



Action (verb) fluency deficits in schizophrenia spectrum disorders: linking language, cognition and interpersonal functioning



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ABSTRACT

Deficits in action (verb) fluency have previously been reported in schizophrenia spectrum disorders. The degree to which this reflects difficulties generating verbs in different semantic categories is unknown. Here, action fluency responses of 46 patients with schizophrenia spectrum disorders and 76 healthy controls were classified as action or mental state verbs, using well-established taxonomies. The word length, frequency, age of acquisition, valence and concreteness of the verbs produced were also examined. Participants also completed measures of cognitive function, and clinical symptoms. Independent inter-rater agreement of semantic categorization was high. The percentage of action verbs produced was significantly lower in patients than controls, whilst the percentage of mental state verbs produced did not differ. Patients' action verbs were: significantly less concrete; positively correlated with memory and intelligence; and negatively correlated with interpersonal symptoms. Impaired action verb, but intact mental state verb generation is consistent with the neural separability of these processes.

1. Introduction

Abnormalities of language and its use are key phenomena in schizophrenia (Bleuler, 1950; Brown and Kuperberg, 2015; Li et al., 2012). The signs and symptoms of these abnormalities range from odd or disorganized speech to disturbed semantic processing and poorer verbal abilities relative to other cognitive domains, which may also be exhibited by unaffected relatives (Hinzen and Rosselló, 2015; Levy et al., 2010; Walenski et al., 2010). Language dysfunction emerges early in the neurodevelopmental course of the disorder (Welham et al., 2009) and predicts both risk of transition to illness (Bedi et al., 2015) and long-term functional impairment (Green, 2006; Lin et al., 2011; Holshausen et al., 2014), sparking renewed interest in novel analytic techniques to improve the detection and understanding of psychosis (Elvevåg et al., 2010; Nicodemus et al., 2014). Decline in verbal fluency is a characteristic finding in schizophrenia, involving a combination of mechanisms including semantic processing skills (Bozikas et al., 2005), difficulties using context (Docherty et al., 2011; Vogel et al., 2009) and executive dysfunction (Stirling et al., 2006; Ojeda et al., 2010).

The aim of this study was to gain an understanding of the action (verb) fluency impairments in schizophrenia patients using a cognitive-linguistic approach. Deficient semantic fluency has been reported in

schizophrenia (Fusar-Poli et al., 2012; Henry and Crawford, 2005) and proposed as a potential endophenotypic marker of disorder (Szöke et al., 2008) but the majority of previous studies have focused on fluency for object words (nouns) rather than action words (verbs). Consequently much less is known about the semantic, lexical and cognitive characteristics of action fluency in people with schizophrenia spectrum disorders.

The Action (Verb) Fluency Task (AFT) was developed by Piatt et al. (1999), drawing on evidence of a dissociation in the neural systems supporting the generation of verbs and nouns (Damasio and Tranel, 1993). Recent research, including the development of a detailed semantic atlas of the cerebral cortex (Huth et al., 2016) suggests that topographical differences in brain activation are driven by word meaning, i.e. action vs. object semantics, rather than grammatical class (verbs vs. nouns); with further evidence coming from studies examining different semantic categories within the same lexical class (Moseley and Pulvermuller, 2014). The neural and anatomical systems involved in processing verbs referring to concrete actions (e.g. to run, to poke) or abstract mental states (e.g. to think, to desire) is still a matter of considerable debate (Hauk et al., 2004; Kemmerer et al., 2008; Lin et al., 2015). However, converging lines of evidence suggest that processing action verbs (AV) and mental state verbs (MSV) involves dissociable

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cortical networks that are flexibly engaged (according to the demands of the task) in representing (i) the sensory, motor and affective features of actions and (ii) the abstract motives driving those actions (Buccino et al., 2016; Kemmerer, 2015; Spunt et al., 2016). While many studies have addressed the neurolinguistic consequences of focal brain lesions, relatively little is known about the functional psycholinguistic impairments associated with severe mental illness. Significant action fluency deficit has been reported in three previous studies of patients with schizophrenia or schizophrenia spectrum disorders (Badcock et al., 2011; Marvel et al., 2004; Woods et al., 2007) and related to clinical symptoms of odd speech, constricted affect and increased social anxiety, but not to hallucinations or delusions (Badcock et al., 2011). However, none of these prior studies analyzed the specific semantic content of the verbs produced. Consequently, it is as yet unknown if this action fluency impairment reflects a greater difficulty generating AV or MSV – potentially reflecting a difference in recruitment of dissociable neural networks by patients, when generating semantically different verb types.

