

Are idiom comprehension difficulties in patients with schizophrenia due to working memory and executive deficits?

Agnès Lacroix^{*,a}
Audrey Noël^a
Murielle Sollier-Guillery^{a,d}
Thibaut Dondaine^b
Gabriel Robert^{b,c}
David Levoyer^{a,c}
Bruno Millet^{b,c}
Dominique Drapier^{b,c}
Virginie Laval^d

^a Psychology, Cognition and Communication Research Center (EA 1285), University of Rennes 2

^b “Behavior and Basal Ganglia” research unit (EA 4712), University Hospital and University of Rennes 1, Rennes

^c University Department of Adult Psychiatry, Guillaume Régnier Hospital, Rennes

^d Cognition and Learning Research Center (UMR CNRS 6234), University of Poitiers

FRANCE

ABSTRACT – Background and Objectives: We investigated idiom comprehension in patients with schizophrenia, and the involvement of working memory and executive functions in this comprehension.

Methods: Nineteen patients with schizophrenia aged 22-46 years (mean = 34.73 years) took part in this study, and were matched for age and education level with a control group. Our assessment consisted of (1) an experimental task assessing idiom comprehension through short stories, (2) three tasks assessing verbal, visuospatial and multimodal spans, and (3) four tasks assessing executive functions (Hayling test, Stroop test, Wisconsin Card Sorting Test and Trail Making Test).

Results and Conclusion: Results highlighted several deficits in the comprehension of idioms in patients with schizophrenia. An executive deficit is not sufficient to explain

these difficulties. Nevertheless, the conceptual disorganization observed in the patients conduce them to not focus their attention on the relevant elements avoiding the comprehension of idioms.

Received: 4 October 2015

Revised: 4 December 2015

Accepted: 9 December 2015

Introduction

First described schizophrenia¹⁻³, researchers have emphasized the centrality of language and communication abnormalities in this disorder often illustrated by the difficulty patients have interpreting figurative forms of language⁴. A decade ago, the language disorders observed in patients with schizophrenia were attributed to difficulty taking account of the context and planning the discourse. More recently, other hypotheses have been put forward to explain figurative language impairment, notably in idiom comprehension.

Several studies⁵⁻⁸ have reported impaired idiom comprehension in patients with schizophrenia. The difficulties of these patients are attributed to a failure to inhibit the literal interpretations of literally plausible idioms, rather than an inability to process contextual information⁸. Recently, it was found that patients with schizophrenia were impaired on both literal and idiomatic sentences⁶. The authors also observed that executive dysfunction therefore appeared to be one of the factors responsible for deficits in idiom comprehension⁹. The influence of clinical factors on idiom comprehension in schizophrenia was investigated⁶. Results indicated that the severity of the negative symptoms (i.e., psychomotor poverty symptoms) assessed on the Positive and Negative Symptom Scale (PANSS)¹⁰

was negatively correlated with the patients' performance on ambiguous idioms: the greater the severity of their negative symptoms, the lower their accuracy on ambiguous idioms.

Some authors confirmed that plausible idioms pose more problems to patients with schizophrenia than implausible ones, and reported that the plausibility of literal interpretations was influenced by salience⁵. Moreover, results indicated that the severity of the positive symptoms was negatively correlated with the patients' performances on targets that were semantically unrelated to literal sentences. In other words, the more severe the patients' positive symptoms, the lower their accuracy on unrelated word targets. Positive symptoms increased the likelihood of seeing a semantic relation between a literal phrase and a word, even though the two were actually unrelated.

To sum up, few studies have explored idiom comprehension in schizophrenia up to now and they have seldom assessed executive functions. No study has simultaneously investigated the impact of familiarity, transparency and context on the comprehension of idioms in schizophrenia. Our study was intended to determine whether idiom comprehension in schizophrenia is influenced by context and type of expression (transparency and familiarity), and whether it is affected by working memory and/or executive function deficits.

