

## SENSORY GATING DEFICITS AND IMPAIRED QUALITY OF LIFE IN PATIENTS WITH SCHIZOPHRENIA: A PRELIMINARY STUDY

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### SUMMARY

**Background:** New determinants of quality of life in schizophrenia need to be identified. As sensory gating deficit is core impairment in schizophrenia, the present study hypothesized that sensory gating deficit is a determinant of impaired quality of life in schizophrenia. This study therefore investigated the relationship between sensory gating deficit and quality of life in patients with schizophrenia after adjusting for key confounding factors.

**Subjects and methods:** Sensory gating was assessed with the auditory event-related potential method by measuring P50 amplitude changes in a double-click conditioning-testing procedure, perceptual impairments related to sensory gating deficit was assessed with the SGI questionnaire and quality of life was assessed with the SQoL 18 questionnaire in 39 patients with schizophrenia.

**Results:** Patients with sensory gating deficit ( $n=14$ ) had a lower subjective quality of life on the psychological well-being dimension evaluated with SQoL 18 questionnaire ( $p=0.008$ ) compared to those without it ( $n=25$ ). This result remained significant ( $B=-0.45$ ,  $Wald=4.84$ ,  $p=0.02$ ) after taking into account 7 potential confounding factors (gender, age, level of education, duration of disorder, positive symptoms, depressive symptoms and anxiety symptoms). Poorer psychological well-being was related to a higher score on the SGI ( $\rho=-0.40$ ,  $p=0.01$ ), in particular on the Distractibility dimension ( $\rho=-0.47$ ,  $p=0.001$ ).

**Conclusions:** These findings suggest that sensory gating deficit may be a determinant of impaired quality of life in schizophrenia. Further studies are needed to address the causal relationship between sensory gating deficit, perceptual impairments, attentional deficit and impaired quality of life in schizophrenia in order to act more efficiently on the quality of life of patients with this disorder.

**Key words:** schizophrenia - quality of life - sensory gating - P50 suppression - perceptual impairments

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### INTRODUCTION

Schizophrenia is a chronic disease characterized by psychotic symptoms (Kay et al. 1987) and cognitive impairments (Gold & Harvey 1993, Heinrichs & Zakzanis 1998) that are critical determinants of functional disability and quality of life (Boyer et al. 2011, Boyer et al. 2015, Dickinson et al. 2004, Fervaha et al. 2013, Nuechterlein et al. 2004). However, psychotic symptoms and cognitive impairments explain only a small amount of variance in the impaired quality of life in schizophrenia (Boyer et al. 2015, Eack & Newhill 2007, Fervaha et al. 2013, Tolman & Kurtz 2010). Although there is strong evidence that multicomponent treatment involving medication, cognitive behavioral therapy and cognitive remediation has beneficial effects on symptoms

and cognitive impairments (McGurk et al. 2007, Zimmermann et al. 2005), most patients with schizophrenia still have an impaired quality of life (Boyer et al. 2015, Boyer et al. 2014). Thus, in order to develop new approaches to act more efficiently on impaired quality of life in schizophrenia, a new determinant of quality of life in schizophrenia has to be identified.

Recently, emphasis has been placed on sensory and perceptual impairments in schizophrenia (Javitt & Freedman 2014, Lipskaya-Velikovsky et al. 2015, Nelson et al. 2014, Postmes et al. 2014). For long time it was suggested that sensory and perceptual impairments might be linked to impaired subjective experiences and thus impaired quality of life in schizophrenia (Hetrick et al. 2012, Light & Braff 2003, Light & Braff 2000, McGhie & Chapman 1961, Venables 1964). Thus, several types

