Metaphor interpretation and use:

a window into semantics in schizophrenia

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ABSTRACT

The nature of putative semantic anomalies in schizophrenia is controversial. Metaphor interpretation and use provide a useful methodology with which to probe semantics since metaphors are critical in reasoning processes and in how conceptual knowledge is organized. The first study examined free speech for figurative language. The second study explored whether emotional versus non-emotional metaphorical language interpretation elicits differences in the tendencies to produce idiosyncratic (bizarre) or literal interpretations or use of other metaphors to describe the meaning of a metaphor. The third study examined the interpretation of time metaphors. We expected the time perspective in ambiguous sentences to be differentially influenced by previously presented unambiguous sentences of a specific perspective, either events moving relative to a stationary observer (moving-time) or an observer moving relative to a stationary event (moving-ego). First, we found that patients used a similar amount of figurative language as control participants. Second, we did not find any difference between the groups in terms of idiosyncratic interpretations, although patients did interpret more metaphors literally and controls utilized more figurative language. Third, we did not find evidence of a difference between the groups in terms of time perspectives influencing ambiguous target sentences differentially. As operationalized here, the interpretation and use of metaphors is similar in patients with schizophrenia to that of healthy control participants. To the extent that metaphors recruit semantic processes this area of cognition is generally intact in schizophrenia.

Keywords: schizophrenia, metaphor, semantic memory, language

1. INTRODUCTION

It is unequivocal that in many patients with schizophrenia communication can at times be difficult to understand due to its tangential nature or frank incoherence. However, the underlying mechanisms of this remain unclear. One popular theory is disruption in the semantic memory system, resulting in overinclusive thinking (Cameron, 1939; Payne, 1960; Chen et al., 1994), differences in the spreading of activation through the network (Maher, 1983; Moritz et al., 2002; for a meta analysis see Pomarol-Clotet et al., 2008), a disorganization within the semantic system (Paulsen et al., 1996), or a disruption of expression at the semantic level (McKenna and Oh, 2005),. However, studies adopting alternative methodological frameworks (i.e., not priming paradigms) and different statistical approaches have not found support for notions of a difference in the putative boundaries of categories (Elvevåg et al., 2002), or underlying semantic structure and organization (Elvevåg and Storms, 2003; Cohen et al., 2005; Elvevåg et al., 2005). Indeed, we have argued that some techniques (e.g., multidimensional scaling and clustering techniques to analyze category fluency and triad comparison data) employed to suggest increased variability is attributable to semantic deficits fail statistical requirements concerning consistent and reliable variability across participants, which renders many such techniques ill-suited for clinical populations where there is an implicit assumption about more variance (Elvevåg and Storms, 2003). Although such findings do not refute the hypothesis of semantic deficits in schizophrenia *per se*, they highlight the need for tests and methodologies better suited where variability within and between patients exists.

We have previously suggested alternative methodologies and statistical approaches to this interesting set of issues. One approach has been to collect typicality ratings of categories (e.g., how typical is milk of the category food) to establish whether patients and controls

agree on how representative an item is of its category. Typicality predicts performance on category-related tasks, such as speed of categorization. Our examination of consistency and reliability of typicality ratings (i.e., interindividual consistency within patients and controls and between control and patient groups) revealed similar correlations both between and within each group. The inter-patient consistency derived was high compared to that from fluency and triad tasks, and semantic representations in schizophrenia paralleled those in healthy participants (Elvevåg et al., 2005). However, this raises the question then of what aspect of semantics accounts for the unusual speech and comprehension deficits in schizophrenia. It is of course possible that anomalies are present in more value-laden concepts. Therefore, we have examined concepts differing in variance (i.e., more variance in less well defined and value-laden categories), and adopted a variety of methods - including feature verification - to directly assay core semantic knowledge (as compared with category fluency which is susceptible to pragmatic influences). As expected, patients performed worse than controls and this varied depending upon concept: less for familiar concepts (mammals), average for most, but increasingly worse for value-laden concepts (family). These findings again highlight that methods adopting statistical 'averaging' run the risk of being flawed in clinical populations (Storms and Elvevåg, 2010).