Method

Participants

Nineteen patients (12 males, 7 females) fulfilling the criteria for schizophrenia according to the *Diagnostic and Statistical Manual of Mental Disorders, Version IV* (DSM-IV)¹¹ and the *International Classification of Diseases, Version 10* (ICD-10)¹² were recruited from the Guillaume Régnier Hospital in Rennes, France. All the patients were native French speakers. They were all stable and on antipsychotic medication within the normal recommended range of dosage. The mean duration of illness in these patients was 10.45 years ($SD = 5.43$) (see Table 1). Psy-

chopathology was measured on the PANSS. The patients' mean age at the time of assessment was 34.73 years ($SD = 6.8$), and they had received 12.10 mean years of education ($SD = 2.15$). Depressive patients were excluded using the Montgomery-Åsberg Depression Rating Scale (MADRS)¹³ (mean score = 5, $SD = 3.33$). The comparison control group consisted of 32 healthy control participants with no history of psychiatric disorders. They were recruited from the community. The schizophrenia and control groups did not differ significantly on either age or educational level (Table 1). The present study was conducted in accordance with the ethical guidelines set out by Guillaume Régnier Hospital.

Table 1
Demographic and clinical data for patients with schizophrenia and healthy control participants

	Patients with schizophrenia (12M/7F)		Healthy controls (17M/15F)		<i>p</i> value
	Mean	<i>SD</i>	Mean	<i>SD</i>	
Age	34.73	6.8	32.4	7.25	.268
Education level	12.10	2.15	13	2.10	.138
Duration of illness	10.45	5.43			
PANSS (Positive)	10	2.93			
PANSS (Negative)	16	5.20			
PANSS (General)	27	5.80			
PANSS (Total)	54	10.98			

Note. M = male; F = female; PANSS = Positive And Negative Syndrome Scale.

Experimental task

We selected 12 very familiar and very transparent idioms, and 12 less familiar and less transparent (opaque) idioms. Table 2 lists our final selection of 24 idioms, together with their mean familiarity and transparency ratings.

One short narrative was written for each idiomatic expression. Stories staged events

experienced by two main characters (Anthony and Mickaël) in the course of their everyday lives. The 24 experimental stories varied in context (idiomatic *vs.* ambiguous), transparency level (transparent *vs.* opaque) and familiarity level (familiar *vs.* unfamiliar). The stories came in three parts (see example in Fig. 1).

Table 2
Mean familiarity and transparency ratings of the 24 idioms used

French idiom	Familiarity score	Transparency score
Familiar and transparent idioms		
<i>Passer l'éponge</i>	4.20	4.66
Literal interpretation: <i>To clean up with a sponge.</i>		
Idiomatic interpretation: <i>To forgive someone</i>		
<i>Ne dormir que d'un oeil</i>	4.06	4.73
Literal interpretation: <i>To sleep with one eye</i>		
Idiomatic interpretation: <i>Hardly be able to sleep</i>		
<i>Jouer avec le feu</i>	4.26	4.60
Literal interpretation: <i>To play with fire</i>		
Idiomatic interpretation: <i>To take a lot of risk</i>		
<i>Gagner le gros lot</i>	4.17	4.32
Literal interpretation: <i>To gain the best prize</i>		
Idiomatic interpretation: <i>To benefit suddenly from an exceptional stroke of luck</i>		
<i>C'est un jeu d'enfant</i>	4.02	4.28
Literal interpretation: <i>This is a game for children</i>		
Idiomatic interpretation: <i>It is easy</i>		
<i>Jeter l'argent par les fenêtres</i>	4.21	4.06
Literal interpretation: <i>To throw money out of the windows</i>		
Idiomatic interpretation: <i>To be very extravagant</i>		
Familiar and opaque idioms		
<i>Poser un lapin</i>	4.01	1
Literal interpretation: <i>To place a rabbit [somewhere]</i>		
Idiomatic interpretation: <i>To not go to an appointment</i>		
<i>Passer un savon à quelqu'un</i>	4.40	1.53
Literal interpretation: <i>To give a soap to someone</i>		
Idiomatic interpretation: <i>To scold someone</i>		
<i>Se lever du pied gauche</i>	4.23	1.25
Literal interpretation: <i>To get up on the left foot</i>		
Idiomatic interpretation: <i>To be in a bad mood</i>		
<i>Etre dans de beaux draps</i>	4.53	1.33
Literal interpretation: <i>To be in nice sheets</i>		
Idiomatic interpretation: <i>To be in a right mess</i>		
<i>A côté de la plaque</i>	4.07	1.05
Literal interpretation: <i>To be next to a manhole cover</i>		
Idiomatic interpretation: <i>To make a mistake</i>		
<i>Ne pas manquer d'air</i>	4.13	1.46
Literal interpretation: <i>Not to lack air</i>		
Idiomatic interpretation: <i>To have a cheek</i>		