of sensory remediation have been proposed that could have a beneficial effect on quality of life in schizophrenia (Adcock et al. 2009). In contrast to usual cognitive remediation, these approaches postulate that optimization of relatively simple sensory processes is the major driver of improved cognition (Minzenberg & Carter 2011). For example, auditory training interventions have been developed to train patients with schizophrenia to distinguish frequency, timing, or complex sequential relationships between sounds (Fisher et al. 2009). It has been also suggested using synthetic sounds, which can be precisely controlled (Aramaki et al. 2006), such as immersive sounds (El-Kaim et al. 2015), to treat sensory gating deficit by teaching the patients with an attentional procedure that focuses on the auditory processing of specific acoustic features (Bless et al. 2014). However, research on the relationship between sensory and perceptual impairments and quality of life in schizophrenia is very scarce and further investigations are needed.

Sensory gating deficits are considered to be the main sensory and perceptual impairments in schizophrenia (Javitt et al. 2014). Sensory gating is the ability of the brain to filter or gate intrusive sensory information. It is a fundamental protective mechanism that prevents the flooding of higher brain structures with irrelevant information (Venables 1964), which might be a determinant of quality of life in schizophrenia (Hetrick et al. 2012, Light et al. 2003). Sensory gating can be assessed with neurophysiological tests using auditory event-related potential (ERP) methods that measure P50 amplitude changes in double-click conditioning-testing procedures (Freedman, Adler et al. 1987). Healthy subjects exhibit a >50% reduction in P50 amplitude after the second click (testing click). A reduction <50% indicates a sensory gating deficit (Freedman et al. 1983) that is found in most patients with schizophrenia (Bramon et al. 2004, de Wilde et al. 2007, Patterson et al. 2008). Perceptual impairments related to sensory gating deficit can be assessed with a dedicated and validated self-report questionnaire: the Sensory Gating Inventory (SGI) (Hetrick et al. 2012, Micoulaud-Franchi et al. 2014). Perceptual impairments related to sensory gating deficit are frequent and represent a common subjective complaint in patients with schizophrenia (Hetrick et al. 2012, McGhie et al. 1961, Venables 1964). Moreover, schizophrenia patients with sensory gating deficit were found to report worse perceptual impairments on the SGI than those without it (Micoulaud-Franchi et al. 2014). However, to our knowledge, the relationship between sensory gating deficit, perceptual impairments related to sensory gating and quality of life in schizophrenia has not yet been investigated.

In this study, P50 amplitude change (Micoulaud-Franchi et al. 2014), perceptual impairments assessed with the SGI (Micoulaud-Franchi et al. 2014) and subjective quality of life assessed with the SQoL 18 questionnaire (Baumstarck et al. 2013, Boyer et al.

2010) were investigated in a sample of adult patients with schizophrenia. The aim was to investigate the relationship between sensory gating deficit (<50% reduction in P50 amplitude) and quality of life in patients with schizophrenia after adjusting for key confounding factors. We hypothesized that patients with sensory gating deficit report worse quality of life compared to patients without it. We therefore sought to establish the association between perceptual impairments related to sensory gating deficit and quality of life.

## SUBJECTS AND METHODS

### Subjects

Thirty-nine outpatients with chronic schizophrenia were recruited from the Department of Psychiatry, Marseille University Hospital, France. DSM-IV criteria, based on Structured Clinical Interview (SCID) for DSM-IV interviews, confirmed the diagnosis (American Psychiatric Association 2000, First et al. 1997).

Exclusion criteria were reduced capacity to consent, a diagnosis other than schizophrenia on Axis I of the DSM-IV (except tobacco addiction), auditory impairment (no subjective auditory deficit or antecedent of medical advice for auditory impairment), neurological illness, brain injury, severe organic disease and mental retardation.

After receiving a detailed description of the study, participants gave their written informed consent. This study was conducted in accordance with the Declaration of Helsinki and French Good Clinical Practices. Data collection was approved by the Commission Nationale de l'Informatique et des Libertés (CNIL number: 1223715).