Priming provides an attractive paradigm to probe the mechanisms underlying the unconventional discourse, and its methodology underlies the influential theory that abnormalities accessing semantic representations - through spreading activation within a network - is the core mechanism for subsequent problems forming meaningful and coherent speech (Goldberg and Weinberger, 2000). However, there are many limitations with this framework most notably that language involves processes other than spreading activation between associated words. In the example "Marcella ate the spaghetti with the marinara

sauce," and "Marcella ate the spaghetti with a large fork," "spaghetti" is associated with and primes both "sauce" *and* "fork" (i.e., denotes accompaniment in the first sentence and instrument in the second sentence). However, understanding the first sentence requires inferring the person ate "sauce", but understanding the second sentence requires inferring she used a fork to eat "spaghetti." Therefore, to address some of these issues, we recently assessed language understanding by explicitly probing interpretations of novel noun-noun expressions, and found that patients both interpret concepts similarly to healthy people and use similar cognitive processes to access these concepts (Elvevåg et al., 2010a). Thus, we concluded that the production of unconventional speech cannot be attributable to how patients represent and combine concepts, since this is strikingly similar to that of controls. Nonetheless the question remains as to what could account for this atypical discourse. It is of course possible that there could be a specific problem in combining concepts into more complex semantic expressions or in specific types of concepts, namely emotionally-laden concepts and expressions. Indeed, it is clear that previous experimental frameworks have not fully captured the very essence of a language production problem, because language is 'colorful' due to the enormous numbers of metaphors that we use. Of note, metaphors are not simply linguistic devices but rather are core components of reasoning and inferential processing, and indeed fundamental to how we organize and map our conceptual knowledge (Lakoff and Johnson, 1980; Lakoff, 1987). "For example, one of the root metaphors in Western industrialized cultures is TIME IS MONEY, leading to the easily understood, almost literal, metaphorical expressions: *Don't waste my time. Spend your time wisely. It cost me a whole hour*" (Blasko, 1999; p.1677). Nonetheless, most of cognitive neuroscience's operationalizations of 'language' are rather devoid of these more 'colorful' aspects, yet there is clearly a central role of metaphors in defining language (Lakoff and Johnson, 1980; Kövecses, 2000). Thus, we sought to probe this more 'colorful'

aspect of language, and employ more personally relevant (i.e., 'emotional') noun-noun phrases, since one may be able to interpret noun-noun phrases 'literally' but the metaphor forms have to be interpreted 'figuratively.' For example, "roller-coaster dinner" could be interpreted metaphorically but it could also be interpreted literally as in "dinner eaten while traveling on a roller coaster." In contrast, "that dinner is a roller coaster" has to be interpreted figuratively. There are some reports that patients may interpret phrases in literal ways, or choose the dominant meaning despite the context suggesting an alternative meaning (Langdon et al., 2002; Iakimova et al., 2005; Langdon and Coltheart, 2004). Speculatively, 'interpretations' of the world via discourse may contribute to some of the symptoms that patients display in which a confusion in interpretation may paint a picture of the world that is quite scary or hostile. In keeping with our approach of employing direct methods to probe language and semantics, our current three studies examined interpretation and production of metaphors directly.

Additionally, we examined 'emotional language' as we expected discussion of emotions to provoke figurative speech. Moreover, emotions play a crucial role in regulating our interactions with our social environment. The amygdala, located in the medial temporal cortex, is central in both normal and pathological emotional behaviors, especially fear (LeDoux, 2000). The amygdala has been found to display strong activity in response to angry and fearful faces (e.g., Morris et al., 1996; Phillips et al., 2003), and in response to negatively affective verbal stimuli (Isenberg et al., 1999; Strange et al., 2000; Garolera et al., 2007). Importantly, amygdala dysfunction has been reported in schizophrenia, and a study comparing patients and their unaffected siblings reported a pattern of response (to negative face stimuli) that was similar to that of healthy controls, thus concluding that the inability of patients to normally recruit the amygdala in fearful situations in not likely to be a heritable phenotype

that is related to risk for schizophrenia but rather related to disease and specifically treatment (Rasetti et al., 2009; for a meta-analysis of neuroimaging studies of the amygdala in schizophrenia, see Anticevic et al., in press/2011). Indeed, impairments in emotion perception and production are widely documented in schizophrenia, although may vary as a function of modality (e.g., visual versus auditory) (Vaskinn et al., 2007), and importantly "emotion perception is a mediator between neurocognition and functional outcome as assessed with a social problem-solving task and thus a key factor in understanding functional outcome of schizophrenia" (p.279; Vaskinn et al., 2008).

2. PARTICIPANTS

Twenty-one in-patients who were enrolled in a residential program of the university hospital in Kortenberg (Belgium) participated. They all met criteria for schizophrenia as specified by DSM-IV, were medicated (see Table 1), and received between €3.50 and €5.00 for their time. Their level of intelligence (IQ) was assessed by the Wechsler Adult Intelligence Test (average = 95.68; range 71-122). Symptoms in patients were assessed by the Psychosis Evaluation tool for Common use by Caregivers (PECC, which is a comprehensive, standardized, computerized assessment instrument that evaluates a broad range of functional and symptomatic outcome measures (De Hert et al., 2002) and were clearly moderately ill, and this was also evident from moderate symptoms or moderate difficulties in overall functioning as captured by the Clinical Global Impression (CGI; Guy, 1976) and Global Assessment of Functioning (GAF; Hall, 1995) scales (see Table 2).