French idiom	Familiarity score	Transparency score
Unfamiliar and transparent idioms		
<i>Pleurer dans le gilet de quelqu'un</i>	1.73	4.20
Literal interpretation: <i>To cry in someone's cardigan</i>		
Idiomatic interpretation: <i>To complain</i>		
<i>Être au bout du tunnel</i>	1.57	4.11
Literal interpretation: <i>To be at the end of the tunnel</i>		
Idiomatic interpretation: <i>To emerge from a difficult time</i>		
<i>Donner sa chemise</i>	1.40	4.32
Literal interpretation: <i>To give one's shirt to somebody</i>		
Idiomatic interpretation: <i>To be very generous</i>		
<i>Avoir un bandeau sur les yeux</i>	1.46	4.60
Literal interpretation: <i>To wear a blindfold</i>		
Idiomatic interpretation: <i>To be blind</i>		
<i>Avoir les mains libres</i>	1.50	4.25
Literal interpretation: <i>To have empty hands</i>		
Idiomatic interpretation: <i>To have the freedom to act</i>		
<i>Accorder vos violons</i>	1.66	4.33
Literal interpretation: <i>To tune the violins</i>		
Idiomatic interpretation: <i>To reach an agreement</i>		
Unfamiliar and opaque idioms		
<i>Bâtir des châteaux en Espagne</i>	1.17	1.50
Literal interpretation: <i>To build castles in Spain</i>		
Idiomatic interpretation: <i>To form impractical projects</i>		
<i>Avoir les dents longues</i>	1.23	1.25
Literal interpretation: <i>To have long teeth</i>		
Idiomatic interpretation: <i>To be very ambitious</i>		
<i>Monter à l'échelle</i>	1.46	1.13
Literal interpretation: <i>To climb a ladder</i>		
Idiomatic interpretation: <i>To take people's jokes seriously</i>		
<i>Baigner dans l'huile</i>	1.40	1.46
Literal interpretation: <i>To bathe in the oil</i>		
Idiomatic interpretation: <i>Everything is OK</i>		
<i>Il y a à boire et manger</i>	1.53	1.40
Literal interpretation: <i>There is something to drink and eat</i>		
Idiomatic interpretation: <i>There are some good and some bad things</i>		
<i>Casser sa pipe</i>	1.43	1.05
Literal interpretation: <i>To break one's pipe</i>		
Idiomatic interpretation: <i>To die</i>		

The familiarity score ranged from 1 (*very unfamiliar*) to 5 (*very familiar*).

The transparency score ranged from 1 (*highly opaque*) to 5 (*highly transparent*)

Procedure

The participants' comprehension of the idioms was assessed in a multiple-choice task in which they had to choose one of three interpretations of the idiom to finish the story.

The task was administered on a laptop computer, and the entire experimental paradigm was computerized with E-Prime 2.0,

which synchronized the images and sounds of the 24 stories (see Fig. 1). Participants were tested individually in a quiet room, where the experimenter settled them in front of the computer. The 24 stories, displayed one by one in random order, were preceded by two practice stories that helped participants to understand the task procedure.



Figure 1. Screen capture of a story (idiomatic context) just before the participant responds.

Coding the story completion answers (comprehension)

The participants' task was to finish each story by choosing one of three possible endings. Idiomatic answers were the ones in which the audio material of the chosen pic-

ture expressed the idiomatic meaning of the expression. Given the aims of our study, we only analyzed results for the idiomatic answers. The number of answers therefore varied from one participant to another (maximum = 24).

Coding the explanations for the idiomatic answers (metapragmatic knowledge)

The participants also had to explain their choice of ending by answering the question “Why did you choose this picture?” Their explanations were divided into three categories:

explanations expressing knowledge of the linguistic convention of the idiomatic expression (LC), explanations relating to the utterance production context (Co), and other explanations (Others). Examples are given in Table 3. These explanations were rated by two independent judges. Inter-rater agreement was very good (kappa coefficient = 0.91).

Table 3
Examples of participants’ explanations of idiomatic answers in each category for the story illustrating the idiom To wipe it with a sponge

Category	Example
Knowledge of linguistic convention	Because he has to forgive his father.
Utterance production context	Because he is angry with his father.
Other explanations	Because he wants to.

Assessment of working memory and executive functions

Working memory was assessed by means of three span tasks: (1) verbal span task, (2) spatial span task and (3) multimodal span task (assessing the central executive).

