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Mismatch and lexical retrieval gestures are associated with visual information processing, verbal production, and symptomatology in youth at high risk for psychosis

Zachary B. Millman [a,*], James Goss [b], Jason Schiffman [c], Johana Mejias [a], Tina Gupta [a], Vijay A. Mittal [a,d]

[a] University of Colorado Boulder, Department of Psychology and Neuroscience, United States
[b] Independent Scholar, United States
[c] University of Maryland, Baltimore County, Department of Psychology, United States
[d] University of Colorado Boulder, Center for Neuroscience, United States

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ABSTRACT

Introduction: Gesture is integrally linked with language and cognitive systems, and recent years have seen a growing attention to these movements in patients with schizophrenia. To date, however, there have been no investigations of gesture in youth at ultra high risk (UHR) for psychosis. Examining gesture in UHR individuals may help to elucidate other widely recognized communicative and cognitive deficits in this population and yield new clues for treatment development.
Method: In this study, *mismatch* (indicating semantic incongruency between the content of speech and a given gesture) and *retrieval* (used during pauses in speech while a person appears to be searching for a word or idea) gestures were evaluated in 42 UHR individuals and 36 matched healthy controls. Cognitive functions relevant to gesture production (i.e., speed of visual information processing and verbal production) as well as positive and negative symptomatologies were assessed.
Results: Although the overall frequency of cases exhibiting these behaviors was low, UHR individuals produced substantially more *mismatch* and *retrieval* gestures than controls. The UHR group also exhibited significantly poorer verbal production performance when compared with controls. In the patient group, *mismatch* gestures were associated with poorer visual processing speed and elevated negative symptoms, while *retrieval* gestures were associated with higher speed of visual information-processing and verbal production, but not symptoms.
Conclusions: Taken together these findings indicate that gesture abnormalities are present in individuals at high risk for psychosis. While *mismatch* gestures may be closely related to disease processes, *retrieval* gestures may be employed as a compensatory mechanism.

1. Introduction

Because gesture serves a variety of key communicative and cognitive functions (Feyereisen, 1987; Streek, 1994; Alibali and DiRusso, 1999), investigators have argued that these movements provide a "window to the mind" (Goldin-Meadow, 2003). The field of psychosis research has prioritized the search for readily observable markers that can identify risk or elucidate pathogenic processes, leading researchers to examine gesture in patients with schizophrenia. Studies of individuals with psychosis have observed abnormal gesture activity (Troisi et al., 1998; Meilijson et al., 2004; Lavelle et al., 2013; Walther et al., 2013a) with specific links to dysfunctional neural integration (Straube et al., 2013a), altered functional connectivity (Straube et al., 2013b), and both frontal cortex function and symptom severity (Walther et al., 2013b). Despite this growing body of evidence, and an earlier study observing gesture deficits in schizotypal personality disorder (SPD; Mittal et al., 2006), to date there have been no investigations of gesture in those at ultra high risk (UHR) for psychosis. Such research is important because gesture may be related to other impairments that are characteristic of this group, such as cognitive function (Seidman et al., 2010; Fusar-Poli et al., 2012). In addition, because gesture appears to be a useful tool for bolstering communicative ability and cognitive function (Alibali and DiRusso, 1999; Goldin-Meadow, 1999), and these domains are often affected in the prodromal period (Cornblatt et al., 2007; Niendam et al., 2007; Eack et al., 2010), understanding this behavior

* Corresponding author at: Department of Psychology and Neuroscience, University of Colorado at Boulder, 345 UCB, Boulder, CO 80309-0345, United States. Tel.: +1 303 492 4616.
E-mail address: zachary.millman@colorado.edu (Z.B. Millman).

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in UHR youth may have important implications for novel treatment development.

In any particular speech–gesture combination the information conveyed in the gesture is typically congruent with the speech. However, in some speech–gesture combinations the information in gesture can conflict with the speech (e.g., the speaker says "to the right" as they simultaneously point to the left). In normative samples, these "speech–gesture mismatches" (*mismatch* gestures) can appear when an individual's cognitive resources are taxed. For example, researchers have observed increased *mismatch* cases when participants are discussing a difficult math problem or narrating a story with frequent shifts between characters' physical viewpoints, their own, and their listener's (Church and Goldin-Meadow, 1986; Melinger and Kita, 2004). Despite the relevance of *mismatch* gestures, this subtype has received limited attention in clinical populations; to date, one study has examined *mismatch* gestures in patients with schizophrenia (Goss, 2011, unpublished dissertation), and no studies have examined this behavior in UHR individuals.

Retrieval gestures occur when individuals make a hand movement while appearing to search for a word or idea. The role of gesture in lexical retrieval renders this behavior particularly important. One view is that semantically related gestures are derived from lexical entries and assist in retrieval of relevant phonological forms (Butterworth and Hadar, 1989; Alibali et al., 2000). It is also possible that semantically related gestures are a product of spatially encoded information and that, in turn, provide access to lexical entries that contain syntactic and semantic information (Krauss et al., 1996; Alibali et al., 2000). Both possibilities suggest the gesture boosts activation levels for retrieval and subsequently plays a direct role in the process of speaking (Alibali et al., 2000). Given the importance of *retrieval* gestures and related deficits in psychosis (i.e., broad social cognition and fluency deficits; see Bokat and Goldberg, 2003; Couture et al., 2006), it is somewhat surprising that no studies have examined *retrieval* gestures in schizophrenia or spectrum disorders.