INSERT TABLES 1 and 2 HERE

Twenty-one voluntary control participants were matched to the patients on age (patients' average age = 33.52 (±8.10) and controls' average age = 33.81 (±8.54); p = 0.91) and level of education (p = 0.59) [Footnote 1]. Controls' IQ was not assessed. Participation in our three studies took approximately 25 minutes. All participants provided written informed consent after the study details had been explained to them. Dutch was the first language for all participants. Conversations were recorded electronically. Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Psychology and Educational Sciences of the University of Leuven (Belgium).

3: STUDY 1: METAPHOR USE DURING FREE SPEECH

3.1: BACKGROUND

The first study sought to investigate metaphor use during free speech. Any putative deviance in semantics should manifest itself as a difference in the manner in which language is explicitly used. Examining free speech, it has been reported that compared to patients with borderline personality disorder and nonpsychiatric (minor) medical diagnoses that patients with schizophrenia (matched for intelligence and years of education) employed more metaphoric or evocative language, but often inappropriate to its context even though each speech segment was semantically correct (Billow et al., 1997). Importantly, this study found that patients with schizophrenia did use as much appropriate figurative language as compared to the two other groups. Thus, the purpose of our first study was to expand on this when patients were to describe emotions. In light of Vaskinn's et al. (2007) findings in schizophrenia of an impairment in auditory - but not visual - emotion perception, we presented the emotional cue both verbally and visually.

3.3: METHODS

3.3.1: MATERIALS AND PROCEDURE

Participants were asked to describe a personal event in which they experienced the six emotions respectively: (1) anger, (2) fear, (3) happiness, (4) sadness, (5) love and (6) lust. Each emotion was asked about individually, and once they were finished describing one personal event the next emotional word was given as a cue. We examined the use of spontaneous metaphors in their descriptions.

3.4: RESULTS

Only seven out of the 21 patients employed one or more metaphors to describe a personal event concerning a specific emotion. Metaphors were used when talking about a personal event concerning the emotions anger, fear, sadness and love, but not when describing a personal event concerning happiness and lust. In the control group eleven participants used at least one metaphor to describe the six emotions. In contrast to patients, all emotions were described at least once using a metaphor. Four patients and five controls refused to describe a personal event considering the emotion lust, maybe due to a personal taboo concerning discussion of lustful experiences. Patients used on average 0.80 metaphor (range 0-6) to describe a personal event in response to a presented emotion, and controls used 1.23 (range 0-8) ($F(1,40) = 0.62$; $p = 0.44$).

3.5: DISCUSSION OF STUDY 1

Our first study examined free speech for figurative language and found that patients used a similar amount of figurative language as controls. Although this may seem surprising,

clinicians often respond to psychotic patients in a manner that suggests they think patients actually believe the literal content of the figurative statements, whereas this is less frequently the case in non-clinical conversation (Wynn et al., 2009). In other words, in many settings we may inadvertently be more attentive to figurative language in patients than in a non-clinical conversation. Although not statistically significant, it is noteworthy that in our current study several patients employed metaphors when describing the emotion 'fear'. This merits future exploration of any connection with specific symptoms such as paranoia or the hearing of derogatory voices. However, overall this free speech study resulted in few metaphors being generated. Therefore, we next examined metaphor interpretation as the study design would ensure more responses.

4: STUDY 2: METAPHOR INTERPRETATION

4.1: BACKGROUND

In the second study we examined metaphor interpretation of the same set of emotions as in Study 1, specifically with a view to establish whether patients employ more literal or bizarre interpretations and whether presentation of metaphors prompts metaphorical descriptions. Previous research with proverbs found that patients generated interpretations that were more concrete (Sponheim et al., 2003; Brüne and Bodenstein, 2005) literal and idiosyncratic (Shimkunas et al., 1967; Harrow et al., 1972). We focused on metaphorical utterances, which are less complex than proverbs, but expected them to follow a similar pattern, as proverbs are a category of metaphorical language. Specifically, we hypothesized patients would interpret metaphorical sentences more literally and idiosyncratically, and be less likely to use metaphorical language in general. Also, we sought to investigate whether there were differences in interpretations between emotional and neutral presented

metaphorical sentences in patients versus controls. As in Study 1, no distinction was made to the participant between positive and negative affective material.

4.2: METHODS

4.2.1: MATERIALS AND PROCEDURE

A series of 30 metaphors was presented to the participants - one per piece of paper - each which was also read out aloud to them. The list of metaphorical sentences was inspired by Kövecses (2000) (see Appendix A). Participants were asked to provide the meaning of the presented metaphor. The emotions examined were the same as in Study 1, namely anger, fear, happiness, sadness, love and lust. Every emotional sentence referred to either a fluid in a container (e.g., She was boiling with anger), insanity (e.g., He was insane with fear), a social superior (e.g., His actions were completely dictated by fear), a natural force (e.g., Waves of depression came over her) or a captive animal (e.g., She brings out the beast in him). Three extra sentences that did not fit into these categories were included since they are commonly used prototypical expressions in Dutch regarding these emotions. Based upon a pilot study, Study 2 was divided into two parts (eight emotional and seven neutral metaphors) and interspersed within the three components of Study 3 so as to improve alertness of participants. Four different presentation orders were used.