### Methods

#### Characteristics of sample

The following data were collected:

- Socio-demographic information: gender, age and education level;
- Clinical parameters: duration of disorder (first diagnosis); psychotic symptoms based on the Positive and Negative Syndrome Scale (PANSS) total scores and subscores for positive, negative and general psychopathology dimensions (Kay et al. 1987); smoking status assessed by the Fagerström test for nicotine addiction (Heatherton et al. 1991), level of depression in schizophrenia based on the Calgary Depression Scale for Schizophrenia (CDSS) (Lancon et al. 1999), level of anxiety based on the Trait Anxiety Inventory (TAI) (Spielberger & Vagg 1984), and severity of handicap based on the Global Assessment of Functioning (GAF) (American Psychiatric Association 2000);
- Antipsychotic medications: second-generation antipsychotics, presence of clozapine or olanzapine, chlorpromazine equivalent dose (Davis 1976, Woods 2003).

### **Assessments of sensory gating and perceptual impairments related to sensory gating deficit**

Sensory gating was measured with auditory ERP and perceptual impairments related to sensory gating deficit were assessed with the SGI.

Patients were submitted to auditory ERP recordings seated in a comfortable recliner in a quiet room, wore headphones for the presentation of auditory stimuli and were instructed to stay awake and relaxed. They were asked to abstain from cigarette-smoking 1 hour before electrophysiological measurements, thus minimizing the possible effects of nicotine on ERP amplitudes (Adler et al. 1993). Electroencephalographic activity (EEG) was recorded by scalp gold disc electrodes affixed at the Fz, Cz, Pz according to the International 10/20 convention. The ground electrode was on the nose and the reference electrode was on an ear. The Electro-oculographic activity (EOG) was recorded by electrodes affixed above and below the left eye. Trials contaminated by ocular movements and movement artifacts were rejected by visual inspection. The remaining trials (more than 90% for each participant) were then averaged for each participant. In a conditioning-testing P50 procedure described previously in (Micoulaud-Franchi et al. 2014), the P50 amplitude was measured in response to an auditory-paired click stimulus of brief tones: S1 (conditioning stimulus) and S2 (testing stimulus). The inter-stimulus interval was set to 500 ms and the inter-pair interval to 10 sec. The auditory clicks were delivered through the headphones with an intensity of 100 dB sound pressure level (SPL). A set of 60 auditory click pairs was delivered binaurally. P50 measurement was made from the Cz electrode. The percentage of reduction in P50 amplitudes is termed “P50 suppression”. The conditioning P50 component was identified as the positive component presenting the largest peak occurring between 40 and 80 ms after the S1 onset. The testing P50 component was identified in a similar way after the S2 onset. The amplitudes of these components were defined as peak-to-peak amplitudes, i.e., between the peak of the P50 component and the preceding negative peak. The percentage of P50 suppression (P50supp) was calculated using the following formula:  $P50supp = [1 - (AS2/AS1)] \times 100$ , where AS1 and AS2 are the P50 amplitudes of the conditioning and testing, respectively (Clementz et al. 1997). A 50% threshold for the P50 suppression value is classically defined. Patients below this threshold are considered to have a sensory gating deficit (Freedman et al. 1983).

Perceptual impairments related to sensory gating were measured with the SGI. In this questionnaire, participants assign 6-point Likert ratings (from 0 “never true” to 5 “always true”) to 36 items (Hetrick et al. 2012). To enable the evaluation of our group of French patients, a French version of the SGI was designed and formally validated (Micoulaud-Franchi et al. 2014). In practice, the algebraic sum of Likert ratings for each participant was computed for the overall SGI score and

for each of the 4 dimensions which are similar to the original instrument: Perceptual Modulation, Over-Inclusion, Distractibility and Fatigue-Stress Modulation. Perceptual Modulation PM is linked to 16 items (e.g., “My hearing is so sensitive that ordinary sounds become uncomfortable”), Over-Inclusion OI to 7 items (e.g., “I notice background noises more than other people”), Distractibility D to 8 items (e.g., “There are times when I can’t concentrate with even the slightest sounds going on”), and Fatigue-Stress Modulation FS to 5 items (e.g., “It seems that sounds are more intense when I’m stressed”).

