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## The influence of idiomatic salience during the comprehension of ambiguous idioms by patients with schizophrenia<sup>☆</sup>

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## ABSTRACT

This study investigates whether figurative comprehension in schizophrenia is influenced by the salience of idiomatic meaning, and whether it is affected by clinical and demographic factors and IQ. Twenty-seven schizophrenic patients and 25 healthy participants performed a semantic relatedness judgement task which required the comprehension of idioms with two plausible meanings (literal and figurative). The study also used literal expressions. The figurative meaning of the idioms was less salient (ILS), more salient (IFS), or equally salient (IES) compared to the literal meaning. The results showed “a salience effect” (i.e., all participants understood the salient meanings better than the less salient meanings). There was also a “figurativeness effect” (i.e., healthy individuals understood the figurative meaning of IES better than the literal meaning but not schizophrenic patients). In patients, their thought disorder influenced the figurative comprehension of IFS. The verbal IQ influenced the figurative comprehension of ILS. The thought disorder, the verbal IQ, and the educational level influenced the figurative comprehension of IES. The patients' clinically evaluated concretism was associated with a reduced figurative comprehension of IFS and IES evaluated at a cognitive level. The results are discussed in relation to cognitive mechanisms which underscore figurative comprehension in schizophrenia.

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## 1. Introduction

Language and communication abnormalities, regarded as cardinal symptoms of schizophrenia (Bleuler, 1911), are often illustrated by patients' difficulty in interpreting the figurative forms of a language (for a review, Thomas and Daum, 2006). Evidence of impaired figurative language comprehension was provided using different forms of figurative language in a large variety of tasks: an oral interpretation of proverbs (Carpenter and Chapman, 1982; Harrow et al., 1974; Shimkunas et al., 1967; Sponheim et al., 2003; Kiang et al., 2007), metaphors and idioms (Tavano et al., 2008) during standardized clinical interviews; comprehension of proverbs (Barth and Küfferle, 2001; Brüne and Bodenstein, 2005) or of ambiguous idioms (Iakimova et al., 2006; Schettino et al., 2010) with multiple choice

tasks; and irony or/and metaphor comprehension in the context of short stories (Langdon et al., 2002; Mo et al., 2008), idioms (Titone et al., 2002; Strandburg et al., 1997) and comprehension of proverbs with semantic tasks (Spitzer, 1997).

Several studies have explored which clinical factors and cognitive impairments influence figurative comprehension in schizophrenic patients. It was shown that the bizarre and idiosyncratic interpretation of proverbs was associated with the severity of the schizophrenic patients' thought disorder (Sponheim et al., 2003), but less abstract and highly concrete interpretations were associated with several cognitive deficits related to attentional processes (Sponheim et al., 2003), executive functioning (Sponheim et al., 2003; Kiang et al., 2007), planning (Sponheim et al., 2003), working memory (Kiang et al., 2007), verbal memory (Sponheim et al., 2003), and general IQ (Sponheim et al., 2003). The comprehension of irony (Langdon et al., 2002), proverbs (Brüne and Bodenstein, 2005), and metaphors in the context of short stories (Mo et al., 2008) was associated with the theory of mind deficit in schizophrenia, but the comprehension of familiar metaphors and idioms was associated with linguistic dysfunctions, such as impaired syntax (Tavano et al., 2008). Langdon et al. (2002) suggested that metaphor and irony impairments in schizophrenia are related to different aspects of the psychopathology

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and may be underscored by different cognitive dysfunctions. These authors suggested that poor comprehension of metaphors, which was associated with negative symptoms, may be related to semantic memory dysfunctions, while impaired irony comprehension, which was associated with positive symptoms, may be related to the theory of mind deficits.

One common characteristic of these heterogeneous forms of figurative language is that most of them can also be interpreted literally. Titone et al. (2002) demonstrated that literalness has a negative impact on schizophrenic patients' ability to understand figurative language. By using a semantic priming paradigm, the authors examined the comprehension of two types of idioms: literally plausible and literally implausible. They demonstrated that schizophrenic patients were only able to actively generate a figurative meaning when no other interpretation of the idiom was possible. However, patients showed impaired activation of the figurative meaning when both figurative and literal meanings were plausible. Titone et al. (2002) suggested that schizophrenic patients' difficulties in accessing the figurative meaning when the literal one was also plausible may be explained by working memory limitations and/or a deficit of controlled processing. Schettino et al. (2010) studied the comprehension of ambiguous and unambiguous idioms in schizophrenic patients and healthy individuals by the means of a sentence-to-picture-matching task. The authors showed that schizophrenic patients were impaired in both types of idiomatic sentences but their performance was particularly poor in the case of ambiguous (literally plausible) idioms. In this study executive dysfunctions, which were considered to impair the literal meaning suppression/inhibition, were strong predictors of schizophrenic patients' performance on idiom comprehension.

However, one important characteristic of literally plausible figurative forms is that the plausibility of the literal interpretation may vary in function with its salience (familiarity, conventionality, and frequency of use). The salience of the idiomatic meaning crucially influences the cognitive and the brain processes involved in figurative comprehension (Giora et al., 2000; Giora, 2007; Mashal et al., 2005, 2008; Mashal and Faust, 2008; Laurent et al., 2006).

According to the Graded Salience Hypothesis (Giora, 1997, 2003), when the meaning is salient it is automatically activated from the semantic memory (before the less salient meaning). In this sense, this activation does not require the intervention of controlled processes. In contrast, when the figurative meaning is not salient, the comprehension involves the inhibition/suppression of the firstly accessed salient meaning, so more extra inferential processes, and a strong contextual support.

The focus on meaning salience may provide a fruitful cue to the understanding of the neurocognitive processes, underlying impaired figurative comprehension in patients with schizophrenia. Its relation to the clinical dimensions of the disorder can also be clarified. On its basis, we may suggest that potential difficulties in figurative comprehension in patients with schizophrenia would be particularly marked when the figurative meaning is not salient (for example, in irony, poetic metaphors, and in some idioms and proverbs). This result would be due to a deficit in controlled processes, such as a deficit of executive inhibitory mechanisms (Titone et al., 2000; Schettino et al., 2010), context processing (Chapman et al., 1976; Cohen and Servan-Schreiber, 1992), and other extra-linguistic mechanisms, such as the theory of mind comprehension (Brüne and Bodenstein, 2005; Mo et al., 2008). In contrast, the comprehension of figurative meaning may be relatively preserved when the figurative meaning is salient (for example, in literally implausible idioms, Titone et al., 2002, and in familiar metaphors, Iakimova et al., 2006). This facility is due to the fact that salient meaning is directly retrieved from semantic memory. Thought disorder may particularly influence the comprehension of figurative meaning when it is salient, given the well-established relationships between thought disorders and functional impairments in semantic memory (Goldberg et al., 1998;

Kuperberg, 2008). In contrast, positive and negative symptoms may influence the comprehension of figurative meaning, in particular when it is not salient, consistently with the correlations found between irony or metaphor comprehension and both positive and negative symptoms in patients with schizophrenia (Langdon et al., 2002).

Therefore, the first aim of the current study was to explore whether schizophrenic patients are sensible to the meaning salience or to the literalness/figurativeness of the idioms. Patients had to understand idioms with two meanings, one figurative and one literal. The second aim was to evaluate the impact of clinical and demographical factors and verbal IQ on the comprehension of meaning salience and figurativeness of idioms in schizophrenic patients.

These issues were addressed using a semantic decision task involving the comprehension of French ambiguous idioms with high literal (e.g., "to open the umbrella") or figurative (e.g., "to lose the compass") salience and of idioms with equal figurative and literal salience (e.g., "to swallow the pill") (for examples, see the Appendix). Subjects had to judge whether a target word was semantically related to the preceding idiom. As the idiomatic target was related to either the *global* literal or the *global* figurative meaning, the results (percentage of accuracy and reaction time) are expected to reflect the extent to which both (or one of the two) idiomatic meanings were activated and maintained after the idiomatic offset. If the schizophrenic patients can understand the salient aspects of the idiomatic meaning, they will more quickly and accurately judge the relationship between an idiom and a target word related to its salient meaning compared with its less salient meaning. When idioms have two equally salient meanings, all participants are expected to identify them with equal accuracy and rapidity. Alternatively, if patients are more likely to interpret the literal plausibility of the idioms, they will more rapidly and accurately identify the word targets related to their literal meaning compared with those related to their figurative meaning. The question of whether verbal IQ, demographical factors (age, education, and length of illness), and clinical symptoms (positive, negative, and thought disorder) influence the comprehension of idioms with two meanings will be explored using analyses of correlations between these factors, and the participants' ability to understand the figurative and literal meanings of the idioms.

