subscale scores as measured with the sO-LIFE questionnaire.
[d] Scales for the assessment of negative symptoms.
[e] Scales for the assessment of positive symptoms.
[f] Chlorpromazine equivalent.