As far as executive functions are concerned, we investigated inhibition, shifting (flexibility) and planning processes. Inhibition abilities were measured with the Stroop test^{14,15} and the Hayling test^{16,17}. To assess shifting processes, we used the Trail Making Test¹⁸ (TMT). Finally, the WCST was used to assess all three processes (inhibition, shifting and planning).

sion (Fig. 2). Regarding the total number of idiomatic answers, the patients with schizophrenia performed more poorly than normal control participants ($t = 2.26, p < 0.05$).

More specifically, the patients with schizophrenia had greater difficulty interpreting the idiomatic expressions than normal controls in the idiomatic context ($t = 2.41, p < 0.05$). Their scores were also lower than those of controls when they had to interpret unfamiliar ($t = 2.56, p < 0.05$) or transparent ($t = 2.73, p < 0.01$) idiomatic expressions, and there was a trend toward lower scores for opaque idiomatic expressions ($t = 1.83, p = 0.07$).

Results

Idiom comprehension

Results revealed significant differences between the two groups on idiom comprehension

Metapragmatic knowledge

As we can see in Table 4, compared with healthy controls, the patients with schizophrenia tended to justify their responses less by citing a linguistic convention ($t = 1.91, p = 0.06$).

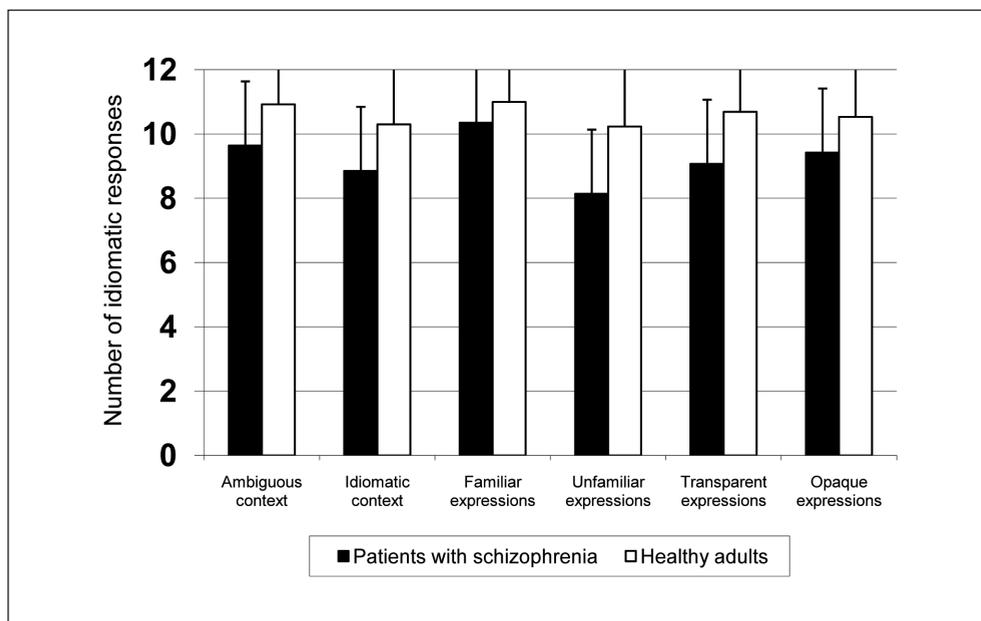


Figure 2. Mean number of idiomatic responses in each condition and for each group.

Table 4

Breakdown of justifications provided by patients with schizophrenia and healthy controls

	Linguistic convention	Context	Other
Patients with schizophrenia	0.63	0.23	0.14
Healthy controls	0.75	0.17	0.08

Assessment of working memory and executive functions

The patients with schizophrenia did not differ significantly from healthy controls on the working memory tasks (Table 5). For executive functions, however, we observed a significant difference between the two groups on the number of errors produced in the Hayling test ($t = -2.22, p < 0.05$), with the patients with schizophrenia producing more errors than the healthy controls. We also observed more perseverative errors in the WCST for patients with schizophrenia than

for healthy controls ($t = 3.49, p < 0.01$). Moreover, it took the patients with schizophrenia longer to complete the TMT than it did the controls ($t = 3.22, p < 0.01$).

Relationship between idiom comprehension, working memory and executive function performances

For the patients with schizophrenia, results failed to reveal any significant correlation between working memory/executive functions and idiom comprehension.

