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Shall we use non-verbal fluency in schizophrenia? – A pilot study

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ABSTRACT

Over the last few years, numerous studies have attempted to explain fluency impairments in people with schizophrenia, leading to heterogeneous results. This could notably be due to the fact that fluency is often used in its verbal form where semantic dimensions are implied. In order to gain an in-depth understanding of fluency deficits, a non-verbal fluency task – the Five-Point Test (5PT) – was proposed to 24 patients with schizophrenia and to 24 healthy subjects categorized in terms of age, gender and schooling. The 5PT involves producing as many abstract figures as possible within 1 min by connecting points with straight lines. All subjects also completed the Frontal Assessment Battery (FAB) while those with schizophrenia were further assessed using the Positive and Negative Syndrome Scale (PANSS). Results show that the 5PT evaluation differentiates patients from healthy subjects with regard to the number of figures produced. Patients' results also suggest that the number of figures produced is linked to the "overall executive functioning" and to some inhibition components. Although this study is a first step in the non-verbal efficiency research field, we believe that experimental psychopathology could benefit from the investigations on non-verbal fluency.

1. Introduction

In the field of neuropsychology, *fluency* generally refers to two distinct forms of verbal ability. The first concerns linguistic aptitude and implies speaking in a given rhythm while respecting coherence and conjunctions, and refers both to the content and to the form of speech. Good *fluency* skills thus ensure a fluent, fluid, meaningful and structured discourse (Rondal and Seron, 2003; De Perrot and Weyeneth, 2004). In schizophrenia, *fluency* problems mainly consist of the unusual usage of words, neologisms, stereotypes or perseverations, and could be due to both thought and cognitive disorders (Frith, 1992; Kuperberg and Caplan, 2003). The second form concerns *fluency* in terms of a neuropsychological task in which the experimenter focuses on how to mobilize both semantic and cognitive skills (Troyer et al., 1998, 2002; Sauzéon et al., 2004; Meulemans and Seron, 2004) by asking the subject to produce as many words as he can with regard to a certain semantic category, a letter (Cardebat et al., 1990; Pradat-Dhiel, 2006) or a word class such as verbs (Piatt et al., 1999; Woods et al., 2005). Many studies exploring verbal fluency tasks in schizophrenia have shown different, and sometimes inconsistent types of impairments (for a review, see Bokat and Goldberg, 2003; Van Beilen et al., 2004; Ojeda et al., 2010). Globally, these two meanings (linguistic ability or neuropsychological task) rely on the same concept of *efficiency* because they both imply that subjects use strategies to maximize their production while respecting a set of rules and environmental constraints.

In this paper, we will consider *efficiency* as the ability of a subject to integrate instructions and contextual/environmental constraints in order to accomplish a specific activity that results in something directly quantifiable where the higher the magnitude, the more efficient the subject's processing. This definition suggests that *efficiency* is a key concept to investigate in neuropsychological assessment not only because of its close links with daily life issues (Rempfer et al., 2003; Kurtz, 2011), but also because it could enable a more global view of executive functioning (and in particular, how executive functions are associated, enabling the subject to increase his performance).

However, considering what we have mentioned above with regard to verbal language impairments in schizophrenia, verbally evaluating a subject with schizophrenia can potentially lead to misinterpretations. This could be due to the fact that in the tasks specified, executive functions and semantic/linguistic abilities and their impairments are confounded. Non-verbal fluency makes it possible to override these issues because it does not refer to any semantic representations.

Indeed, we can still focus on efficiency in a non-verbal way without narrowing down to a simple motor task and propose a task that constantly involves high cognitive functioning. Non-verbal fluency has been mentioned in the literature since 1977 when Jones-Gotman and Milner focused on the impairments of brain-injured patients with fronto-central lesions during a task in which subjects had to create drawings on a sheet of paper. In this

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task, subjects had to draw something they had never seen before (even regular geometric forms were excluded). There were two conditions: one in which they could draw freely and another in which they had to draw using four lines; both conditions lasted 5 min and examples were given along with the instructions. The researchers also found that patients with left and right temporal lesions had more moderate impairments (Jones-Gotman and Milner, 1977). Today, there are two designed tasks that are mainly used as non-verbal fluency tests: the Ruff Figural Fluency Test (RFFT) and the Five-Point Test (5PT), the RFFT being primarily a modified version of the 5PT (Regard et al., 1982). These two tests involve creating as many *abstract figures* as possible within one minute by connecting points in different patterns using straight lines. The RFFT (see Fig. 1) consists of five parts; each part is composed of a specific point arrangement and lasts one minute. Scores are computed from the number of figures produced and the perseverations, but other scores such as the number of rotations and enumerations can also be computed and used qualitatively. This task was recently tested in a cohort of 1651 adults aged between 35 and 82 years old and the results indicated a correlation between RFFT, age and the education level (Ruff et al., 1987; Izaks et al., 2011). The 5PT (see Fig. 2) is also a structured figural fluency test that involves drawing different figures but only in one given configuration of symmetrically and identically arranged dots (identical to the arrangement on a dice). Several studies have collected normative data for this test using different size samples (Goebel et al., 2009; Cattelani et al.,2011; Khalil, 2010; Tucha et al., 2012). They have demonstrated the test's construct validity, as well as good correlations with verbal fluency, processing speed and mental flexibility (Tucha et al., 2012); its sensitivity to large and significant differences between the performance of healthy subjects and patients with Parkinson's disease (Goebel et al., 2012; Tucha et al., 2012) and its inter-rater (Tucha et al., 2012) and test–retest reliability (Fernandez et al., 2009; Goebel et al., 2009; Tucha et al., 2012).