### **Assessment of subjective quality of life**

Subjective quality of life was measured with the SQoL 18 questionnaire. In this questionnaire, participants assign 5-point Likert ratings (from 1 “less than expected” to 5 “more than expected”) to 18 items (Baumstarck et al. 2013, Boyer et al. 2010). The SQoL 18 was designed and formally validated in French (Boyer et al. 2010). In practice, the algebraic sum of Likert ratings for each participant was computed for the overall SQoL score and for each of the 8 dimensions and the scores were transferred to a scale from 0 to 100; 0, indicating the lowest quality of life, 100, the highest quality of life. The SQoL explores the following 8 dimensions: Psychological Well-being (PsW) linked to 3 items (e.g., “I have difficulty concentrating or thinking straight”), Self-Esteem linked to 2 items (e.g., “I am confident in life”) (SE), Family Relationships (RFa) linked to 2 items (e.g., “I am helped and supported by my family”), Relationships with Friends (RFr) linked to 2 items (e.g., “I am helped and supported by my friends or my relatives”), Resilience (RE) linked to 3 items (e.g., “I fight to succeed in my life”), Physical Well-being (PhW) linked to 2 items (e.g., “I am in good physical shape”), Autonomy (AU) linked to 2 items (e.g., “I feel free to make decisions”), and Sentimental Life (SL) linked to 2 items (e.g., “I am satisfied with my love life”) (Boyer et al. 2010).

### **Statistical analyses**

Data were expressed as a proportion or as mean and standard deviation. Two groups of patients with schizophrenia according to the absence (P50supp  $\geq$  50%) or the presence of sensory gating deficit (P50supp  $<$  50%) were defined. Chi-square tests on categorical variables and t-tests on continuous variables were conducted to compare the characteristics of the sample in terms of sensory gating deficit (absence or presence).

Demographic (gender, age and education level), clinical (duration of disorder, PANSS scores, Fagerström test, CDSS scores, TAI scores and GAF score), antipsychotic medications (second generation antipsychotics, presence of clozapine or olanzapine, chlorpromazine equivalent dose), neurophysiological (latencies and amplitudes of the S1 and S2 peaks, P50supp), perceptual impairments on the SGI (global score, PM, D, OI, FS) and quality of life on the SQoL (global score, PsW, SE,

RFa, Rf, RE, PhW, AU, SL) variables were compared between the two groups (with and without sensory gating deficit).

For SQoL dimensions significantly different between the two groups in the univariate analysis, multivariate analysis using logistic regression analysis was conducted to control for potential confounding effects. Gender, age, level of education, duration of disorder, positive symptoms, depression symptoms (CDSS) and anxiety symptoms (TAI) were included. These variables were chosen because they may have an influence on quality of life (Bechdolf et al. 2003, Browne et al. 2000, Eack et al. 2007, Fervaha et al. 2013).

Lastly, the correlation between SQoL dimensions significantly different between the two groups and

perceptual impairments on the SGI were investigated using Spearman's correlation tests in the entire group. Bonferroni correction was applied.

P-values were considered significant when  $p < 0.05$ . The data were analyzed using the SPSS software package, version 20.0.