Table 5
Assessment of working memory and executive functions in patients with schizophrenia and healthy controls

	Patients with schizophrenia		Healthy controls		<i>t</i> value	<i>df</i>	<i>p</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>			
Verbal span	4.94	0.70	5.12	1.09	-0.62	49	0.53
Visuospatial span	4.47	0.84	4.81	0.96	-1.26	49	0.21
Multimodal span	4.15	0.60	4.43	0.94	-1.15	49	0.25
Hayling test							
Number of errors	8.57	5.36	5.25	3.60	2.22	49	0.04
Stroop test							
Interference score	2.46	4.04	8.08	6.35	-0.77	49	0.23
Wisconsin test							
Number of perseverative errors	5.47	7.64	0.72	1.02	3.49	49	0.001
Trail Making Test							
Duration Part B	81.26	29.23	55.46	26.66	3.22	49	0.002
Trail MakingTest							
Number of errors	0.36	0.59	0.37	1.43	-0.02	49	0.98

For healthy controls, however, we observed a significant negative correlation between the interference score in the Stroop test and the number of idiomatic answers in an ambiguous context (Spearman's $\rho = -0.45$, $p < 0.05$). These results indicate that idiom comprehension in an ambiguous context is better when inhibition abilities are good. Finally, we also observed significant correlations between TMT Part B completion time and the total number of idiomatic answers (Spearman's $\rho = 0.46$, $p < 0.05$), the number of idiomatic answers in an ambiguous context (Spearman's $\rho = 0.54$, $p < 0.05$), the number of idiomatic answers for unfamiliar expressions (Spearman's $\rho = 0.50$, $p < 0.05$), and the number of idiomatic answers for opaque expressions (Spearman's $\rho = 0.46$, $p < 0.05$). These results indicate that idiom comprehension is dependent upon flexibility abilities.

Relationships between PANSS scores and comprehension abilities in patients

The comprehension of idioms, those presented in an idiomatic context, in an ambiguous context, the unfamiliar ones, and opaque ones was correlated with the P2 score (Conceptual Disorganization, respectively Spearman's $\rho = -0.58$, $p < 0.05$; Spearman's $\rho = -0.63$, $p < 0.05$; Spearman's $\rho = -0.65$, $p < 0.05$; Spearman's $\rho = -0.53$, $p < 0.05$ and Spearman's $\rho = -0.48$, $p < 0.05$). In other words, the more severe the P2 symptom, the lower their accuracy was.

Discussion

Our study was designed to determine whether idiom comprehension in schizophrenia is influenced by context and type of expression

(transparency, familiarity), and whether it is affected by working memory and/or executive function deficits.

Our results showed that the patients with schizophrenia had particular difficulty understanding idioms in an idiomatic context, as opposed to an ambiguous one, regardless of the degree of familiarity and transparency of the expressions. Some studies showed that plausible idioms are more problematic for patients with schizophrenia than implausible ones^{5,6,8}. Our results indicated that this effect of familiarity and transparency disappeared when we added the context variable. The idiomatic context does not help patients to access the nonliteral interpretation. Previous studies⁴⁻⁸ ascribed the difficulties of patients with schizophrenia to a failure to inhibit literal interpretations, rather than an inability to process contextual information. On contrary, we believe that they have difficulties to process contextual information because the context contained more information and required to select relevant elements.

Analysis of the justifications supplied by our patients with schizophrenia highlighted the difficulty they had processing language, as they tended to focus on details (contextual, syntactic, semantic or prosodic) that were not relevant to the interpretation. We also found that some patients tried to draw a link between the story that was presented and their own concerns, showing that their responses were centered around their personal experience.

The patients with schizophrenia in our study performed more poorly than controls on several cognitive ability measures, most notably verbal inhibition and cognitive flexibility, reflecting the dysexecutive functioning that is classically observed in this population.

Results for the healthy controls indicated that good inhibition abilities are important in

idiom comprehension. In the patients, however, we did not observe any significant correlations between their cognitive profile and the results for idiom comprehension. This underlines that an executive deficit is not enough to explain the difficulties with idiom comprehension observed in schizophrenia. Moreover, several interesting results emerged regarding the link between the clinical aspects assessed on the PANSS and idiom comprehension. For a start, patients whose thought processes were disturbed had greater difficulty understanding unfamiliar idioms. The conceptual disorganization we observed in the patients prevented them from focusing their attention on the relevant elements, probably owing to an impairment of selective attention. In line with first descriptions of schizophrenia¹⁻³, our study confirmed that language and communication abnormalities are central to this disorder. Although the patients with schizophrenia exhibited dysexecutive functioning, our results do not allow us to conclude that it explained the difficulty they had understanding idioms. Our results nonetheless suggest that the difficulties we observed were linked to a deficit in attentional processes, and we can hypothesize that there is a dysfunction in information selection. Attentional processes therefore need to be explored in greater detail in relation to the comprehension of figurative language, and more specifically, the ability to extract relevant information from a given context, in order to test our hypothesis.