## 2. Method

### 2.1. Participants

Twenty-seven patients, whose symptoms met the DSM IV criteria for schizophrenia (APA, 1996), took part in the study. All were outpatients from the psychiatric unit of Versailles Hospital (Centre Hospitalier de Versailles, Le Chesnay, France). The diagnosis of schizophrenia was confirmed by a short semi-structured interview (M.I.N.I., French version, Lecrubier et al., 1997). All patients received stable doses of medication (mean chlorpromazine equivalent per day: 329 mg, S.D. = 460 mg). Clinical symptoms were evaluated using the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987), the Scale for Thought, Language and Communication Disorders (TLC, Andreasen, 1979, French Translation, Bazin et al., 2002), and the Schizophrenia Communication Disorder scale (SCD, Bazin et al., 2005). The SCD assesses specific communication difficulties in patients with schizophrenia during a semi-structured conversational interview. It is one of the first theoretically-derived tools to assess communication difficulties in schizophrenic patients, and is based upon cognitive neuropsychological models of disorganised speech in schizophrenia (Hardy-Bayle et al., 2003).

Twenty five healthy participants were recruited from the local community through a newspaper advertisement. These participants were evaluated with the M.I.N.I. to assure that they had no past or present psychiatric disorders. Healthy participants were paid 30.50 Euros (~37 US dollars) for participating. The demographic and clinical data of the participants are presented in Table 1. All participants were native French speakers aged between 20 and 54. They had no history of neurological impairments, epilepsy, alcoholism, or regular drug use, and they had not undergone electroconvulsive therapy during the 6 preceding months. Healthy participants were matched on age and vocabulary skills (assessed with the Binois and Pichot vocabulary scale, Binois, 1947) with the patients with schizophrenia, but, in general, patients were less educated than healthy volunteers (see Table 1). All participants were informed of the study procedures and gave written informed consent.

**Table 1**  
Clinical and demographic characteristics of schizophrenic patients and healthy participants (mean values  $\pm$  standard deviation).

	Healthy participants	Schizophrenic patients	P
N	25	27	
Age	31.3 (8.8)	35.5 (8.2)	$P=0.09$ ns
Education (years)	13.4 (2.6)	11.2 (2.8)	$P<0.001$
Vocabulary	27.5 (4.02)	25.2 (5.7)	$P=0.09$ ns
Gender	17 men, 8 women	20 men, 7 women	
Length of illness		14.22 (8.24)	
PANSS <sup>a</sup>			
Positive scale		15.52 (6.18)	
Negative scale		18.63 (6.93)	
General scale		30.63 (11.6)	
V-SCD <sup>b</sup>		7.78 (3.29)	
TLC <sup>c</sup>		12.15 (5.72)	
CPZ <sup>d</sup>		329 (460)	

<sup>a</sup> Positive and Negative Syndrome Scale (Kay et al., 1987).

<sup>b</sup> Schizophrenic Communication Disorders Scale (Olivier et al., 1997; Bazin et al., 2005).

<sup>c</sup> Scale for Thought, Language and Communication Disorders (Andreasen, 1979).

<sup>d</sup> Medication: chlorpromazine equivalent mg/day.

## 2.2. Material

### 2.2.1. Experimental design

The material consisted of 240 expressions (idiomatic and literal). There were a) 80 experimental idioms which included 20 idioms with figurative salience, 20 with literal salience, and 40 with equal figurative and literal salience. Each idiom was followed by a target word which was semantically related to the *global* expression meaning (half to the literal meaning and half to the figurative one), but unrelated to the meaning of the last word of the idiom. The idioms were presented in two counterbalanced experimental lists so that idioms followed by a literal target in the first list by one participant are seen with the figurative target in the second list by another participant. There were b) 80 literal expressions with non ambiguous literal meanings, half of which were followed by semantically-related words and half by an unrelated ones; and c) 80 fillers expressions (40 idiomatic and 40 literal) followed by an unrelated word were presented to ensure a balance between related and unrelated targets in the material (120 related versus 120 unrelated targets). The fillers were not analysed. Literal expressions and fillers appeared unchanged in the two lists. An example of the material is presented in the Appendix.

### 2.2.2. Construction of the material and normative studies

All characteristics of the idioms used in our materials are presented in Table 2. All characteristics of the target words are presented in Table 3.

**2.2.2.1. The idioms. Selection of the experimental idioms:** the selection of the experimental idioms was guided by the normative data of Denhière et al. (2002). The “idiomatic” database contained 650 French idioms for which the ambiguity, familiarity, compositionality, literality, predictability and idiomaticity were rated in a series of separate rating procedures. For the purpose of the rating procedures, the 650 idioms were divided into eight lists and mixed with literal expressions. Each rating procedure was completed by a minimum of 180 participants. To evaluate the *idiomatic ambiguity*, the participants had to write down the first meaning that came to mind after reading each idiom. Of 650 idioms, 311 idioms were considered to have two or more meanings (e.g., figurative and literal). In our material, the experimental idioms were selected from these ambiguous idioms in the database. The selected idioms had a high

“idiomaticity” or figurative salience, a very low “idiomaticity” or literal salience, and equal figurative and literal salience.

*Salience or the “idiomaticity”* refers to the probability of providing the figurative meaning spontaneously. The % of the idiomaticity was calculated by dividing the number of the spontaneous idiomatic interpretations from the number of total interpretations given by the subjects (idiomatic and literal). Idioms with figurative salience (IFS) were idioms for which the % of the idiomaticity was at least 60%. Idioms with literal salience (ILS) were those for which the % of the idiomaticity was no more than 30%. Idioms with equal salience (IES) were those in which the % of the idiomaticity was around 50%. The % of the idiomaticity of the three types of idioms in our material was highly significant ( $F[2,77]=140.8$ ;  $P<0.0001$ ; IFS versus ILS,  $P<0.00001$ ; ISF versus IES,  $P<0.00001$ ; IES versus ILS,  $P<0.0001$ ).

*Literality of the idioms:* to evaluate the literality of the idioms subjects were asked to decide the degree to which there was a plausible literal interpretation of the idioms. The evaluation was done using a seven-point scale ranging from 1 – “the idiom did not have a possible literal interpretation” to 7 – “the idiom definitely had a clear and well-formed literal interpretation”. An example for 1 is the idiom “manger ses mots”, which in English means “to eat his/her own words”. An example of 7 is the idiom “briser la glace” which in English means “to break the ice”. All experimental idioms were chosen to have a clear and a well-formed literal interpretation. However, the plausibility of the literal meaning of idioms with literal salience was slightly higher (see Table 2) than the plausibility of the literal meaning of idioms with figurative salience ( $P<0.007$ ) and the idioms with equal figurative–literal salience ( $P<0.007$ ) (IES versus IFS,  $P=0.44$ ;  $F[2,77]=7.98$ ,  $P<0.007$ ).

All experimental idioms were familiar. The *familiarity* was rated on a seven-point familiarity scale ranging from 1 (highly unfamiliar) to 7 (highly familiar). The familiarity did not differ across the three types of idioms ( $F[2,77]=0.84$ ,  $P=0.43$ ).

The *predictability* of the idioms was evaluated with a standard closed procedure in which each participant had to complete the first portion of the idiom (e.g., “To lose the...”) with the first word (or a group of words) that comes to his mind (e.g., “compass”). The idioms had a moderate predictability level, which did not differ across the three types of idioms ( $F[2,77]=1.32$ ,  $P=0.27$ ).

The *compositionality* refers to the degree to which the individual meaning of each word in an idiom contributes independently to its idiomatic interpretation (Gibbs et al., 1989; Libben and Titone, 2008). The degree of the idioms’ compositionality was rated on a six-point scale. The first level was 1, that is the global figurative meaning is independent of the meaning of each individual word of the idiom. An example of such independence is the idiom: “avoir la dalle,” which in English means “to be very hungry”. The other extreme, 6 is attributed when the global idiomatic meaning results from the independent contribution of the meaning of each individual word in an idiom. An example for this is the idiom “jouer la comédie” which in English means “to play a comedy”. All experimental idioms had moderate to high compositionality. Idioms with equal literal and figurative salience were slightly less decomposable in comparison with the two other types of idioms ( $F[2,77]=15.11$ ,  $P<0.0003$ : IES versus ISL,  $P<0.008$ ; IES versus ILS:  $P<0.0001$ ; ISF versus ILS,  $P=0.13$ ).