Besides semantics, the lexical characteristics of verbs also influence action fluency performance. For example, in healthy people higher frequency verbs are recognized/produced faster and more accurately than lower frequency verbs (Balota et al., 2004; Sidhu et al., 2016). Both schizophrenia patients and healthy controls (HC) produce a greater number of higher frequency words when performing semantic (noun) fluency tasks (Paulson et al., 1996). However, the specific effect of word frequency on action (verb) fluency production in schizophrenia has yet to be examined. Furthermore, data from healthy individuals show that earlier acquired words tend to be retrieved faster than later acquired words (Kuperman et al., 2012). Juhasz et al. (2012) showed that patients with schizophrenia generated words with a lower average Age of Acquisition (AoA) (though similar frequency and word length) on a semantic (animal) fluency task compared to HC, but the influence of AoA on action fluency performance has not been evaluated. AV, such as those associated with the leg (e.g., kick, walk) and mouth (e.g., bite, lick), are typically acquired earlier than MSV denoting states of cognition (e.g., think, pretend) or emotion (e.g., like, love) in healthy participants (Levi et al., 2014; Maouene et al., 2016). These early learned verbs have a systematic and meaningful link to body parts, hence are tightly coupled to motor actions and more certain meanings (Maouene et al., 2016). Indeed, Brysbaert et al. (2014) proposed that “concrete words are easier to remember than abstract words, because they activate perceptual memory codes in addition to verbal codes” (p. 904). In healthy individuals, concrete words may also be easier to process because of their imagistic representations (Paivio et al., 1988) and strong affiliation to memory contexts (Schwanenflugel et al., 1988). However, Kuperberg and colleagues (2008) showed that patients with schizophrenia “failed to recruit the dorsolateral prefrontal cortex to concrete (relative to abstract) sentences” (p. 407). Though not specifically focused on action verbs, these findings suggest that processing concrete words may be more challenging for people with schizophrenia than healthy controls.

Conversely, MSV may be more difficult to acquire since they refer to events that are not directly observable (e.g. beliefs, desires) and demand the conceptual development of a “theory of mind”¹ (Barak et al., 2012). Difficulties with abstract thinking and mentalizing are common in schizophrenia (Chung et al., 2014), yet the role of concreteness/abstractness on verb fluency in schizophrenia has not been investigated. Similarly, valence has a significant influence on language production, including a faster response to words with positive meaning (Kuperman et al., 2014) but its effect on fluency in schizophrenia is unknown. In sum, the lexical characteristics of AV and MSV may cause variations in action fluency performance across groups and merit further investigation.

Finally, impairment in action (verb) fluency is strongly correlated with general cognitive ability. At a general level, intelligence and education are positively correlated with verb production, whilst verbal fluency appears to decrease with age (McDowd et al., 2011) – though see Stokholm et al. (2013) for contrary findings with age. Specific associations have also been reported with measures of working and semantic memory, response inhibition and cognitive flexibility (Woods et al., 2007), suggesting a significant, though not exclusive, role of executive dysfunction in action fluency performance (Whiteside et al., 2016). Importantly, no previous studies have examined the relationships between AV/MSV production and cognitive functioning or clinical profiles in schizophrenia. Under-mentalizing (deficient theory-of-mind) which refers to a reduced ability to understand the beliefs, intentions and mental states of others, has been linked to the prominence of negative symptoms (Montag et al., 2012). Conversely, hyper-mentalizing (or enhanced theory-of-mind), involving excessive attribution of beliefs or intentions to others, has been more strongly associated with positive psychotic symptoms, such as delusions (Clemmensen et al., 2016; Frith, 2004).

Based on the literature reviewed above, we generated three hypotheses: (1) Patients with schizophrenia spectrum disorders will produce fewer correct words than healthy controls on the Action Fluency Task, in keeping with previous findings. (2) Patients will generate both fewer AV and fewer MSV compared to healthy controls, with a larger effect size for MSV due to their greater cognitive demands. (3) The AoA of the verbs produced will be lower in schizophrenia than in healthy controls, though the average word frequency and length may not differ. In addition, the magnitude of the relationship between action or mental state verb fluency and the cognitive or clinical characteristics of patients will be explored.

2. Methods

2.1. Participants

This study examined the linguistic characteristics of Action Fluency Test responses of 46 patients with an ICD-10 and DSM-IV diagnosis of schizophrenia spectrum disorder (SZ) and 76 healthy controls (HC) using archival data from the Western Australian Family Study of Schizophrenia (WAFSS). The WAFSS has been approved by the Human Research Ethics Committees of the University of Western Australia and the Department of Health of Western Australia. All participants gave written informed consent prior to data collection. Full details of the WAFSS are provided elsewhere (Hallmayer et al., 2005; Jablensky, 2006). The age range of WAFSS participants was 18–60 years. Patients were recruited from inpatient and community-based mental health services in Perth, Western Australia, were in a stable condition for at least one month and maintained on their usual antipsychotic medication at the time of testing (n=7 typical, n=13 atypical, and n=26 combined typical and atypical antipsychotic agents (for management of side effects)). Antipsychotic medication doses were converted to milligram equivalents of chlorpromazine, using standard formulae for typical (American Psychiatric Association, 1997) and atypical antipsychotics (Woods, 2003). The HC group comprised community volunteers with no self-reported personal or family history of psychosis, recruited by random sampling from local telephone directories or among Red Cross blood donors. Exclusion criteria for all participants were: a history of neurological disorder or head injury with concomitant loss of consciousness > 10 min, current substance abuse or dependence, systemic medical disease likely to compromise cognitive function, and poor fluency in English. Participants who had not completed at least 8th grade education and/or were unable to give informed consent were also excluded.

¹ Theory of mind is the capacity to impute mental states to the self or others.

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