4.3: RESULTS

We computed non-parametric randomization tests, comparable to ANOVA's with one between-subjects variable (patients, controls) and one within-subjects variable of type-of-metaphor (emotional metaphors, non-emotional metaphors) to analyze the data from Experiment 2, because of violations of homogeneity of variances. (For details about

randomization tests, see Edgington & Onghena, 2007). Analyses were carried out for three different dependant variables: literal interpretations, metaphorical interpretations, and idiosyncratic interpretations.

First, we compared patients and controls in terms of the number of literal interpretations. There was a main effect for group with patients providing significantly more literal interpretations than controls (on average 0.48 (range 0-3) versus 0 (range 0-0); $p < .01$). The type-of-metaphor variable also yielded significance ($p<.05$) with emotional metaphors leading to less literal interpretations than non-emotional metaphors (on average, respectively, 0.33 (range 0 – 2) versus 0.62 (range 0 – 3)). The interaction between the group and type-of-metaphor variable was not significant ($p = .65$). Second, we compared patients and controls in terms of the number of metaphorical interpretations. Again, there was a significant effect of the group variable, but with patients providing less metaphorical interpretations (on average 3.66 (range 0-9) versus 6.95 (range 0-16); $p < .01$). There was also a significant effect of the type-of-metaphor variable with emotional metaphors prompting more metaphorical interpretations (on average 3.0 (0-11) versus 2.3 (0-8); $p < .05$) but the interaction with the group was not significant ($p = .15$). Third, we compared patients and controls in terms of the number of bizarre/idiosyncratic interpretations. The effect of the group variable was not significant ($p = .15$), since patients generated a similar amount of bizarre interpretations (on average 1.10, with a range of 0 – 5) as control participants (on average 0.52, with a range of 0 – 3). There was no significant effect of the type-of-metaphor variable ($p = .11$), nor was there a significant interaction of group and type of metaphor, $p = .10$.

4.4: DISCUSSION OF STUDY 2

We explored whether the groups were dissimilar in metaphorical - emotional and non-emotional - language interpretation, such that there were variations in the amount of idiosyncratic or literal interpretations or use other metaphors to describe the meaning of a metaphor. Although we did not find any group differences in idiosyncratic interpretations, patients did interpret more literally but controls more figuratively. An interesting future study - with sufficient statistical power - would be to investigate a possible relationship between such linguistic use and specific symptomatology in patients, such as thought disorder or hallucinations. Indeed, metaphors have a central role in the formation and maintenance of our basic concepts (e.g., Lakoff and Johnson, 1980). Therefore, the fact that patients interpreted more metaphors literally is extremely interesting in light of suggestions that figurative thinking in the 'pre-delusional period' may pave the foundation for later delusions: "At some stage, thoughts such as 'am I *like* someone possessed by a devil' become 'I *am* possessed by a devil' " (Rhodes and Jakes, 2004 p.6; our italics). Although highly speculative, it is possible that "the delusional statement is a literal statement about aspects of the world or self which are transformed by metaphor" (p.15; Rhodes and Jakes, 2004).

5: STUDY 3: USE OF METAPHORS CONCERNING TIME

5.1: BACKGROUND

Our third study examined the use of metaphors concerning time. Societies vary on the value placed on 'clock time' (Levine, 1997), and thus there are differences in how concepts of time form part of our everyday discourse, and affect our mental models of the world (e.g., in reading – Ditman et al., 2008). However, the concepts and metaphors associated with time are central in everyday function and are frequently evident in discourse. Indeed, language dictates

use of ‘space frames’ of references to organize our time metaphors (Boroditsky, 2001; Gentner et al., 2002), and is consequently used in a figurative way to make time and relations between temporal events easier to understand (Bender et al., 2005). In many societies, it is assumed that the past is known and the future is unknown and thus temporal metaphors are based upon the experiential correlations *Known is behind ego* (i.e. behind a ‘moving ego’ on a path), *Unknown is in front of ego* (i.e. in front of a ‘moving ego’ on a path) (Núñez and Sweetser, 2006). In other words, time can be conceptualized in two different perspectives, namely moving-ego (ME) perspective, where time is considered to be a stationary entity, or moving-time (MT) perspective, where time is seen as a dynamic entity (Clark, 1973). An example of a ME sentence could be “We have passed the deadline”, with movement directed to the future (We have passed the deadline in the direction of the future). According to a MT perspective this sentence would be “The deadline has passed (us)”, as in this case *the deadline* passes us in direction to the past (McGlone and Harding, 1998).