All idioms were composed by a verb in infinitive followed by one or two nouns and their articles (e.g. “To share the cake” (French: “Partager le gâteau”), “To cut the peach in two” (French: “Couper la poire en deux”) or by a prepositional phrase (e.g., “To turn in circle” (French: “Tourner en rond”). The total length of each idiom was between 3 and 7 words. The IFS had exactly the same number of words as the ILS, whereas the IES had one word more than each of these idioms ( $F[2,77]=5.29$ ;  $P<0.007$ ; IFS versus ILS,  $P=1$ ; IES versus ILS,  $P<0.03$ ; IES versus ILS,  $P<0.03$ ).

**2.2.2.2. The literal expressions.** The control literal expressions had the same syntactic structure, length, level of familiarity ( $F[3,116]=1.67$ ,  $P=0.18$ ), and level of predictability ( $F[3,116]=0.91$ ,  $P=0.44$ ) as the idioms (Table 3).

### 2.2.2.3. The word targets

**2.2.2.3.1. The idiomatic word targets.** The characteristics of the idiomatic targets are detailed in Table 3. An important specificity of our material was that each idiom was followed by a target word which was semantically related to the *global* sentence meaning (half to the literal meaning and half to the figurative one), but was less related to the

**Table 2**  
Characteristics of idioms and literal expressions ( $\pm$  standard deviation).

	Idioms with equal figurative and literal salience	Idioms with figurative salience	Idioms with literal salience	Literal sentences
Length (number of words)	3.8 (1.20)	3.15 (0.37)	3.15 (0.36)	3.8 (0.7)
% Familiarity <sup>a</sup>	88.37 (5.3)	90.35 (4.9)	88.9 (6.6)	85.8 (11.5)
% Predictability <sup>b</sup>	48.25 (28.3)	58.8 (28.9)	45.5 (26)	52 (28.1)
% Literality <sup>c</sup>	63.55 (10.9)	67.15 (10)	75.35 (11.3)	
% Compositionality <sup>d</sup>	56 (11.4)	64.5 (7.8)	70.8 (9.1)	
% Idiomaticity <sup>e</sup>	44.97 (10.5)	78.20 (14.8)	15.7 (11)	

<sup>a</sup> Familiarity of the idioms (scalar ratings were transformed in percentage).

<sup>b</sup> The probability to complete the first portion of an incomplete expression with a final word which achieves an idiomatic expression (cloze procedure).

<sup>c</sup> The degree to which there was a plausible literal interpretation of the idioms (scalar ratings were transformed in percentage).

<sup>d</sup> The degree to which the individual meanings of each word in an idioms contributes independently to its idiomatic interpretation (scalar ratings were transformed in percentage).

<sup>e</sup> The probability of providing the figurative meaning spontaneously.

**Table 3**  
Characteristics of the idiomatic and the literal word targets.

	Idioms with equal figurative and literal salience		Idioms with figurative salience		Idioms with literal salience		Literal sentences	
	Figurative target	Literal target	Figurative target	Literal target	Figurative target	Literal target	Related target	Unrelated target
Length (number of letters)	7.5 (1.8)	6.2 (1.7)	8.2 (2.12)	6.7 (1.8)	7.7 (1.7)	6.7 (1.5)	6.5 (1.6)	6.4 (1.6)
Grammatical class <sup>a</sup>	20% N 52% V 28% A	80% N 20% V	15% N 70% V 15% A	80% N 15% V 5% A	15% N 55% V 30% A	65% N 25% V 10% A	80% N 15% V 5% A	90% N 10% V
Frequency of usage	8023 (1248)	6975 (7397)	7838 (8905)	7273 (9350)	4600 (5211)	6938 (8578)	9689 (1559)	6454 (6807)
Relation to the global meaning <sup>a</sup>	0.32 (0.2)	0.25 (0.1)	0.38 (0.2)	0.27 (0.1)	0.26 (0.1)	0.27 (0.2)	0.22 (0.2)	0.001 (0.07)
Relation to the last word <sup>b</sup>	0.13 (0.1)	0.17 (0.1)	0.18 (0.2)	0.18 (0.1)	0.12 (0.1)	0.20 (0.2)	0.23 (0.2)	0.12 (0.1)

<sup>a</sup> Latent Semantic Analysis.

<sup>b</sup> Nouns (N), verbs (V), and adjectives (A).

meaning of the last word of the idiom. The semantic link between the idiom and the target word and between the last word of the idiom and the target word was calculated with the Latent Semantic Analysis (LSA) (Landauer and Dumais, 1997; <http://lsa.colorado.edu>) using the “Français-Monde” database with 300 factors. To compare the semantic link between multiple terms within a particular semantic space, we used a pairwise “document to term” comparison. We focused on the link between the global expressions’ meaning and the word target. We also did a pairwise “term to term” comparison to calculate the link between the last word of a phrase and the word target.

The level of the relation between the word target and the last word of the idiom and the word target and the global meaning of the idiom was examined by an ANOVA with Idiom-Type of Target (IES-FT, IES-LT, IFS-FT, IFS-LT, ILS-FT, ILS-LT) and “Type of LSA measure” (LSA – global meaning versus LSA – last word). The general effect “Type of LSA” was significant ( $F(1.154) = 122.04; P < 0.0001$ ): word targets were more related to the global meaning of the idioms (LSA: mean = 0.29) than to its last words (LSA: mean = 0.16). The interaction “Idiom-Target Relation” and “Type of LSA measure” was significant ( $F(5.154) = 4.67; P < 0.0005$ ). Pairwise comparisons conducted by the LSD post-hoc test indicated that the difference between the two LSA measures was significant in all idioms: IES figurative target – global meaning versus figurative target – last word:  $P < 0.00001$ ; IES literal target – global meaning versus literal target – last word,  $P < 0.0003$ ; IFS idiomatic target – global meaning versus idiomatic target – last word,  $P < 0.0001$ ; IFS literal target – global meaning versus literal target – last word,  $P < 0.0001$ ; ILS idiomatic target – global meaning versus idiomatic target – last word of the idiom,  $P < 0.0001$ ; ILS literal target – global meaning versus literal target – last word,  $P < 0.04$ , whereas in each specific Idiom-target relation the difference between the two levels of LSA measured for figurative targets and for literal targets was not significant (all  $P_s > 0.05$ ).

Idiomatic word targets were nouns, verbs, or adjectives. All of these were of a comparable proportion in each idiomatic type (IES: 50% of nouns, 36% of verbs, and 14% of adjectives; IFS: 48% of nouns, 42% of verbs, and 10% of adjectives; ILS: 40% of nouns, 40% of verbs, and 20% of adjectives). The proportion of each grammatical class differed as a function of the type of target (figurative versus literal). Most of the figurative targets were verbs (59%) but most of the literal targets were nouns (75%). However, this distribution was similar among the three idiomatic types (for a detailed presentation see Table 3). The discrepancy between the percentage of targets of each grammatical class in figurative and literal targets was admitted in order to favour the ecological quality of the material. In fact, subjects who participated in the construction-phase of the study naturally produced these grammatical classes of target words, when asked to provide one word which best resumes the global meaning of each idiom.

The length of the idiomatic targets (mean number of letters) as well as the frequency of use of the target words (BRULEX, Content et al., 1990) did not differ across idiomatic types (length:  $F(2.77) = 0.33, P = 0.71$ ; frequency of use:  $F(2.77) = 0.52, P = 0.59$ ).