## RESULTS

### Patient characteristics

The mean age of the patients was 33.7 years ( $\pm 9.5$ ) and 74.3% ( $n=29$ ) were male. They had moderately severe psychotic symptoms with a total PANSS score of 74.1 ( $\pm 16.6$ ) and sub-scores of 16.5 ( $\pm 6.5$ ), 20.8 ( $\pm 5.8$ )

**Table 1.** Characteristics for the two groups: schizophrenia without sensory gating deficit (P50supp  $\geq 50\%$ ) and schizophrenia with sensory gating deficit (P50supp  $< 50\%$ )

	SCZ (N=39)				P values
	Without Sensory Gating deficit (N=25)		With Sensory Gating deficit (N=14)		
	Mean	SD	Mean	SD	
Gender (number of subjects)					
Male	21	-	8	-	-
Female	4	-	6	-	0.060 <sup>a</sup>
Age (years)	33.84	9.81	33.64	9.23	0.900
Education level (years)	11.20	3.40	13.00	3.23	0.100
Duration of disorder (years)	13.32	9.114	10.86	6.36	0.400
Positive And Negative Syndrome Scale (PANSS)					
Total	70.78	16.43	79.50	16.08	0.100
Positive factor	15.04	5.65	18.93	7.37	0.080
Negative factor	20.22	5.68	21.79	6.12	0.400
General psychopathology factor	35.52	8.26	38.79	8.75	0.200
Calgary Depression Scale for Schizophrenia (CDSS)	3.04	2.92	5.28	5.42	0.200
Trait Anxiety Inventory (TAI)	33.80	11.38	35.78	12.40	0.600
Global Assessment of Functioning (GAF)	57.50	17.43	49.79	10.21	0.090
Fagerström test	4.86	2.03	5.82	2.27	0.300
Antipsychotics					
Chlorpromazine equivalent dose (mg)	895.31	743.07	965.71	761.41	0.800
Clozapine or Olanzapine (presence)	8 (32%)	-	2 (14.3%)	-	0.200 <sup>a</sup>
Second generation antipsychotics (presence)	22 (88.00%)	-	12 (85.71%)	-	0.600 <sup>a</sup>
Sensory Gating assessment					
Stimulus S1					
P50 Amplitude ( $\mu V$ )	2.64	1.90	1.89	1.99	0.200
P50 Latency (msec)	55.44	14.46	61.29	14.47	0.200
Stimulus S2					
P50 Amplitude ( $\mu V$ )	0.41	0.36	1.93	1.86	0.009
P50 Latency (msec)	54.20	13.10	65.00	12.04	0.010
P50-suppression <sup>b</sup> (%)	81.18	14.54	8.61	48.08	<0.001
Sensory Gating Inventory (SGI)					
Perceptual modulation (PM)	17.92	14.74	30.71	15.31	0.010
Distractibility (D)	14.04	9.49	23.43	9.25	0.005
Over Inclusion (IO)	9.64	6.49	18.86	4.93	<0.001
Fatigue-Stress modulation (FS)	7.12	6.27	11.64	5.17	0.030
Global score	48.72	33.55	84.64	29.69	0.002

<sup>a</sup>  $\chi^2$  test for qualitative variables; <sup>b</sup> The percentage of P50 suppression was calculated as  $[1 - (\text{stimulus 2 amplitude} / \text{stimulus 1 amplitude})] \times 100$

and 36.8 ( $\pm 8.5$ ) for positive, negative and general psychopathologic dimensions, respectively. They had a level of depressive symptoms below the threshold of 6 (which is the threshold to suggest depression in patients with schizophrenia) with a CDSS score of 3.84 ( $\pm 4.1$ ), mild anxiety symptoms with a TAI score of 34.5 ( $\pm 11.6$ ), and a moderate level of handicap with a GAF score of 54.6 ( $\pm 15.5$ ). Of all the patients, 87.2% (n=34) had been taking second-generation antipsychotics.

### Sensory gating deficit

Fourteen patients had a sensory gating deficit (P50 suppression value  $< 50\%$ ). Socio-demographic, clinical and treatment data were not significantly different between patients with or without sensory gating deficit. Sensory gating deficit was related to abnormal P50 amplitude at S2. Patients with sensory gating deficit reported more perceptual impairments on the SGI than those without it. Table 1.