When people activate one of these two perspectives (moving-time or moving-ego) during the reading of unambiguous temporal sentences, this might influence interpretation of a subsequent ambiguous sentence in favor of the perspective previously used. Alternatively, information about temporal ordering is only used when reading unambiguous sentences, without considering the underlying perspectival entailments. In the latter case people would not show a preference for the previously activated perspective (McGlone and Harding, 1998). We sought to examine how this might be affected by schizophrenia given their problems in temporal judgments, which are likely intertwined with working memory limitations (Elvevåg et al., 2003, 2004). From a phenomenological perspective, the seemingly disrupted consciousness of time may be due to disruptions synthesizing time relationships underlying the formation of Gestalt perceptions. Speculatively, such temporal problems may be related to

misperceived causal roles (Elvevåg et al., 2010b) and subsequent delusion formation (e.g., of control, reference or persecution).

5.2: METHODS

5.2.1: MATERIALS AND PROCEDURE

As mentioned earlier, Study 3 was divided into three parts and interspersed with the two parts of Study 2 so as to increase participants' alertness. This study was a replication of Experiment 2 of McGlone and Harding (1998), albeit in patients and in Dutch. Since the purpose was to establish whether perspective information was utilized when interpreting temporal language the study was conducted only on Wednesdays.

Forty-five sentences about unique events were split into three blocks of 15 sentences (see Appendix B). There was one moving-ego (ME) context block, one moving-time (MT) context block and one mixed context block. The mixed context block was always presented as the second block. After four unambiguous context sentences one ambiguous target sentence was presented. This sentence could be interpreted in accordance with both a moving-ego and a moving-time perspective. Our goal was to establish whether the perspective activated earlier would influence subsequent interpretation of the target sentence.

Each block consisted of three target sentences with a time indication of the spatiotemporal verbs 'moved forward' (*voorwaarts verplaatst*; e.g., "The meeting, originally scheduled for next Wednesday has been moved forward two days"), 'pushed back' (*teruggeschoven*; e.g., "The party, originally scheduled for next Wednesday has been pushed back two days") and 'advanced' (*vervroegd*; e.g., "The reception, originally scheduled for next Wednesday has been advanced two days"). The four context sentences that belonged to a target sentence were presented in four random orders. The sentences were read out aloud

(e.g., “We are coming up on the wedding in two days”; “The concert passed two days ago”). Since the study always took place on Wednesday, the only possible answers were Monday or Friday. Thus, after four unambiguous context sentences one ambiguous target sentence always followed (e.g., “The meeting originally scheduled for next Wednesday has been moved forward two days”), and the task was to determine whether the event would occur on Monday or Friday.

5.3: RESULTS

Thirteen patients and 18 controls obtained 100% accuracy on the 36 unambiguous sentences. Five patients and two control participants made one error. There were two patients who gave two incorrect answers to the unambiguous sentences questions. One patient and one control made 16 and 11 mistakes respectively, and because of their high amount of errors these two people were excluded from further analyses [Footnote 2]. All remaining participants obtained an accuracy level of at least 94.44% which was considered sufficient for inclusion in subsequent analyses.

The response to the ambiguous sentences was the dependent variable. Answers were coded as ME or MT consistent. ‘Monday’ was an MT consistent and Friday was a ME consistent response for the verbs ‘moved forward’ (*voorwaarts verplaatst*) and ‘advanced’ (*vervroegd*). Considering the verb ‘pushed back’ (*teruggeschoven*) ‘Monday’ was a ME consistent response whereas ‘Friday’ was a MT consistent answer.

INSERT FIGURE 1 HERE

ME and MT consistent responses are presented by context-list condition in Figure 1. It is apparent that controls interpreted the verbs ‘advanced’ (*vervroegd*) and ‘pushed back’ (*teruggeschoven*) in a similar manner, which patients did also [Footnote 3]. Thus, it is possible that information concerning temporal ordering was only used when reading unambiguous sentences, without considering the underlying time perspectives. Alternatively, it may be that the Dutch equivalents of the verbs ‘advanced’ and ‘pushed back’ are not as ambiguous as we had assumed. Concerning the spatiotemporal verb form ‘moved forward’ (*voorwaarts verplaatst*), responses were at chance level. For example, to the sentence “The meeting, originally scheduled for next Wednesday has been moved forward two days”, ten patients and seven controls in the moving-ego context claimed the meeting was rescheduled for Friday, which was a moving-ego consistent answer, and ten patients and 13 controls concluded that the meeting would take place on Monday. In the mixed context condition with the ambiguous sentence “The communion, originally scheduled for next Wednesday has been moved forward two days”, ten patients and six controls claimed the communion would take place on Friday, which was a moving-ego consistent answer. Finally, regarding the moving-time context, using the ambiguous sentence “The auction, originally scheduled for next Wednesday has been moved forward two days”, eleven patients and 10 controls claimed the auction would take place on Monday, which was a moving-time consistent answer. Thus, there was no clear preference for specific answer for this verb form.