**2.2.2.3.2. The targets of the literal control expressions.** Word targets related to the literal expressions had a semantic link with the global literal meaning and with the last word in the expression: LSA literal expression – global meaning = 0.22 (S.D. = 0.16), LSA literal expression – last word = 0.23 (S.D. = 0.16). In contrast, unrelated word targets did not have any link with the global meaning of the literal expressions: LSA = 0.001 (S.D. = 0.07). Unrelated word targets had also a minimal link with its last word: LSA: last word target = 0.117 (S.D. = 0.1). The ANOVA 2 (Relation: related versus unrelated)  $\times$  2 (Type of LSA: global meaning versus last word) revealed a significant “Relation effect” ( $F(1.39) = 39.55; P < 0.0001$ ). The level of LSA was higher for related targets (mean = 0.22) than for unrelated targets (mean = 0.06). The “Type of LSA” effect ( $F(1.39) = 23.99; P < 0.0002$ ) revealed that the level of LSA was higher for Target-Last word than for Target-Global meaning. However, the interaction Relation  $\times$  Type of LSA ( $F(1.39) = 12.67; P < 0.0009$ ) indicated that the latter difference was observed only when word targets were unrelated (unrelated targets: LSA – global meaning versus LSA last word,  $P < 0.00001$ ). On the contrary, this difference was not observed when the word targets were related to literal sentences (related targets: LSA – global meaning versus LSA last word,  $P = 0.45$ ).

The literal targets were nouns (related targets = 80%; unrelated = 90%), verbs (related targets = 15%; unrelated = 10%), or adjectives (related targets = 5%; unrelated = 0).

Related targets had a similar length and frequency of use in comparison with unrelated targets (length:  $F[1.39] = 0.17, P = 0.69$ ; frequency of use:  $F[1.39] = 1.62, P = 0.21$ ). The frequency of use was highly similar across all experimental targets ( $F[7.31] = 0.42, P = 0.88$ ).

**2.2.2.4. The fillers.** Both idiomatic and literal expressions used as fillers had the same syntactic structure and length as the experimental expressions. The idiomatic fillers had a similar level of familiarity (mean = 86%) and predictability (mean = 52%) in comparison with the three types of experimental idioms (familiarity:  $F[3.116] = 1.67; P = 0.18$ ; predictability:  $F[3.116] = 0.92, P = 0.44$ ). All fillers were followed by unrelated word targets. The absence of any semantic relation between each filler expression and its target word was confirmed by the LSA measures (mean value of semantic relation = 0.003 (S.D. = 0.05)).

### 2.3. Procedure

Participants were seated in front of a computer screen. They were at about 80 cm away from it. Each expression was presented visually in two successive blocks: the first part (e.g. “To stow the”) appeared for 550 ms and the second part (e.g. “weapons”) for 450 ms. There was a pause of 300 ms between the two blocks. The target word was presented 300 ms after each sentence’s offset and was displayed for 450 ms. Participants were instructed to silently read the expressions and to decide as rapidly and as accurately as possible whether or not the target word was semantically related to the global meaning of the sentence. The subjects had to indicate their reply by pressing a button (the left button of the mouse was used for “yes” and the right button was used for “no”). A new trial appears 1850 ms after the target offset. The participants could respond at any time after the target word appeared, within the total reaction time interval of 2300 ms. A practice session containing a similar set of 20 stimuli preceded the experiment and familiarized the participants with the task.

### 2.4. Statistical analysis

The accuracy of the semantic judgment (mean percentage of correct judgments) and the response latency (in milliseconds) of correct judgements were recorded for all participants.

These data were analysed by two separate ANOVAs for literal expressions, group (healthy versus schizophrenic participants)  $\times$  relatedness (related versus unrelated literal targets); for idioms, group  $\times$  idiom (figurative salience [IFS], literal [ILS] salience, equal figurative and literal salience [IES])  $\times$  word target (figurative [FT], literal [LT]). Significant interactions were analysed using post-hoc tests (HSD Tukey). Pearson product moment correlations were calculated between the demographic and clinical variables (schizophrenic patients) and the participants’ accuracy. The  $\alpha$  level was set to 0.05.

## 3. Results

The results are summarized in Table 4.

### 3.1. Literal expressions – semantically related versus unrelated word targets

The ANOVAs performed for literal expressions revealed significant “group” effects for both accuracy ( $F[1.50] = 12.51, P < 0.0008$ ) and reaction time ( $F[1.50] = 25.77, P < 0.0006$ ). Schizophrenic patients were slower (1155 ms for patients versus 932 ms for controls) and less accurate (90% for patients versus 95% for controls) than healthy participants. A significant “relatedness” effect was obtained on

**Table 4**

Mean reaction times (in milliseconds) and mean percentage of correct responses ( $\pm$  standard deviation) for healthy participants and schizophrenic patients in the semantic relatedness judgement task.

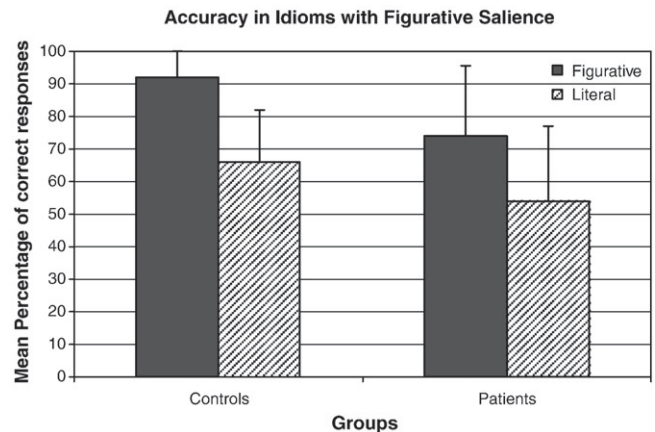
Type of expressions/word target	Healthy controls N = 25	Schizophrenic patients n = 27
<b>Idiom with figurative salience</b>		
Figuratively related target	92% ( $\pm$ 8.6)	74% ( $\pm$ 21.5)
	855 ms ( $\pm$ 102)	1130 ms ( $\pm$ 239)
Literally related target	66% ( $\pm$ 16)	54% ( $\pm$ 23)
	889 ms ( $\pm$ 121)	1140 ms ( $\pm$ 190)
<b>Idiom with literal salience</b>		
Figuratively related target	58% ( $\pm$ 13.8)	48% ( $\pm$ 20.6)
	934 ms ( $\pm$ 113)	1147 ms ( $\pm$ 210)
Literally related target	86% ( $\pm$ 12.5)	72% ( $\pm$ 21.5)
	856 ms ( $\pm$ 123)	1073 ms ( $\pm$ 200)
<b>Idiom with equal salience</b>		
Figuratively related target	79% ( $\pm$ 12.6)	63% ( $\pm$ 21.5)
	863 ms ( $\pm$ 120)	1116 ms ( $\pm$ 242)
Literally related target	61% ( $\pm$ 15)	56% ( $\pm$ 20.8)
	908 ms ( $\pm$ 181)	1122 ms ( $\pm$ 206)
<b>Literal expressions</b>		
Related target	94% ( $\pm$ 4.8)	92% ( $\pm$ 7.5)
	978 ms ( $\pm$ 134)	1198 ms ( $\pm$ 180)
Unrelated target	96% ( $\pm$ 4.8)	89% ( $\pm$ 6.9)
	885 ms ( $\pm$ 181)	1112 ms ( $\pm$ 172)

reaction time measures ( $F[1.50] = 31.46$ ,  $P < 0.00001$ ) revealing that participants were slower to judge the related targets compared to unrelated ones (999 ms for unrelated versus 1088 ms for related). The accuracy did not differ as a function of the relatedness ( $F[1.50] = 0.19$ ,  $P = 0.55$  ns). The interactions “group  $\times$  relatedness” were not significant for either accuracy ( $F[1.50] = 3.07$ ,  $P = 0.10$ ) or reaction time ( $F[1.50] = 0.04$ ,  $P = 0.85$ ).

### 3.2. Idioms – word targets related to the figurative or literal meaning

The ANOVA measures of group (schizophrenic versus controls)  $\times$  idiom (IFS, ILS, and IES)  $\times$  target (FT and LT) showed significant “group” effects for both accuracy ( $F[1.50] = 13.48$ ,  $P < 0.0005$ ) and reaction times ( $F[1.50] = 30.11$ ,  $P < 0.0001$ ): schizophrenic patients were slower (1122 ms for patients versus 884 ms for controls) and less accurate (60% for patients versus 74% for controls) than healthy participants. The main effect of “idiom type” was significant only in the analysis of accuracy ( $F[2.100] = 0.99$ ,  $P < 0.0001$ ). All participants were more accurate in judging the relatedness of targets associated with IFS (72%) relative to targets related with ILS (66%) and IES (65%) (IFS versus ILS,  $P < 0.01$ ; IFS versus IES,  $P < 0.001$ ; ILS versus IES:  $P = 0.76$ ).