To a larger extent, non-verbal fluency impairments, as tested with the RFFT, have been found in populations with several neurological or psychiatric conditions including people with borderline personality disorders (Beblo et al., 2006), obsessive-compulsive disorders (Fenger et al., 2005), major depression (Mondal et al., 2007) or head injuries (Ruff et al., 1987) and those with right anterior lesions in particular (Ruff et al., 1994). Deficits have also been found in adolescents with generalized epilepsy (Gelziniene et al., 2011) and in patients with ADHD (Tucha et al., 2005). Moreover, it is worth mentioning that, in some cases, non-verbal fluency can be impaired despite preserved performances with regard to other executive measures (Hanks et al., 1996), and, in particular, verbal fluency (Fenger et al., 2005).

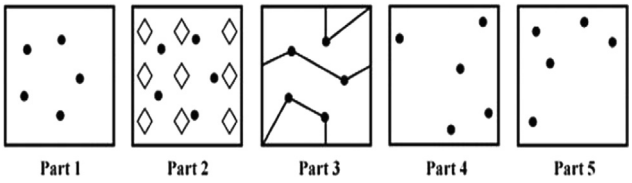

Fig. 1. Five dots patterns of the RFFT (Izaks et al., 2011).

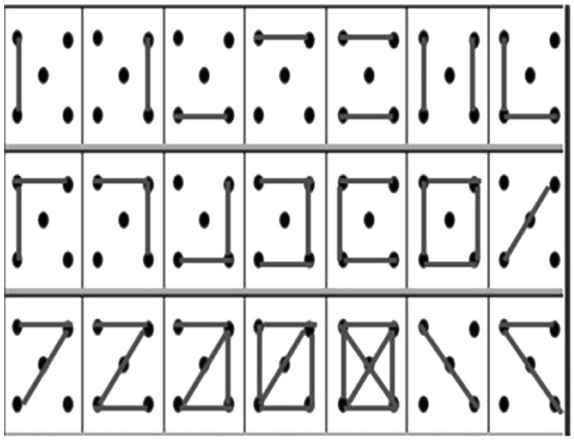

Fig. 2. Example of a 5PT resolution. The original grid is composed of five lines of seven boxes.

Impairments in non-verbal fluency tasks have therefore been found in several psychopathological populations using the RFFT. Nevertheless, this has not led to a more systematic use of the tool, neither in experimental psychopathology nor in the clinical neuropsychology field. To date, we have found only one study using the RFFT in schizophrenia, and only as a secondary measure (Brown et al., 2009).

The aim of this study is therefore to assess how the 5PT differentiates healthy subjects from patients with schizophrenia, and to analyze its potential links with the overall executive functioning and specific components of schizophrenia as symptoms and groups of symptoms. We assume that, as an *efficiency* measure, non-verbal fluency can be linked to the general executive functioning and that symptomatology can specifically influence the results with lesser unique designs in patients with a negative syndrome and more perseverations in patients with a positive or disorganization syndrome. Indeed, whereas negative symptoms might more significantly influence the skills related to *efficiency*, and especially expression and initiation (Frith, 1992; Torres et al., 2004; Langdon et al., 2007), positive and disorganization symptoms could possibly be linked to errors (Woodward et al., 2003).

2. Methods

2.1. Participants

We recruited 24 inpatients from three public mental health institutions from Belgium hosting closed hospitalization services for psychosis. All the individuals met the DSM-IV-TR (American Psychiatric Association, 2004) criteria for schizophrenia, which was determined through consensus between their psychiatrist and a psychiatrist with specific expertise in neuropsychiatric research. Subjects were aged between 20 and 62 years, and included 16 men and eight women. Diagnosed comorbidity with other mental disorders and neurological or vascular past histories were excluded. The age limit was fixed at 65 to avoid an aging effect or any pre-demential/demential state and none of the subjects had mental retardation (IQ < 85, IQ was established from prior evaluation). The socio-cultural level was estimated based on the number of school years accomplished since the first grade. This ranged from 6 to 17 years (see the demographic descriptive data in Table 1). The patients could be described as "stable" (in terms of medication and behavior within an assessment context). Twenty-four control subjects were compared to each experimental subject based on age, sex and schooling (number of school years and type of schooling). Control subjects were recruited on the basis of free participation and were selected depending on their potential similarity to one or several patients. None of them had a psychological, psychopathological, neurological or vascular history, nor were they substance abusers nor on medication.

The study was approved by the ethics committee of each institution, and all participants gave their informed written consent once procedures had been fully explained.

2.2. Procedure

Subjects first completed the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987) (see table 2) and the Frontal Assessment Battery (FAB) (Dubois et al., 2000) in order to control the influence of symptomatology and global executive functioning. The PANSS was filled using the subjects' responses to a semi-structured interview (SCI-PANSS) (Lepine and Perreti, 2008) and further information was obtained from the caregivers when necessary. We computed three scale scores (positive, negative and general psychopathology scales), three factor scores (positive, negative and disorganization factors) (Bell et al., 1994; Clark et al., 2010) and two negative subfactor scores (*core negative symptoms* and *social amotivation* symptoms). The two negative subfactors were used to reinforce the potential symptomatology analysis implications of the negative symptoms by differentiating