5.4: DISCUSSION OF STUDY 3

Our third study was motivated by the assumption that interpreting time metaphors would be a sensitive assay of putative problems in time perspectives in patients. However, we did not uncover evidence of such differences in ambiguous sentences after previously

presented unambiguous sentences of specific time perspectives, namely moving-time or moving-ego. In contrast with McGlone and Harding (1998), we did not find the interpretation of target sentences to be influenced by previously presented time perspectives. Importantly, results were similar for patients and controls.

6: GENERAL DISCUSSION

We sought to utilize metaphor use and interpretation as a window into the nature of putative semantic anomalies in schizophrenia. The first two studies involved metaphoric language in general as well as emotional material. The third study concentrated on time metaphors. As operationalized here, the interpretation and use of metaphors was overall remarkably similar in patients to that of controls. Therefore, to the extent that metaphors recruit semantics this appears intact in schizophrenia.

Surprisingly emotion was not such a strong modulator of language as expected, and it did not elicit any noteworthy different responses from patients. This is likely because the story of emotional experiences in schizophrenia is magnitudes more complex than our conceptualization affords. A recent elegant fMRI study that examined valence and arousal ratings of the stimuli experiences, as well as trait level measures of anhedonia, found that patients' muted ventral striatal and left putamen responses to pleasant stimuli were also associated with less pleasant ratings of the actual stimuli (Dowd and Barch, 2010). Moreover, these differences in brain physiology were mediated by self-reported trait anhedonia, thus suggesting that the differences in brain activation have less to do with diagnosis *per se* and more to do with the trait anhedonia as this was related to physiological responses in both patient and control groups. Thus, future conceptualizations and experimental operationalizations will be more sensitive to subtle differences if the role of a behavioural

phenotype - such as trait anhedonia - is considered. In the current study, we did not examine anhedonia and acknowledge that such measures would have been valuable, although limited given our small sample size.

Indeed, our study's sample size limits our statistical power to examine many interesting characteristics associated with a heterogeneous illness such as schizophrenia, notably illness chronicity and duration, effects of medication and most importantly the effects of symptoms. Although all patients were symptomatic, hence their enrollment in the treatment program, a future larger study would be able to establish to what extent metaphor use and interpretation is modulated by specific types of symptoms, notably thought disorder. Also, many cognitive processes, specifically working memory, play an important role in the understanding and production of metaphors (Blasko, 1999; Kiang et al., 2007). Therefore, a study in which patients and controls are well characterized neuropsychologically would be able to examine whether any potential differences in metaphors use and interpretation are due to limitations in working memory (Goldberg et al., 1998) or deficits in episodic memory (Skelley et al., 2008) that are so characteristic of schizophrenia.

In conclusion, we adopted a methodological framework that challenged the semantic system through metaphor interpretation and use. We examined free speech for figurative language, emotional versus non-emotional metaphorical language interpretations, and also interpretations of everyday time metaphors. Overall, we found the interpretation and use of metaphors to be very similar in patients to that of controls, and conclude that the semantic processes recruited and activated via metaphors are generally intact in schizophrenia.

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FOOTNOTES

Footnote 1: Education is compulsory until 18 years of age. Educational level was coded as follows; 1 = primary school, 2 = secondary school type BSO (vocational training), 3 = secondary school type TSO (technical training) or ASO (academic training), and 4 = higher education (bachelor or master). Patients had an average educational level of 2.86 (±0.86) and controls scored on average 3.00 (±0.89); p=0.59.

Footnote 2: Although the responses were rated unblinded we are confident that the interpretation of the metaphors is unequivocal as two ratings of the same sample but a year apart produced near perfect test-retest reliability (across the sample a total of 1 error only).

Footnote 3: Except one patient who gave a MT consistent answer to the sentence with spatiotemporal verb form ‘pushed back’ and a ME consistent answer to the sentence with spatiotemporal verb form ‘advanced’, regardless of the presented context.