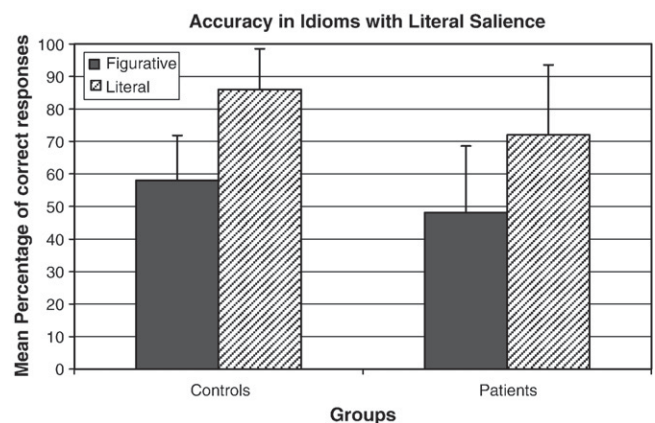
The interactions “idiom type”  $\times$  “word target” were significant in both accuracy ( $F[2.100] = 102.80$ ;  $P < 0.0001$ ) and reaction time measures ( $F[2.100] = 13.71$ ,  $P < 0.0005$ ). As for the accuracy, a detailed analysis of the interaction revealed a “salience effect” both for IFS and ILS. Figurative targets associated with IFS were judged more accurately than literal targets (FT: 83% versus LT: 60%,  $P < 0.0001$ ) (see Fig. 1). However, literal targets associated with ILS were judged more accurately than figurative ones (FT, 54% versus LT, 79%;  $P < 0.0001$ ) (see Fig. 2). There was a “bias of figurativeness” as far as IES were concerned. Figurative targets associated with the IES were judged more accurately than literal targets (FT, 71% versus LT, 58%;  $P < 0.0002$ ). However, FT of IES were judged less accurately than FT of IFS ( $P < 0.0002$ ). The interaction “group”  $\times$  “idiom”  $\times$  “target” approached the level of significance ( $F[2.100] = 2.39$ ;  $P < 0.09$ ). We further analysed the sense of the interaction because our main hypotheses were focused on any differential effect between patients



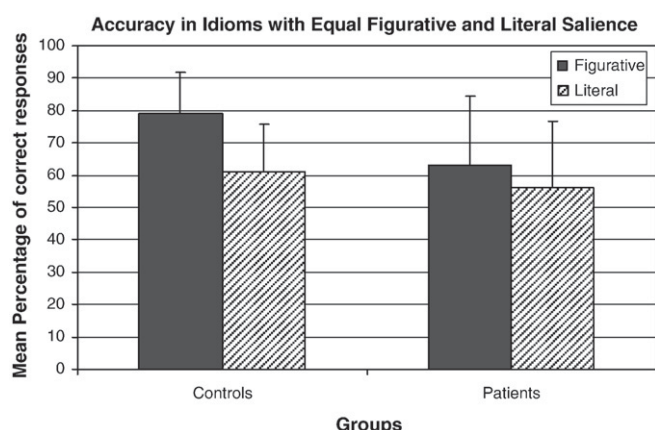
**Fig. 1.** Patients' and controls' mean percentage of correct responses for figuratively related and literally related word targets to idioms with figurative salience.

and control participants on each idiomatic type. These analyses showed that the “salience effect” was observed in both groups (healthy subjects, IFS–FT versus LT,  $P < 0.0001$ ; ILS–FT versus LT,  $P < 0.0001$ ; schizophrenic patients, IFS–FT versus LT,  $P < 0.0001$ ; ILS–FT versus LT,  $P < 0.0001$ ). However, the “bias of figurativeness” was significant only in the group of healthy participants (healthy participants, IES–FT versus LT,  $P < 0.0003$ ; schizophrenic patients, IES–FT versus LT,  $P = 0.76$ ) (see Fig. 3).

In the reaction time data, literal ILS targets were more rapidly accepted than figurative targets (ILS: literal [965 ms] versus figurative [1041 ms],  $P < 0.0001$ ). In contrast, the rapidity of the semantic judgement did not differ as a function of the literality or the figurativeness of the targets associated with IFS and IES (IFS, literal [1029 ms] versus figurative [1014 ms],  $P = 0.94$ ; IES: literal [1010 ms] versus figurative [1034 ms],  $P = 0.63$ ). Analyses of RT, repeated after logarithmically transforming the data, yielded the same pattern of results. All other main effects or interactions were not significant in both % CR and RT measures: the percentage of correct judgements – group  $\times$  idiom:  $F(2.100) = 0.99$ ,  $P = 0.37$ ; word target:  $F(1.50) = 1.72$ ,  $P = 0.20$ ; group  $\times$  word target:  $F(1.50) = 0.78$ ,  $P = 0.38$ ; reaction times – word target:  $F(1.50) = 0.81$ ,  $P = 0.37$ ; type of idiom: ( $F[2.100] = 0.003$ ,  $P = 0.99$ ; group  $\times$  idiom,  $F[2.100] = 1.45$ ,  $P = 0.24$ ; word target,  $F[1.50] = 0.81$ ,  $P = 0.37$ ; group  $\times$  word target:  $F[1.50] = 0.91$ ,  $P = 0.34$ ; group  $\times$  idiom type  $\times$  word target:  $F[2.100] = 0.47$ ,  $P = 0.63$ ).



**Fig. 2.** Patients' and controls' mean percentage of correct responses for figuratively related and literally related word targets to idioms with literal salience.



**Fig. 3.** Patients' and controls' mean percentage of correct responses for figuratively related and literally related word targets to idioms with equal figurative and literal salience.

#### 4. Correlations

All correlations are presented in Table 5.

##### 4.1. Schizophrenic patients

When the figurative meaning was salient (IFS), the accuracy of figurative comprehension was negatively correlated with the patients' level of thought disorder evaluated with the SCD scale ( $r = -0.53$ ,  $P = 0.004$ ) and with the abstraction score evaluated by item N5 of the PANSS scale ( $r = -0.47$ ,  $P = 0.01$ ). When the figurative meaning was not salient (ILS), the accuracy of figurative comprehension was negatively correlated with the abstraction score ( $r = -0.41$ ,  $P = 0.03$ ) and positively correlated with the verbal IQ ( $r = 0.47$ ,  $P = 0.01$ ). When the figurative meaning was equally salient to the literal meaning (IES), accuracy on figurative comprehension was negatively correlated with the thought disorder evaluated by the SCD scale ( $r = -0.47$ ,  $P = 0.01$ ) and positively correlated with education ( $r = 0.40$ ,  $P = 0.04$ ), and the verbal IQ ( $r = 0.62$ ,  $P = 0.001$ ). Accuracy of related

targets to literal expressions was negatively correlated with the thought disorder evaluated by the SCD scale ( $r = -0.54$ ,  $P = 0.004$ ). Accuracy of unrelated targets to literal expressions was negatively correlated with the positive symptoms (PANSS scale) ( $r = -0.44$ ,  $P = 0.02$ ).

##### 4.2. Healthy participants

In healthy participants, the figurative meaning comprehension of idioms with equally salient meanings was positively correlated with the verbal IQ ( $r = 0.51$ ,  $P < .01$ ).

#### 5. Discussion

The current study investigated whether the comprehension of idioms with two meanings (literal and figurative) is guided by the salience or by the literality/figurativeness of the idioms. We compared patients with schizophrenia with healthy individuals. We also assessed what demographic and/or clinical factors may influence the comprehension of the literal/figurative meaning or the salient/less salient meanings of the idioms.

In general, schizophrenic patients were less accurate and slower in their response than healthy individuals. However, despite these general quantitative differences between the two groups, it was crucial to explore whether patients and healthy individuals were sensitive to the same linguistic factors which modulate figurative comprehension.