It is extremely important to explore pragmatic language abilities in pathologies like these, as deficits can have a major impact on aspects of everyday life, particularly social interactions and social adaptation. The deficits observed in pragmatic comprehension have repercussions on patients' social integration.

References

1. Bleuler E. *Dementia praecox: Or the group of schizophrenias*. New York: International Universities Press, 1911.
2. Kraepelin E. *Manic-depressive insanity and paranoia* (R.M. Barclay, Trans.). Edinburgh: Livingstone, 1919.
3. Kraepelin E. *Dementia praecox and paraphrenia* (R.M. Barclay, Trans.). Huntington, NY: Robert E. Krieger, 1971.
4. Thoma P, Daum I. Neurocognitive mechanisms of figurative language processing-evidence from clinical dysfunctions. *Neurosci Biobehav Rev*. 2006; 30(8): 1182-205.
5. Iakimova G, Passerieux C, Denhière G, Laurent JP, Vistoli D, Vilain J, *et al*. Comprehension of idioms with multiple meanings by patients with schizophrenia. *Psychiatry Research*. 2010; 177: 46-54.
6. Schettino A, Lauro LR, Crippa F, Anselmetti S, Cavallaro R, Papagno C. The comprehension of idiomatic expressions in schizophrenic patients. *Neuropsychologia*. 2010; 48(4): 1032-40.
7. Tavano A, Sponda S, Fabbro F, Perlini C, Rambaldelli G, Ferro A, *et al*. Specific linguistic and pragmatic deficits in Italian patients with schizophrenia. *Schizophr Res*. 2008; 102(1-3): 53-62.
8. Titone D, Holzman PS, Levy DL. Idiom processing in schizophrenia: literal implausibility saves the day for idiom priming. *J Abnorm Psychol*. 2002; 111(2): 313-20.
9. Champagne-Lavau M, Stip E, Joannette Y. Language functions in right-hemisphere damage and schizophrenia: apparently similar pragmatic deficits may hide profound differences. *Brain*. 2007; 130(Pt 2): e67; author reply e68.
10. Kay SR, Opler LA, Lindenmayer JP. The Positive and Negative Syndrome Scale (PANSS): rationale and standardisation. *Br J Psychiatry Suppl*. 1989; (7): 59-67.
11. Saß H, Wittchen HU & Zaudt, M. *Diagnostisches und statistisches Manual psychischer Störungen – DSM IV* [Diagnostic and Statistical Manual of Mental Disorders – DSM IV]. Göttingen: Hogrefe, 1996.
12. Dilling H, Mombour W & Schmidt M. *Internationale Klassifikation psychischer Störungen, ICD-10 – Kapitel V (F), klinisch-diagnostische Leitlinien* [International Classification of Psychiatric Disorders, ICD-10 – Chapter V (F), Clinical and Diagnostic Guidelines]. Bern: Huber, 2000.
13. Montgomery SA, Asberg M. A new depression scale designed to be sensitive to change. *Br J Psychiatry*. 1979; 134: 382-9.
14. Spreen O, Strauss E. *A compendium of neuropsychological tests: Administration, norms, and commentary* (2nd ed.). 1998. New York: Oxford University Press.
15. Stroop JR. Studies of interference in serial verbal reactions. 1935. *Journal of Experimental Psychology*, 18, 643-662.
16. Belleville S, Rouleau N, Van der Linden M. Use of the Hayling Test to measure inhibition of familiar schemas in normal aging and Alzheimer's disease. 2006. *Brain and Cognition*, 62, 113-119.
17. Burgess PW, Shallice T. *The Hayling and Brixton Tests*. Bury St. Edmunds: Thames Valley Test Company; 1996.
18. Reitan RM. Validity of the Trail Making Test as an indicator of organic brain damage. 1958. *Perceptual Motor Skills*, 1958, 8, 271-276.

* Corresponding author:
 Agnès Lacroix
 Université Européenne de Bretagne
 Rennes 2 – CRPCC
 Place du Recteur H. Le Moal,
 35043 Rennes Cedex
 France
 Tel.: +33 (0)2.99.14.19.00
 E-mail: agnes.lacroix@uhb.fr