Table 1: Medication use in patient sample

	Number (%)
Second-generation antipsychotic	
- **Amisulphide**	1 (3.8)
- **Aripiprazole**	6 (23.1)
- **Clozapine**	5 (19.2)
- **Quetiapine**	1 (3.8)
- **Risperidone**	6 (23.1)
- **Olanzapine**	2 (7.7)
First-generation antipsychotic	5 (19.2)
Mean dose Chlorpromazine equivalents	514mg (SD 768)
Monotherapy antipsychotic	16 (76.2)
Combination of antipsychotics	5 (23.8)
- **second-gen. antipsychotics only**	2 (9.5)
- **first-gen + second gen. antipsychotics**	3 (14.3)
Other medication	
- **Anticholinergic**	6 (28.6)
- **Antidepressant**	11 (52.4)
- **Benzodiazepine**	9 (42.9)
- **Mood stabilizer**	7 (33.3)
- **Somatic medication**	10 (47.6)

Table 2: Scores from the psychosis evaluation tool for common use by caregivers variables (PECC) in patients (Panel A) and scores in patients from the Clinical Global Impression (CGI) and Global Assessment of Functioning (GAF) scales (Panel B)

	Mean	±SD
PECC total score	42.1	16.3
- **Positive symptoms**	7.5	3.9
- **Negative symptoms**	10.8	5.4
- **Depressive symptoms**	9.4	4.2
- **Excitement**	7.6	3.8
- **Cognitive symptoms**	6.9	3.1

[Panel A]

	Mean	±SD
Clinical Global Impression	4.1	1.2
Global Assessment of Functioning	54.8	14.7

[Panel B]

FIGURE LEGENDS

Figure 1: Percentages of moving-ego (ME) and moving-time consistent (MT) answers for the three spatiotemporal verbs in three different contexts. Patient data are shown in panels A to C and control data in panels D to F. Categories on the horizontal axes represent the perspectives used in the unambiguous context sentences. The vertical axes represent the percentages of responses to the ambiguous sentences consistent with a certain perspective.

'Friday' is a ME consistent and 'Monday' a MT consistent answer for the spatiotemporal verbs 'moved forward' and 'advanced'. Regarding the verb 'pushed back', 'Monday' is a ME consistent and 'Friday' a MT consistent answer.

With respect to the verb 'pushed back' (Panels B and E), most answers were ME consistent, whereas for 'advanced' (Panels C and F) most responded with a MT consistent answer, irrespective of the previously used context perspective. Concerning 'moved forward' (Panels A and D), most responses are at (or close to) chance level for all context perspectives. No evidence was found for the influence of the previously used context perspective on the responses in the ambiguous sentences in either verb.

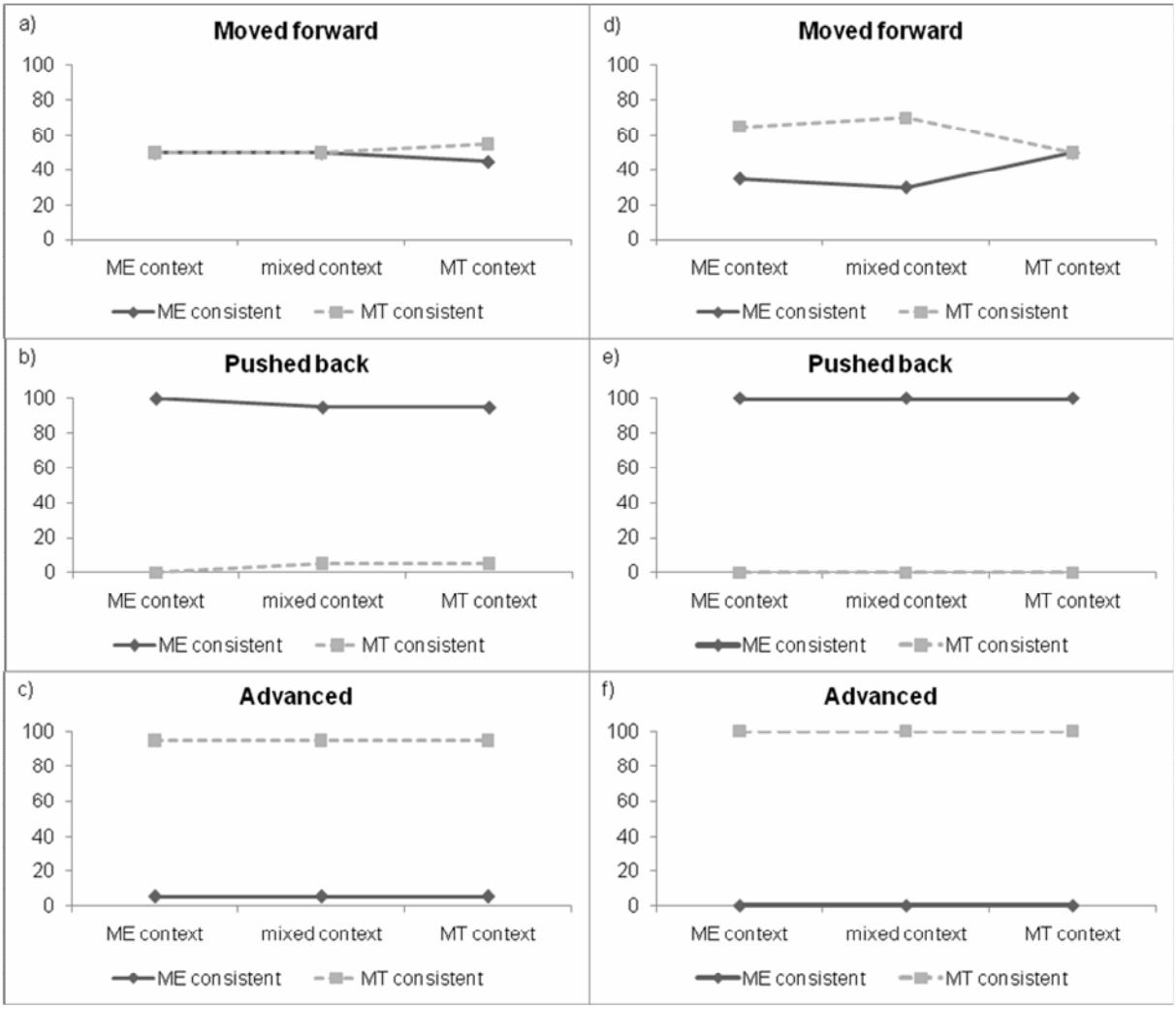
a)
Moved forward
100
80
60
40
20
0
ME context
mixed context
MT context
ME consistent
MT consistent
d)
Moved forward
b)
Pushed back
e)
Pushed back
c)
Advanced
f)
Advanced