The major factor which exerted an influence on idiomatic comprehension was the salience of the idiomatic meaning, consistent with the graded salience hypothesis of Giora (1997, 2003). In both groups, word targets related to the salient meaning of an idiom (figurative targets of idioms with figurative salience and literal targets of idioms with literal salience) were more accurately judged as related to the idiom compared with word targets related to the less salient meaning (literal targets of idioms with figurative salience and figurative targets of idioms with literal salience, Figs. 1 and 2). A previous study by Titone et al. (2002) showed that the literal plausibility of the idioms negatively influences the figurative comprehension in schizophrenic patients. We extended this conclusion by demonstrating that the impact of the literal plausibility on

**Table 5**

Correlations between the mean percentage of schizophrenic patients' correct responses and their demographic and the clinical characteristics.

	Idioms with figurative salience		Idioms with literal salience		Idioms with equal figurative and literal salience		Literal expressions	
	Figurative word target	Literal word target	Figurative word target	Literal word target	Figurative word target	Literal word target	Related word target	Unrelated word target
Age	0.09	0.09	0.05	0.05	0.16	-0.005	0.29	0.07
Verbal IQ	0.33	0.02	0.47**	0.25	0.62**	0.21	0.23	0.24
Education	0.07	0.42	0.31	0.80	0.40*	0.22	0.10	-0.001
Illness duration (years)	0.10	0.06	0.04	-0.04	0.10	-0.03	0.26	0.06
Abstraction (N5 PANSS) <sup>a</sup>	-0.47**	-0.06	-0.41*	-0.23	0.10	-0.03	0.26	0.06
TLC <sup>b</sup>	-0.20	-0.15	0.20	-0.19	-0.28	-0.03	0.01	0.25
SCD <sup>c</sup>	-0.53**	-0.28	-0.22	-0.26	-0.47**	-0.33	-0.54**	-0.22
PANSS positive scale <sup>a</sup>	-0.23	-0.22	-0.06	-0.28	-0.15	-0.38	0.15	-0.44**
PANSS negative scale <sup>a</sup>	-0.31	-0.36	-0.14	-0.22	-0.29	-0.33	-0.24	-0.03
PANSS general scale <sup>a</sup>	-0.19	-0.05	-0.27	0.03	0.02	-0.28	-0.04	-0.07

<sup>a</sup> Positive and Negative Syndrome Scale (Kay et al., 1987).

<sup>b</sup> Scale for Thought, Language and Communication Disorders (Andreasen, 1979).

<sup>c</sup> Schizophrenic Communication disorders Scale (Olivier et al., 1997; Bazin et al., 2005).

\*  $P < .05$ .

\*\*  $P < .01$ .

idiom comprehension in schizophrenia depends on the salience of the idiomatic meaning. Schizophrenic patients are able to access the figurative meaning of idioms with literal plausibility when the figurative meaning is more salient than the literal meaning. However, our results also showed that when the figurative meaning was salient, the accuracy of its comprehension was negatively correlated with the patients' severity of thought disorder as evaluated by the French SCD scale. In contrast, it was neither correlated with verbal IQ nor with the educational level.

When the figurative meaning is salient, its comprehension does not require controlled or extra-linguistic processes but is directly accessed from the lexicon (Giora, 1997, 2003; Laurent et al., 2006). Consequently, it is plausible that schizophrenic patients with severe thought disorder may exhibit reduced comprehension of salient figurative meaning because of functional impairments in semantic memory. Other authors have also established a hypothetical relationship between a dysfunction in semantic memory and an impaired metaphor comprehension in patients with schizophrenia (Langdon et al., 2002). At the clinical level, such functional deficits in thought-disordered schizophrenic patients may be reflected by the bizarre and the idiosyncratic interpretations of familiar proverbs that are relatively independent of general intelligence (Sponheim et al., 2003).

Furthermore, the severity of positive symptoms evaluated by the PANSS scale was negatively correlated with the patients' performance on unrelated targets to literal sentences; the higher the level of positive symptoms, the lower the accuracy on unrelated word targets. In other words, positive symptoms enhance the possibility of considering whether a literal phrase and a word which does not have a semantic relation are related.

When the figurative meaning was not salient, the accuracy of figurative comprehension was correlated with the verbal IQ. This result suggests that a less expanded vocabulary may reduce the patients' awareness of figurative meanings of idioms with literal salience. An additional explanation comes from the focus on cognitive processes required to access the less salient meaning of idioms. In fact, according to the Graded salience hypothesis (Giora, 2003), when the figurative meaning is not salient, its comprehension requires several high-level cognitive processes, such as suppression of the salient (literal) meaning, efficient context processing, and other inferential processes. These cognitive processes are generally less efficient in schizophrenic patients in comparison with healthy individuals (e.g., executive functions: Schettino et al., 2010; suppression: Titone et al., 2000; context processing: Chapman et al., 1976; Cohen and Servan-Schreiber, 1992). Consequently, other figurative forms of language in which the figurative meaning is less salient than the literal meaning may be particularly difficult for schizophrenic patients to understand (e.g. irony, Langdon et al., 2002; Mo et al., 2008; some proverbs, Brüne and Bodenstein, 2005; Kiang et al., 2007; poetic metaphors, Kircher et al., 2007).

Interestingly, we found a negative correlation between the accuracy on both salient and less salient figurative meaning comprehension and the score of concretism obtained from proverb and simile comprehension (item N5 of the PANSS) in schizophrenic patients. A previous study by Kircher et al. (2007), reported that the quantitative reduction of brain activation during metaphor comprehension was correlated with the concretism evaluated by the same item of the PANSS scale in schizophrenic patients. These authors suggested that the concretism may be mediated by a dysfunction of the left inferior frontal and the right lateral temporal cortices during metaphor comprehension in schizophrenic patients. Our results provide further evidence that concretism, which is observed at the clinical level, may be underscored by distinct cognitive dysfunctions in schizophrenic patients at the cognitive level.

When the figurative meaning was as equally salient as the literal meaning, we expected that both meanings would exhibit an equal level of activation. In contrast with this hypothesis, our results showed a

“figurativeness bias”; the figurative meaning was more accurately accessed in comparison with the literal meaning of these idioms (cf. Fig. 3). The “figurativeness bias” may have been induced by the high percentage of idioms in our experiment (50% of idioms). Consequently, the internal characteristics of the task may have provided *global contextual cues* which may have biased the figurative meaning of the idioms with equal salience (for earlier psycholinguistic discussion of this view see Bobrow and Bell, 1973).

The marginally significant interaction “group × type of idiom × target word” showed that the “figurativeness bias” was exhibited by healthy participants, but not by schizophrenic patients (cf. Fig. 3). This result provides evidence that schizophrenic patients may have been less sensitive than healthy individuals to implicit contextual cues which may have enhanced the probability of comprehending figuratively the idioms with equal figurative and literal salience (see also Iakimova et al., 2006). The absence of a “figurativeness bias” in schizophrenic patients may be further influenced by the patients' thought disorder consistently with correlation found between the severity of formal thought disorder evaluated by the V-SCD scale and the accuracy of figurative comprehension of idioms with equal figurative and literal salience. In contrast, figurative comprehension of idioms with equal figurative and literal salience appeared to be enhanced by high verbal IQ and high educational level. Interestingly, the correlation between the verbal IQ and the figurative comprehension of idioms with equal figurative and literal salience was also observed in healthy subjects. A previous study by Kazmerski et al. (2003) also reported that healthy individuals with a low verbal IQ have more difficulty to understand the figurative meaning of literally plausible metaphors in comparison with individuals with a high verbal IQ. In light of the latter results, it may be suggested that the comprehension of the figurative meaning of other forms of figurative language in which the figurative and the literal meanings are salient enough to be activated in parallel (e.g., some familiar metaphors, Giora, 2003) may be influenced by the severity of formal thought disorder, verbal IQ and education in schizophrenic patients.

It should be noted that the analysis of the mean reaction times were only partially modulated by salience. In effect, a salience effect on reaction times was observed only with the idioms with literal salience: figurative targets of the idioms with literal salience took longer to accept than their figurative counterparts. In contrast, both word targets (literal and figurative) were judged with similar reaction times when they were related to idioms with figurative salience. The latter results should be further explored with methods sensitive to the precise temporal dynamic of the meaning activation as a function of the idiomatic saliency (i.e. literal or figurative) (i.e. the method of event-related potentials).