### Relationship between sensory gating deficit and quality of life

In the univariate analyses, patients with sensory gating deficit reported worse quality of life on the SQoL for the psychological well-being dimension ( $p=0.008$ ) and the self-esteem dimension ( $p=0.04$ ). A trend was observed for the global score ( $p=0.06$ ). Table 2.

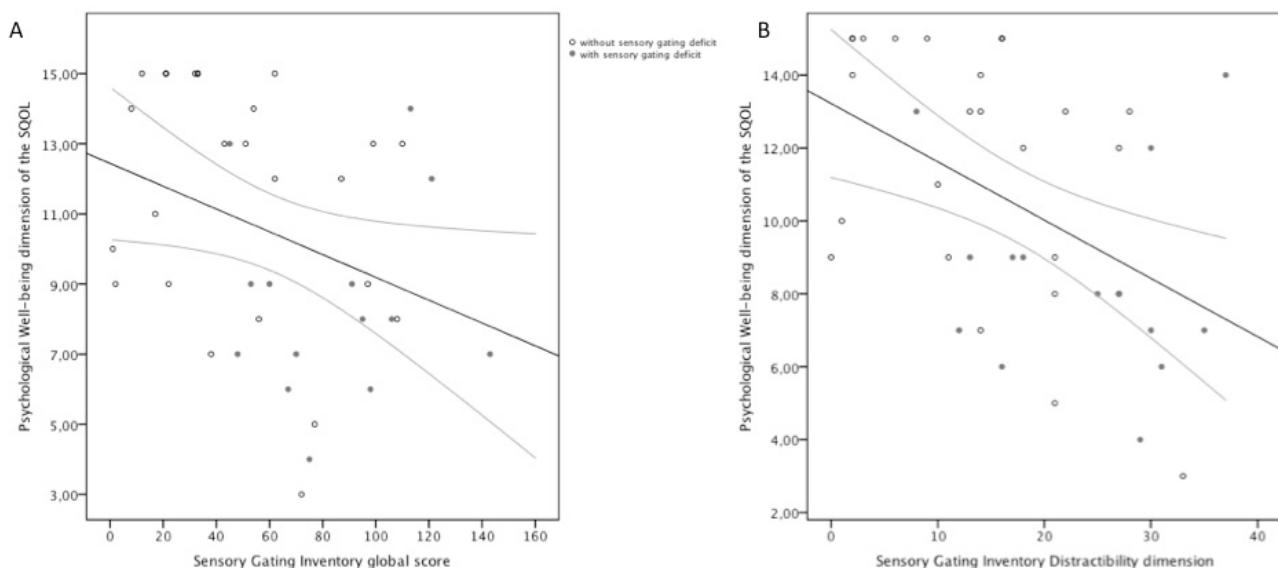
The difference remained significant after adjustment for confounding factors (gender, age, level of education, duration of disorder, positive symptoms, depression symptoms and anxiety symptoms) for the psychological well-being dimension ( $B=-0.45$ , Wald=4.84,  $p=0.02$ ).

### Relationship between perceptual impairments related to sensory gating deficit and quality of life

The psychological well-being dimension of the SQoL correlated negatively with the SGI global score ( $\rho=-0.40$ ,  $p=0.01$ ), Figure 1-A, and the Distractibility dimension ( $\rho=-0.47$ ,  $p=0.001$ ), Figure 1-B.

