



## Executive function as predictors of persistent thought disorder in first-episode schizophrenia: A one-year follow-up study



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### ABSTRACT

Language disorganization is an important clinical indicator of acute psychosis, yet the longitudinal course and pathogenesis are not well understood. Executive dysfunction has been suggested as a vital contributor to formal thought disorder (FTD) and may serve as a stable predictor of symptomatic risk. The paper reports a one-year prospective study of language disorganization in sixty patients with first-episode schizophrenia-spectrum disorders and investigates executive function as a predictor of persistent FTD one year after illness onset. FTD was captured using the Clinical Language Disorder Rating Scale (CLANG), which segregates language abnormalities into three empirically validated levels: syntactic, semantic, and production.

After one year, patients' syntactic and semantic deficits were substantially reduced, but production impairments persisted. Patients' improvement of semantic impairment was associated with reduced disorganized symptoms while production impairment was associated with negative symptoms. We further identified two different patterns of baseline executive function predictors for both residual semantic and production impairment. We found that sustained FTD at the semantic level was predicted by both sustained attention and planning at illness onset, while residual production failure was only predicted by sustained attention.

In conclusion, the present paper documents the distinct characteristics of psycholinguistic levels in FTD and isolates two different patterns of executive function predictors for persistent semantic and production language disorganization at follow-up. The findings help to disentangle FTD dimensions at different levels of language production processes, which provide clinical implications for targeting patients at risk for prolonged FTD concordant upon executive dysfunction at illness onset.

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### 1. Introduction

Language disorganization is an observable expression of formal thought disorder (FTD) that has been strongly associated with clinical expression and broader neurocognitive deficits in psychotic disorders, including schizophrenia-spectrum disorders (Kerns and Berenbaum, 2002; Subotnik et al., 2006; Ceccherini-Nelli et al., 2007). Previous studies have demonstrated a close association between FTD and other symptomatology in schizophrenia-spectrum disorders, such as delusions and hallucinations, (Andreasen and Grove, 1986; Harrow and Marengo, 1986; Kimhy et al., 2005; Strik et al., 2008), implicating it as a clinical indicator of acute psychotic states. Despite the diagnostic significance of language disorganization among patients with schizophrenia-spectrum diagnoses, its pathogenesis and longitudinal course are not yet well understood. Marengo and Harrow (1987) reported heterogeneous

change patterns in patients with schizophrenia over four years, where symptoms were most common at first episode and persisted after first episode for 40% of patients. Additionally, FTD during the acute phase of illness was present across a range of psychotic disorders, and associated with psychotic symptoms rather than being isolated to those with schizophrenia diagnoses (Marengo and Harrow, 1987, 1997). Persistent FTD was related to positive symptoms (Harrow and Marengo, 1986) and lower levels of social functioning (Harrow and Marengo, 1986; Racenstein et al., 1999; Bowie et al., 2011). Therefore, understanding characteristics of acute illness that reliably predict persistent FTD will identify patients at greatest risk of poor long-term outcomes and most in need of targeted clinical interventions.

The Thought, Language and Communication disorder rating scale (TLC) (Andreasen, 1979a,b) provides a more detailed account of FTD than previous measures by evaluating two main categories of language disorganization, namely, positive (pressure of speech, tangentiality, derailment, incoherence, and illogicality) and negative (poverty of speech and poverty of content of speech) FTD. Longitudinal studies applying the TLC have demonstrated that negative thought disorder

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remains stable over the course of illness while positive FTD declines in most patients (Andreasen and Grove, 1986; Docherty et al., 1988; Harvey et al., 1990; Bowie et al., 2005). These results elucidate the independent temporal courses of FTD subtypes.

To better capture and quantify the full complexity and diversity of FTD, the Clinical Language Disorder Rating Scale (CLANG) was developed based on modern psycholinguistics. CLANG segregates language abnormalities into three empirically validated levels: syntactic (syntactic abnormalities, including phonetic abnormalities and abnormal word choice), semantic (corresponding to the traditional idea of loose associations) and production (corresponding to the notion of poverty of speech) (Chen et al., 1996). Using CLANG to assess linguistic deviations, Ceccherini-Nelli and Crow (2003) also found a three factor structure, namely 'semantic', 'poverty', and 'excess'. This overlapped Chen et al. (1996)'s structure on the semantic and production/poverty factors. Ceccherini-Nelli & Crow also demonstrated a strong correlation between their CLANG dimensions and Schneiderian first-rank symptoms. Like previous TLC research, they demonstrated the diagnostic significance of CLANG in differentiating ICD-10 schizophrenia-spectrum diagnoses from other psychiatric disorders (Ceccherini-Nelli and Crow, 2003; Ceccherini-Nelli et al., 2007). Thus, the clinical relevance and psycholinguistic detail of CLANG can help elucidate the underlying mechanism and longitudinal pattern of FTD across the schizophrenia-spectrum.