Some limitations of the present study should be highlighted. The first limitation is related to our willingness to preserve the ecological validity of the idiomatic material and to control a large number of stimuli characteristics. For example, the grammatical class (i.e. nouns, verbs, and adjectives) of word targets differed in the idiomatic type condition. Such limitation was accepted in order to privilege the spontaneous interpretations of the idioms, reported by the participants in the pre-test procedures. In our study, the grammatical class of word targets did not influence salient meaning comprehension, since word targets related to the salient meaning (i.e. figurative targets which were in majority verbs and literal targets which were in majority nouns) were better understood than word targets related to the less salient meaning. Rossell and Batty (2008) showed that the semantic deficits in schizophrenic patients were not dependent on the grammatical class of the words (nouns, verbs and adjectives). However, given that verbs and nouns differ on their semantic, syntactic and morphological characteristics (Vigliocco et al., 2008) and that their processing is found to be associated with different brain areas (Shapiro et al., 2005; Newman et al., 2009) the proportion of nouns and verbs should be further

controlled in studies which aim to explore the neural bases of idiomatic comprehension.

The second limitation was that some intrinsic characteristics of the idioms such as literality and compositionality, which may influence idiomatic comprehension (Titone and Connine, 1994; Gibbs et al., 1989), were not perfectly matched across idioms. For example, idioms with literal salience were more literal than idioms with figurative salience and than idioms with equal literal and figurative salience. It might have further reinforced the literal meaning of the idioms with literal salience. Idioms with equal literal and figurative salience were less compositional than the two other types of idioms. However, the role of the compositionality in idiom comprehension in adults was empirically contested (Tabossi et al., 2009) but it plays a critical role in idiom comprehension in young children (Caillies and Butcher, 2007; Caillies and Le Sourn-Bissaoui, 2006). Further studies should specifically explore the role of intrinsic characteristics of the idioms on figurative comprehension in patients with schizophrenia.

Scientific research on figurative comprehension can provide a clue to a better understanding of the neurocognitive mechanisms underlying schizophrenia. The focus on salience in figurative language may be interesting when exploring the pathophysiology of schizophrenia, especially with regard to hemispheric lateralisation. In fact, a growing body of recent research provides evidence that the relative contribution of each brain hemisphere in figurative comprehension differs, especially as a function of the meaning salience (Giora et al., 2000; Mashal et al., 2005; Giora, 2007). The left hemisphere was shown to be highly involved in processing salient meanings (Ahrens et al., 2007; Lee and Dapretto, 2006), while the right hemisphere was shown to be involved in processing weakly salient meanings (Arzouan et al., 2007; Faust and Mashal, 2007; Mashal et al., 2005, 2008; Mashal and Faust, 2008; Giora, 2007). Thus, our experiment may be used to further explore the lateralized cerebral mechanisms involved in figurative language in schizophrenia.

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#### Appendix A. Example of the experimental material in French (English translation in brackets)

I. Idiomatic sentences and its related target words		
	Figurative target	Literal target
<i>1. Idioms with figurative salience</i>		
Jeter l'éponge (to throw the sponge)	Abandonner (to give up)	Poser (to put down)
Tender la main (to hold out the hand)	Aider (to help)	Saluer (to salute)
Vider son sac (to empty his/her bag)	Confession (confession)	Décharger (to relieve oneself)
Perdre la boussole (to lose the compass)	Affolé (frightened)	Négligent (negligent)
<i>2. Idioms with literal salience</i>		
Ouvrir le parapluie (to open the umbrella)	Protéger (to protect)	s'abriter (to take shelter)
Partager le gâteau (to share the cake)	Répartir (to share)	Couper (to cut)
Fermer les yeux (to close the eyes)	Pardonner (to forgive)	Dormir (to sleep)
Cultiver son jardin (to cultivate his/her garden)	Intérêt (interests)	Bêcher (to dig with a spade)

#### Appendix A (continued)

I. Idiomatic sentences and its related target words		
	Figurative target	Literal target
<i>3. Idioms with equal literal and figurative salience</i>		
Régler son compte (to regulate his/her account)	Se venger (to take revenge)	Rembourser (to repay)
Avaler la pilule (to swallow the pill)	Accepter (to accept)	Malade (to be ill)
Montrer les dents (to show the teeth)	Menacer (to threaten)	Chien (a dog)
Tourner en rond (to turn in round)	Désœuvré (unoccupied)	Toupie (whirligig)
II. Literal expressions		
Accorder la guitare (to accord the guitare)	Related target	Unrelated target Loge (loge)
Remplir une feuille (to fill a sheet)		Dresser (to tame)
Appuyer sur le bouton (to press on a button)	Sonner (to ring)	
Trier le courrier (to sort the mail)	Facteur (postman)	

#### References

- A.P.A (American Psychiatric Association), 1996. Diagnostic and statistical manual of mental disorders, French version: Manuel diagnostique et statistique des troubles mentaux. Fourth Edition. Masson, Paris.
- Ahrens, K., Liu, H., Lee, C., Gong, S., Fang, S., Hsu, Y.Y., 2007. Functional MRI of conventional and anomalous metaphors in Mandarin Chinese. *Brain and Language* 100, 163–171.
- Andreasen, N.C., 1979. Thought, language and communication disorders: I. Clinical assessment, definition of terms, and evaluation of their reliability. *Archives of General Psychiatry* 36, 1315–1321.
- Arzouan, Y., Goldstein, A., Faust, M., 2007. Brainwaves are stethoscopes: ERP correlates of novel metaphor comprehension. *Brain Research* 30, 69–81.
- Barth, A., Küfferle, B., 2001. Development of a proverb test for assessment of concrete thinking problems in schizophrenic patients. *Nervenarzt* 72, 853–858.
- Bazin, N., Lefrère, F., Passerieux, C., Sarfati, Y., Hardy-Bayle, M.C., 2002. Formal thought disorders: French translation of the Thought, Language and Communication Assessment Scale. *Encephale* 28, 109–119.
- Bazin, N., Sarfati, Y., Lefrère, F., Passerieux, C., Hardy-Bayle, M.C., 2005. Scale for the evaluation of communication disorders in patients with schizophrenia: a validation study. *Schizophrenia Research* 77, 75–84.
- Binois, R.P.P., 1947. Test de vocabulaire. Edition du centre de Psychologie appliquée, Paris.
- Bleuler, E., 1911. Dementia praecox oder Gruppe der schizophrenien, Leipzig-Vienne, French Translation. Dementia praecox ou groupe des schizophrénies, Paris, EPEL, 1993.
- Bobrow, S.A., Bell, S.M., 1973. On catching on to idiomatic expressions. *Memory and Cognition* 1, 343–346.
- Brüne, M., Bodenstein, L., 2005. Proverb comprehension reconsidered – ‘theory of mind’ and the pragmatic use of language in schizophrenia. *Schizophrenia Research* 75, 233–239.
- Caillies, S., Butcher, K., 2007. Comprehension of idiomatic expressions: evidence for a new hybrid view. *Metaphor and Symbol* 22, 79–108.
- Caillies, S., Le Sourn-Bissaoui, S., 2006. Idiom comprehension in French children: a cock-and-bull story. *European Journal of Developmental Psychology* 3 (2), 189–206.
- Carpenter, B.N., Chapman, L.J., 1982. Premorbid status in schizophrenia and abstract, literal, or autistic proverb interpretation. *Journal of Abnormal Psychology* 91, 151–156.
- Chapman, L.J., Chapman, J.P., Daut, R.L., 1976. Schizophrenic inability to disattend from strong aspects of meaning. *Journal of Abnormal Psychology* 85, 35–40.
- Cohen, J.D., Servan-Schreiber, D., 1992. Context, cortex, and dopamine: a connectionist approach to behavior and biology in schizophrenia. *Psychological Review* 99, 45–77.
- Content, A., Mousty, P., Radeau, M., 1990. BRULEX : une base de données lexicales informatisée pour le français écrit et parlé. *L'année psychologique* 90, 551–556.
- Denhière, G., Pariollaud, F., Verstiggel, J.C., 2002. Comprehension of idiomatic expressions: effect of meaning salience. Proceedings of the 9th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems. Annecy, France.
- Faust, M., Mashal, N., 2007. The role of the right cerebral hemisphere in processing novel metaphoric expressions taken from poetry: a divided visual field study. *Neuropsychologia* 45, 860–870.
- Gibbs, R.W., Nayak, N.P., Cutting, C., 1989. How to kick the bucket and not decompose: analyzability and idiom processing. *Journal of Memory and Language* 28, 576–593.
- Giora, R., 1997. Understanding figurative and literal language: the graded salience hypothesis. *Cognitive Linguistics* 8, 183–206.
- Giora, R., 2003. On our mind: salience. Oxford University Press, Oxford, Context and Figurative Language.
- Giora, R., 2007. Is metaphor special? *Brain and Language* 100, 111–114.
- Giora, R., Zaidel, E., Soroker, N.G., Kasher, A., 2000. Differential effect of right- and left-hemisphere damage on understanding sarcasm and metaphor. *Metaphor and Symbol* 15, 63–83.