FIGURE 1

Appendix A: Study 2: Metaphor interpretation.

Emotion metaphors (16)

Anger (3)

Fluid in a container: She was boiling with anger

Natural force: It was a stormy meeting

Extra: Fume was coming out of his ears

Fear (2)

Fluid in a container: The sight filled her with fear

Natural force: She was engulfed by panic

Happiness (3)

Fluid in a container: He was overflowing with joy

Insanity: They were crazy with happiness

Natural force: She was swept off her feet

Sadness (2)

Insanity: He was insane with grief

Natural force: Waves of depression came over her

Love (3)

Social superior: She was completely ruled by love

Natural force: He swept her off his feet

Extra: You could feel the electricity between them

Lust (3)

Fluid in a container: His whole body exploded in passion

Captive animal: She brought out the beast in him

Extra: He was burning with desire

Neutral metaphors (14)

That surgeon is like a butcher

His brain is a computer

Landlords are vampires

Her memory is like a sponge

His laugh is like a magnet

Her best friend is an anchor

That job is like prison

Lawyers are sharks

Some countries are like dynamite

Cigarettes are time bombs

Talking to some people is like taking sleeping pills

You must keep money moving

Life is like a journey

Appendix B: Materials from Study 3: Use of metaphors concerning time (adapted from McGlone & Harding, 1998) (C = context sentences; T = target sentences)

Moving-Ego context list

C: We are coming up on the wedding in two days.
C: We passed the deadline two days ago.
C: We will arrive at the exam date in two days.
C: We reached the anniversary two days ago.
T: The meeting, originally scheduled for next Wednesday has been moved forward two days.

C: We will reach graduation in two days.
C: We will have passed the closing ceremony in two days.
C: We came up on the quiz two days ago.
C: We arrived at the performance date two days ago.
T: The party, originally scheduled for next Wednesday has been pushed back two days.

C: We passed the holiday two days ago.
C: We will arrive at the election in two days.
C: We reached the gallery opening two days ago.
C: We are coming up on the barbeque in two days.
T: The reception, originally scheduled for next Wednesday has been advanced two days.

Moving-Time context list

C: The wedding is coming up in two days.
C: The baptism ceremony passed two days ago.
C: The date of the game will arrive in two days.
C: The birthday party reached us two days ago.
T: The auction, originally scheduled for next Wednesday has been moved forward two days.

C: The boat trip will reach us in two days.
C: The festival will have passed in two days.
C: The diner party came up on us two days ago.
C: The day of the movie premiere arrived two days ago.
T: The journey, originally scheduled for next Wednesday has been pushed back two days.

C: The explosion passed two days ago.
C: The theatre play will arrive in two days.
C: The demonstration reached us two days ago.
C: The operation is coming up in two days.
T: The day off, originally scheduled for next Wednesday has been advanced two days.

Mixed-context list

C: The hearing is coming up in two days.
C: We passed the wine tasting evening two days ago.
C: We will arrive at the city trip date in two days.
C: The funeral reached us two days ago.
T: The communion, originally scheduled for next Wednesday has been moved forward two days.

C: The migration will reach us in two days.
C: We will have passed the road works in two days.
C: We came up on the zoo visit two days ago.
C: The horse race date arrived two days ago.
T: The helicopter flight, originally scheduled for next Wednesday has been pushed back two days.

C: The concert passed two days ago.
C: We will arrive at the museum in two days.
C: We reached our dream destination two days ago.
C: The festivities are coming up in two days.
T: The cruise, originally scheduled for next Wednesday has been advanced two days.