Although the literature linking gesture with cognitive dysfunction in psychosis is limited, several studies in healthy individuals help to identify potential cognitive domains. One strong line of evidence suggests that co-speech gestures facilitate verbal production (Morsella and Krauss, 2004; Hostetter and Alibali, 2007). For example, healthy individuals produced more gesture when restrictions were imposed on their speech; conversely, prohibiting gesture led to slower and more dysfluent speech (Rauscher et al., 1996). In addition, research has suggested that the recognition of gestures is influenced by contextual information (Peigneux et al., 2000; Osiurak et al., 2012). Indeed, in one of the noted studies that examined gesture behavior in psychosis, Walther et al. (2013b) posited that because visual information processing during social situations is affected in schizophrenia (Green et al., 2008), gesture performance in psychosis may also be hampered by poor visual information processing.

The present investigation evaluated *mismatch* and *retrieval* gestures, symptomatology, and both visual information processing speed and verbal production in UHR and control adolescents and young adults. Based on research suggesting broad nonverbal dysfunction in individuals with psychosis (Troisi et al., 1998; Mittal et al., 2006; Eack et al., 2010), and a previous study observing a high frequency of *mismatch* gestures in patients with schizophrenia (Goss, 2011, unpublished dissertation), we predicted that UHR participants would show elevated occurrences of *mismatch* gestures when compared with healthy controls. Group comparisons for *retrieval* gestures were treated as exploratory analyses given the novelty of examining this behavior in a clinical population. As studies have linked *mismatch* gestures with cognitive instability, a feature observed in patients with psychosis (Becker et al., 2012), we predicted that an elevated frequency of these gestures would be associated with decreased visual processing speed, impaired verbal production, and elevated symptom severity in the UHR group. Because studies have found *retrieval* gestures to facilitate cognitive function in healthy individuals (Cook et al., 2008), and UHR individuals show a range of cognitive deficits (Walder et al., 2008; Mittal et al., 2010; Seidman et al., 2010; Fusar-Poli et al., 2012), we predicted that the use of *retrieval* gestures would be associated with improved cognitive functioning in the clinical group.

2. Methods

2.1. Participants

Thirty six control and 42 UHR participants were recruited by Internet advertising, email postings, newspaper ads, and community professional referrals. Exclusion criteria included history of head injury, the presence of a neurological disorder, lifetime substance dependence, an Axis I psychotic disorder, and the presence of any contraindication to the magnetic resonance imaging environment. To be included in the study UHR individuals needed to meet one or more of three criteria from the Structured Interview for Prodromal Syndromes (SIPS): 1) recent onset or escalation of moderate levels of attenuated positive symptoms, 2) a decline in global functioning over the last 12 months accompanying the presence of schizotypal personality disorder, 3) a decline in global functioning over the last 12 months accompanying the presence of a first-degree relative with a psychotic disorder such as schizophrenia. The presence of a psychotic disorder in a first-degree relative or meeting criteria for any Axis I disorder was an exclusionary criterion for controls. The protocol and informed consent procedures were approved by the university institutional review board.

2.2. Clinical interviews

The SIPS measures several symptom categories of prodromal psychosis, including positive dimensions (unusual thoughts, suspiciousness, grandiosity, perceptual abnormalities, disorganized communication) and negative dimensions (social anhedonia, avolition, emotional expression, expression of self, ideational richness, occupational functioning). The severity of each dimension is represented by the sum of symptom scores within each category. In addition to the SIPS, the Structured Clinical Interview for DSM-IV (First et al., 1995) was used to rule out Axis I psychotic disorders. In this study, raters were advanced doctoral students who were trained over a 2-month period to achieve kappas of $\geq .80$.

2.3. Gesture

The clinical interviews took place in a quiet laboratory setting equipped with video technology. As in our prior study of different gesture subtypes among a distinct sample of schizotypal adolescents (Mittal et al., 2006), study staff rated the structured interview portion of the recorded interviews for different elements of gesticulation (those gestures occurring during the process of speech). Raters began when the first question of the SIPS was asked and then coded a 15-minute segment for each participant. The coding scheme was adapted from the *Handbook of Methods in Nonverbal Behavior Research* (Scherer and Ekman, 1982) and additional criteria for the coding of gesture subtypes were based on procedures described by McNeill (1992). Specifically, trained raters coded incidences of speech–gesture *mismatches*, defined as gestures that are semantically incongruent with the corresponding lexical content. For example, an individual exhibiting a *mismatch* gesture would be speaking about "climbing up a ladder" but would simultaneously be pointing downward. Coders also noted incidences of *retrieval* gestures. These gestures occur during a pause in speech when an individual is searching for a word or phrase. For example, a person might be talking about their lunch and say "The sandwich was almost the very best I ever tasted, it reminded me of that time I was traveling and ate in that café in… [gesture such as grasping air, creating a baton movement] … France!" In the context of preparing for a broader