Executive impairment is an important contributor to language disorder (Liddle, 1987a; McGrath, 1991; O'Leary et al., 2000; Moritz et al., 2001; Kerns and Berenbaum, 2002; Barrera et al., 2005; Stirling et al., 2006). McGrath (1991) has proposed that the failures in planning, editing and monitoring thoughts lead to different manifestations of FTD in schizophrenia. McGrath et al. (1997) have extended this dysexecutive hypothesis by demonstrating associations between language disorder and executive dysfunction (assessed with Wisconsin Card Sorting Test, Stroop Test, and Verbal Fluency Test) in a group of acute onset psychotic patients. Several subsequent studies have successively demonstrated significant correlations between FTD and a range of executive function tests (e.g., Nestor et al., 1998; Kerns and Berenbaum, 2003; Barrera et al., 2005; Stirling et al., 2006). Nonetheless, the role of executive functioning as a predictor of persistent FTD after acute illness onset has scarcely been studied. The current study addresses this gap in research.

The fractionation of executive functioning has been well studied among patients with schizophrenia-spectrum disorders (Marczewski et al., 2001; Alvarez and Emory, 2006; Chan and Touloupoulou, 2006; Chan et al., 2006; Liu et al., 2011). The Supervisory Attentional System (SAS) model proposed by Norman and Shallice (1986) provides a theoretical model to understand the nature of dysexecutive syndrome. Under the SAS model, executive impairments in schizophrenia-spectrum disorders are segregated into distinct executive deficits (Marczewski et al., 2001; Chan et al., 2004, 2006; Liu et al., 2011). A more principled model of executive functioning better captures specific roles of distinct executive impairment in FTD. Hence, the current study decomposes executive functioning to predict residual FTD symptoms at follow-up. In order to identify a clear pattern of longitudinal trajectories of FTD and the role of executive functioning in persistent FTD in first-episode schizophrenia-spectrum disorders, we aim to (1) characterize changes in specific linguistic dimensions of language disorganization over one year after the first episode of schizophrenia-spectrum diagnoses; and (2) assess the role of executive functioning in predicting different dimensions of language disorganization at follow-up.

## 2. Methods

### 2.1. Subjects

Sixty patients (33 males) with first-episode schizophrenia-spectrum disorders were recruited from a larger cohort for a longitudinal study (see Chan et al., 2006). There were no significant differences between included and non-included cases in terms of gender, age, years of

education and PANSS total score at the baseline. The study was approved by the relevant Institutional Review Boards prior to commencement. Written informed consents were attained from each participant at recruitment. All were Cantonese-speaking, Han Chinese diagnosed with schizophrenia-spectrum disorders based on DSM-IV criteria (American Psychiatric Association, 1994). Inter-rater reliability of diagnosis by two experienced clinicians in a sample of 38 patients was 86%. Patients with significant medical illness or having high suicidal risks judged by their attending clinicians were excluded from the study.

### 2.2. Assessments

Assessments at two time points are analyzed, namely at patients' illness presentation (medication naive) and after one year.

#### 2.2.1. General intelligence

General intelligence was measured at first assessment using the Wechsler Adult Intelligence Scale Revised for Cantonese speaking populations (Hong Kong Psychological Society, 1989).

#### 2.2.2. Clinical Language Disorder Rating Scale (CLANG)

Seventeen observer-rated items were anchored on a four-point severity scale (see Appendix A). Rating was derived from a minimum of 15 minute speech output under a standardized condition. Suggestions of conditions eliciting a speech sample and definitions of CLANG items were described in detail in the validation paper (Chen et al., 1996). Severity of CLANG individual items depends on the extent to which it is present in relation to the length and duration of the total speech output. Three major domains of FTD were obtained according to the factor segregation of the CLANG original validation paper: 1) syntax (excess phonetic association, abnormal syntax, excess syntactic constraints, neologisms, and paraphasic error); 2) semantics (lack of semantic association, discourse failure, referential failures, and pragmatic disorder); and 3) production (lack of details, aprosodic speech, and poverty of speech) (Chen et al., 1996).

#### 2.2.3. Positive and Negative Syndrome Scale

The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) assessed symptom severity in patients. Inter-rater reliability of the three raters was 0.83 (by intra-class correlation coefficient). A five-factor (negative, positive, disorganized, excited and anxiety/depression) structure, shown to represent psychopathology structure better than the original three factor structure while maintaining internal consistency (Emsley et al., 2003), was utilized.

#### 2.2.4. Executive functioning measures

Each of the following tests evaluates one specific component of executive functioning in the SAS model, as demonstrated in previous studies on the fractionation of executive functioning of patients with schizophrenia-spectrum disorders (Chan et al., 2004, 2006).

#### 2.2.5. Hayling Sentence Completion Test (HSCT)

Two test sessions (A and B) are administered; session A is conducted first, followed by session B. In each session, fifteen sentences are presented in which the last word is missing but is strongly cued by the context of the sentence. Participants are instructed to fill in the missing word (as administered in Burgess and Shallice, 1996; Chan et al., 2012; see Bloom and Fischler, 1980 for stimuli validation). The total number of correct responses in session A, when subjects are asked to complete with a word related to the context of the sentence, was recorded to assess the "semantic initiation" component of executive function (Chan et al., 2012). The total number of correct answers in session B, which requires subject to inhibit a semantically habitual response to respond with a word that is not related to the context of the sentence, was recorded to assess the "semantic inhibition" capacity (Chan et al., 2012).

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