**Table 2.** Schizophrenia Quality of Life questionnaire 18 (SQoL 18) scores for the two groups: schizophrenia without sensory gating deficit (P50supp  $\geq 50\%$ ) and schizophrenia with sensory gating deficit (P50supp  $< 50\%$ )

	SCZ (N=39)				P values
	Without Sensory Gating deficit (N=25)		With Sensory Gating deficit (N=14)		
	Mean	SD	Mean	SD	
SQoL 18					
Psychological well-being (PsW)	11.52	3.47	8.50	2.82	0.008
Self-esteem (SE)	7.48	2.31	5.79	2.72	0.040
Family relationships (RFa)	7.68	2.87	7.14	2.54	0.600
Relationships with friends (RFf)	5.72	2.84	5.00	2.54	0.400
Resilience (RE)	10.44	3.28	9.36	3.48	0.300
Physical well-being (PhW)	6.76	2.45	6.14	2.45	0.400
Autonomy (AU)	7.60	2.33	6.29	2.27	0.090
Sentimental Life (SL)	5.68	2.78	5.21	3.09	0.600
Global score	66.88	15.25	53.43	13.52	0.060



**Figure 1.** Scatter plots of the relationship between the Sensory Gating Inventory scores (“Global score” in Figure 1-A, and “Distractibility dimension score” in Figure 1-B) and the psychological well-being dimension score of the SQoL in 39 patients with schizophrenia. Filled circles (in grey) indicate the 14 patients with sensory gating deficit according to the percentage of P50 suppression

## DISCUSSION

This is the first study to investigate the relationships between sensory gating deficit, perceptual impairments related to sensory gating deficit and quality of life in patients with schizophrenia. In two groups of patients with chronic schizophrenia with and without sensory gating deficit who were comparable with regard to demographic, psychiatric and drug characteristics, the present findings: i) provide evidence for a worse quality of life in patients with schizophrenia and sensory gating deficit, and ii) establish a relationship between perceptual impairments related to sensory gating deficit and quality of life. Quality of life is poorly explained by psychotic symptoms and cognitive impairments (Boyer et al. 2015, Fervaha et al. 2013, Tolman et al. 2010). By focusing on sensory and perceptual impairments, the present findings afford a new determinant of the quality of life in schizophrenia.

The relationship between impaired sensory gating ability of the brain and impaired quality of life of patients with schizophrenia has long been suggested in patients with schizophrenia (Hetrick et al. 2012, Lipskaya-Velikovsky et al. 2015, McGhie et al. 1961, Venables 1964) but has never been demonstrated. For the first time, the present study provides evidence that impaired sensory gating ability of the brain may particularly impair the psychological well-being of patients with schizophrenia, which is an important dimension of quality of life (Boyer et al. 2015). Moreover, the findings highlight the fact that worse psychological well-being is associated with higher perceptual impairments related to sensory gating deficit (namely, the perception of being flooded with sensory stimuli). This relationship is in line with the fact that perceptual impairments may be a determinant of impaired psychological well-being (Boyer et al. 2015, Lipskaya-Velikovsky et al. 2015, Wilson & Cleary 1995).

Inflammatory processes, which play a central role in the pathogenesis of schizophrenia (Dickerson et al. 2013, Fond et al. 2014, Miller et al. 2014), could be a common pathophysiological pathway to explain the relationship between sensory gating deficit and impaired psychological well-being. Indeed, two separate studies found that a high level of CRP, a nonspecific marker for inflammatory processes that is elevated in patients with schizophrenia (Miller et al. 2014, Singh & Chaudhuri 2014), is related to: i) impaired psychological well-being (Faugere et al. 2015), and ii) sensory gating deficit (Micoulaud-Franchi et al. 2015). Further studies are thus needed to investigate the relationship between sensory gating capacity of the brain, psychological well-being and inflammatory processes in schizophrenia.

Furthermore, the functional involvement of the Superior Temporal Gyrus (STG), especially the left STG, could explain the relationship between sensory gating deficit and impaired psychological well-being. While this remains hypothetical, some facts are in favor of this

relationship. Indeed, on the one hand, the left STG was found to directly produce much or essentially all of the P50 ERP in the conditioning-testing paradigm and may be involved in the neural mechanism of auditory sensory gating deficit in schizophrenia (Hanlon et al. 2005, Huang et al. 2003, Thoma et al. 2003). On the other hand, the left STG has been also involved in the neural mechanism of self-awareness and metacognition (Gallagher & Frith 2003, Murphy et al. 2011), which are important cognitive processes involved in psychological well-being perception (Aghababian et al. 2011, Quiles et al. 2015). Thus, the left STG has been also recently involved in impaired psychological well-being as investigated with the SQoL 18 in schizophrenia (Boyer et al. 2012). However, further studies are thus needed to investigate the relationship between the sensory gating capacity of the brain, psychological well-being and the functional involvement of the STG in schizophrenia.