- Goldberg, T.E., Aloia, M.S., Gourovitch, M.L., Missar, D., Pickar, M.D., Weinberger, D.R., 1998. Cognitive substrates of thought disorder, 1: the semantic system. *American Journal of Psychiatry* 155, 1671–1676.
- Hardy-Bayle, M.C., Sarfati, Y., Passerieux, C., 2003. The cognitive basis of disorganization symptomatology in schizophrenia and its clinical correlates: toward a pathogenetic approach to disorganization. *Schizophrenia Bulletin* 29, 459–471.
- Harrow, M., Adler, D., Hanf, E., 1974. Abstract and concrete thinking in schizophrenia during the prechronic phases. *Archives of General Psychiatry* 31, 27–33.
- Iakimova, G., Passerieux, C., Hardy-Baylé, M.C., 2006. Interpretation of ambiguous idiomatic statements in schizophrenic and depressive patients. Evidence for common and differential cognitive patterns. *Psychopathology* 39, 277–285.
- Kay, S.R., Fisz-Bein, A., Opler, L.A., 1987. The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophrenia Bulletin* 13, 261–274.
- Kazmerski, V.A., Blasko, D.G., Dessalegn, B.G., 2003. ERP and behavioral evidence of individual differences in metaphor comprehension. *Memory and Cognition* 31, 673–689.
- Kiang, M., Light, G.A., Prugh, J., Coulson, S., Braff, D., Kutas, M., 2007. Cognitive, neurophysiological, and functional correlates of proverb interpretation abnormalities in schizophrenia. *Journal of the International Neuropsychological Society* 13, 653–663.
- Kircher, T.T., Leube, D.T., Erb, M., Grodd, W., Rapp, A.M., 2007. Neural correlates of metaphor processing in schizophrenia. *Neuroimage* 34, 281–289.
- Kuperberg, G.R., 2008. Building meaning in schizophrenia. *Clinical EEG and Neuroscience* 39, 99–102.
- Landauer, T.K., Dumais, S.T., 1997. A solution to Plato's problem: the Latent Semantic Analysis theory of the acquisition, induction, and representation of knowledge. *Psychological Review* 211–240.
- Langdon, R., Coltheart, M., Ward, P.B., Catts, S.V., 2002. Disturbed communication in schizophrenia: the role of poor pragmatics and poor mind-reading. *Psychological Medicine* 32, 1273–1284.
- Laurent, J.P., Denhières, G., Passerieux, C., Iakimova, G., Hardy-Baylé, M.C., 2006. On understanding idiomatic language: the salience hypothesis assessed by ERPs. *Brain Research* 1068, 151–160.
- Lecrubier, Y., Sheehand, D., Weillere, E., Amorim, P., Bonora, I., Scheehan, K., Janavs, J., Dunbar, G., 1997. The MINI International Neuropsychiatric Interview (M.I.N.I.) A Short Diagnostic Structured Interview: reliability and validity according to the CID. *European Psychiatry* 12, 224–231.
- Lee, S.S., Dapretto, M., 2006. Metaphorical vs. literal word meanings: fMRI evidence against a selective role of the right hemisphere. *NeuroImage* 29, 536–544.
- Libben, M.R., Titone, D.A., 2008. The multidetermined nature of idiom processing. *Memory & Cognition* 36, 1103–1121.
- Mashal, N., Faust, M., 2008. Right hemisphere sensitivity to novel metaphoric relations: application of the signal detection theory. *Brain and Language* 104, 103–112.
- Mashal, M., Faust, T., Hendlér, Jung-Beeman, M., 2005. The role of the right hemisphere in processing nonsalient metaphorical meanings: application of principal component analysis to fMRI data. *Neuropsychologia* 43, 2084–2100.
- Mashal, N., Faust, M., Hendlér, T., Jung-Beeman, M., 2008. Hemispheric differences in processing the literal interpretation of idioms: converging evidence from behavioral and fMRI studies. *Cortex* 44, 848–860.
- Mo, S., Su, Y., Chan, R.C., Liu, J., 2008. Comprehension of metaphor and irony in schizophrenia during remission: the role of theory of mind and IQ. *Psychiatry Research* 15 (157), 21–29.
- Newman, S.D., Ratliff, K., Muratore, T., Burns Jr., T., 2009. The effect of lexical priming on sentence comprehension: an fMRI study. *Brain Research* 18 (1285), 99–108.
- Olivier, V., Hardy-Baylé, M.-C., Lancrenon, S., Fermanian, J., Sarfati, Y., Passerieux, C., Chevalier, J.-F., 1997. Rating scale for the assessment of communication disorders in schizophrenics. *European Psychiatry* 12, 356–361.
- Rossell, S.L., Batty, R.A., 2008. Elucidating semantic disorganisation from a word comprehension task: do patients with schizophrenia and bipolar disorder show differential processing of nouns, verbs and adjectives? *Schizophrenia Research* 102, 63–68.
- Schettino, A., Lauro, L.R., Crippa, F., Anselmetti, S., Cavallaro, R., Papagno, C., 2010. The comprehension of idiomatic expressions in schizophrenic patients. *Neuropsychologia* 48, 1032–1040.
- Shapiro, K.A., Mottaghy, F.M., Schiller, N.O., Poeppel, T.D., Flüb, M.O., Müller, H.-W., Caramazza, A., 2005. Dissociating neural correlates for nouns and verbs. *Neuroimage* 24, 1058–1067.
- Shimkunas, A.M., Cynther, M.D., Smith, K., 1967. Schizophrenic responses to the Proverbs Test: abstract, concrete, or autistic? *Journal of Abnormal Psychology* 72, 128–133.
- Spitzer, M.A., 1997. Cognitive neuroscience view of schizophrenic thought disorder. *Schizophrenia Bulletin* 23, 29–50.
- Sponheim, S.R., Surerus-Johnson, C., Leskela, J., Dieperink, M.E., 2003. Proverb interpretation in schizophrenia: the significance of symptomatology and cognitive processes. *Schizophrenia Research* 65, 117–123.
- Strandburg, R.J., Marsh, J.T., Brown, W.S., Asarnow, R.F., Guthrie, D., Harper, R., Yee, C.M., Nuechterlein, K.H., 1997. Event-related potential correlates of linguistic information processing in schizophrenics. *Biological Psychiatry* 42, 596–608.
- Tabossi, P., Fanari, R., Wolf, K., 2009. Why are idioms recognized fast? *Memory and Cognition* 37, 529–540.
- Tavano, A., Sponda, S., Fabbro, F., Perlini, C., Rambaldelli, G., Ferro, A., Cerruti, S., Tansella, M., Brambilla, P., 2008. Specific linguistic and pragmatic deficits in Italian patients with schizophrenia. *Schizophrenia Research* 102, 53–62.
- Thomas, P., Daum, I., 2006. Neurocognitive mechanisms of figurative language processing — evidence from clinical dysfunctions. *Neuroscience and Behavioural Reviews* 30 119–82–1205.
- Titone, D.A., Connine, C.M., 1994. Comprehension of idiomatic expressions: effects of predictability and literality. *Journal of Experimental Psychology: Learning, Memory, & Cognition* 20, 1126–1138.
- Titone, D., Levy, D.L., Holzman, P.S., 2000. Contextual insensitivity in schizophrenic language processing: evidence from lexical ambiguity. *Journal of Abnormal Psychology* 109, 761–767.
- Titone, D., Holzman, P.S., Levy, D.L., 2002. Idiom processing in schizophrenia: literal implausibility saves the day for idiom priming. *Journal of Abnormal Psychology* 111, 313–320.
- Vigliocco, G., Vinson, D.P., Arciuli, J., Barber, H., 2008. The role of grammatical class in word recognition. *Brain and Language* 105, 175–184.