Psychological well-being was negatively correlated with the Distractibility dimension of the SGI. This dimension evaluates the subjective ability to be distracted or not by irrelevant environmental stimuli (in line with the perception of being flooded with sensory stimuli) and may be related to attentional deficit (Hetrick et al. 2012). This finding thus seems inconsistent with neurocognitive studies that did not find any relationship between attentional deficit as evaluated with the neuropsychological attention test and subjective quality of life (Tolman et al. 2010). Nevertheless, this finding may be consistent with another neurophysiological study using electrophysiological assessment of attention with the P300 amplitude obtained in classical oddball paradigms, which reflects the resource allocation capacity of the brain (Polich 2007) and which is related to the Distractibility dimension of the SGI (Micoulaud-Franchi et al. 2016). Indeed, an association between P300 amplitude deficit and impaired quality of life has been found (Higuchi et al. 2008). Moreover, in adult with Attention Deficit Hyperactivity Disorder (ADHD) it was found a relationship between P50 suppression deficit and P300 amplitude deficit (Micoulaud-Franchi et al. 2016). Further neurophysiological studies are thus needed to continue to explore the relationship between sensory gating (P50 suppression) and P300 amplitude in schizophrenia in order to better understand the hypothetical protective effect of sensory gating on higher cognitive function (Boutros et al. 2004, Gjini et al. 2010) and on quality of life in schizophrenia (Tolman et al. 2010).

The present study has several limitations. First, a healthy control group was not included and a full factorial statistical analysis with comparisons between healthy subjects with and without sensory gating deficit was not performed. Second, the sample size was relatively small, particularly for the group with sensory gating deficit (n=14), and it may not be representative of the entire population of patients with schizophrenia. Thus, confirmation of these findings is required in larger

groups of patients. Third, the study assessed quality of life with a specific type of instrument based exclusively on patients' subjective point of view (Boyer et al. 2015, Tolman et al. 2010). It would be interesting to know whether the findings can be replicated with objective measures of quality of life and functional disability (i.e. objective measures of community functioning as employment and independent living) (Tolman et al. 2010). Another limitation is that the study was cross-sectional and not prospective, so no causal inference can be made formally between sensory gating deficit, perceptual abnormalities related to sensory gating deficit and impaired quality of life. Replications with longitudinal approaches are required to investigate the effect of the timing of sensory gating deficit on quality of life.

## CONCLUSION

Despite the limitations, the present findings suggest that sensory gating deficit might be linked to impaired quality of life in patients with schizophrenia. Future studies should address the causal relationship between sensory gating deficit, perceptual impairments, attentional deficit and impaired quality of life in schizophrenia. The role of inflammatory processes and the functional involvement of STG also need to be investigated. The characterization of these relationships would have some potential clinical implications. From a clinical evaluation point of view, that would provide a better characterization of perceptual determinant of quality of life in schizophrenia. From a therapeutic point of view, that would provide to design new form of sensory remediation based on sensory gating deficit in order to be able to act more efficiently on quality of life in schizophrenia.

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Design of the study: Jean-Arthur Micoulaud-Franchi, Mélanie Faugere, Raphaëlle Richieri, Jean Vion-Dury, Christophe Lancon;

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Statistical analyses and interpretation of data: Jean-Arthur Micoulaud-Franchi, Mélanie Faugere, Laurent Boyer, Jean Vion-Dury;

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