Published in final edited form as:
Schizophr Res. 2011 November ; 132(2-3): 194–196. doi:10.1016/j.schres.2011.06.028.

Associations between spontaneous movement abnormalities and psychotic-like experiences in the general population

Vijay A. Mittal, Ph.D.[a,b], **Derek Dean, B.A.**[a], **Andrea Pelletier, B.A.**[a], and **Michael Caligiuri, Ph.D.**[c]

[a] Department of Psychology and Neuroscience, University of Colorado at Boulder

[b] Center for Neuroscience, University of Colorado at Boulder

[c] Department of Psychiatry, University of California San Diego

Abstract

An accumulating body of literature supports the notion that psychosis-like experiences (PLEs) may occur as a continuous phenotype. However, researchers are still working to determine if these events accompany an underlying continuum of neurobiological vulnerability as well. Within this context, it is notable that spontaneous dyskinetic movements are linked to specific pathogenic factors underlying schizophrenia, but to date there has been little research directed towards determining whether these events are associated with PLEs. In this study, 119 individuals were assessed for PLEs and administered a sensitive instrumental test of upper extremity dyskinesia. Present findings suggest a relationship between subtle dyskinesia and PLEs in the general population, and provide a new perspective of the psychosis continuum by indicating that basal ganglia pathology may also underlie PLEs at the non-clinical end of this spectrum.

Keywords

Psychotic-Like Experiences; Dyskinesia; Movement Abnormalities; ADAPT

1. Introduction

A growing number of reports showing that non-clinical psychotic symptoms (e.g., fleeting auditory hallucinations) are commonly experienced by otherwise healthy individuals (van Os et al., 2001) suggest that psychosis may occur as a continuous phenotype (Kelleher and Cannon, 2011). However, beyond the evidence documenting that psychotic-like experiences (PLEs) do occur in the general population, it remains largely unclear how these phenomena

Corresponding Author: Vijay A. Mittal, Ph.D., Assistant Professor, Department of Psychology and Neuroscience, University of Colorado at Boulder, 345 UCB, Boulder, Colorado 80309-0345, Phone: 310.923.2882, Fax: 303.492.2967.

Conflict of Interest
There are no conflicts of interest to report.

Contributors
Dr. Mittal attained funding, conceptualized the study, conducted analyses, and drafted the manuscript. Mr. Dean helped to design and run the study, prepare data and draft the manuscript. Mrs. Pelletier helped to interpret data and draft manuscript. Dr. Caligiuri helped to conceptualize the study, design apparatus, and conduct analyses.

are linked to formal psychosis, and if they reflect an underlying continuum of neurobiological vulnerability. More specifically, although research suggests that the presence of non-clinical psychotic symptoms in childhood appears to significantly increase risk of Axis-I psychosis in adulthood (Hanssen et al., 2005), it is unknown if otherwise healthy individuals experiencing psychotic-like symptoms show vulnerability characteristics consistent with a diathesis-stress model. Building upon this knowledge is integral, as understanding the full continuum of biological vulnerability may help to elucidate our conceptions of Axis-I psychotic disorders such as schizophrenia.

Observations that infants who later develop psychosis as adults show motor abnormalities were among the first evidence that a vulnerability for psychosis is present from early childhood (Walker, 1994). Since that time, we have found that movement abnormalities also increase as a function of age among prodromal youth (Mittal et al., 2008). Within this domain, spontaneous dyskinesias (e.g., writhing, jerking movements) in particular are of interest, as these movements reflect an impaired basal ganglia circuitry, which is also later implicated in the onset and maintenance of psychotic symptoms (DeLong and Wichmann, 2007). More specifically, researchers have observed that a natural part of the pathogenesis of psychotic disorders involves increased spontaneous dyskinesias (Cortese et al., 2005; Mittal et al., 2010), and that these movements reflect dysregulated dopaminergic activity in the striatal region (DeLong and Wichmann, 2007).

In the present study, 119 young adults were given a survey designed to gauge PLEs, and assessed with an instrumental measure of upper extremity dyskinesia to test the hypothesis that individuals on the lower end of the continuum of psychosis will still exhibit underlying neurobiological vulnerability factors, in this case reflecting dyskinetic movements.

2. Methods

2.1 Participants

Participants were recruited at the University of Colorado Boulder's Adolescent Development and Preventive Treatment (ADAPT) research program. Young adults (aged 18 and older; median age = 19) were enrolled in Introductory Psychology courses, and completed the assessments anonymously. A total of 1,357 students participated in the Introductory Psychology course research program. Participants signed up for the present study by choosing randomly from a larger list of available studies and to prevent any sampling confounds, no details were provided about any studies until students had already signed up and arrived for the consent (study titles were simply listed as serial numbers; e.g., Study 1077). Of the participant who signed up, 100% agreed to consent and participate. Exclusion criteria were left handed individuals and a history of smoking (which may alter performance on the movement task) (Quik et al., 2007). Based on this criterion, a total of 13 participants were excluded. Taken together, the 119 participants in the study represent 8.7% of the available undergraduate Introductory Psychology population. The protocol and informed consent procedures were approved by the University Institutional Review Board. See Table 1 for demographic characteristics of the sample.

2.2 Prodromal Questionnaire-Brief

PLEs were measured with the Prodromal Questionnaire-Brief (PQ-B) (Loewy et al., 2011), a 21- dichotomous item self-report questionnaire comprised of attenuated positive symptoms items, each with an accompanying question related to distress or impairment scored on a Likert scale ranging from 0–5 ("When this happens, I feel frightened, concerned, or it causes problems for me": *no* - *strongly agree*). Using a conservative approach, participants scoring a 4 or higher on the weighted distress scale ("agree" or "strongly agree"), were considered

as having experienced a definite PLE. Subjects were asked to indicate experiences in the past month and asked to not include experiences that occurred only while under the influence of alcohol, drugs, or medications that were not prescribed. The PQ-B has been validated, and used in studies to examine attenuated psychotic experiences in healthy populations (Loewy et al., 2011; Loewy et al., 2007)

2.3 Measurement of dyskinesia using force variability

To detect subtle dyskinetic movements in the general population, we employed an instrumental measure of dyskinesia, which has been demonstrated to distinguish the same subjects whose abnormalities are identified by standard observer-based severity ratings, but also detect an additional proportion of the participants (i.e., roughly twice as many participants) (Cortese et al., 2005). A research staff member who did not have access to any of the clinical data administered the measure to each participant. Measurements of force instability involve having a subject attempt to apply pressure on a load cell, to maintain constant force over 20 seconds, and measuring the amount of variability in the applied force. Under normal conditions, the flexor digitorum profundus and the flexor digitorum superficialis (index finger flexor muscles) continuously and simultaneously contract to produce a near-constant level of force against the load cell. In the presence of dyskinesia, these muscles contract with an irregular pattern, producing variable levels of force over time. Participants were instructed to match a target (300 cN) with their signal (flexing index finger against transducer) and to maintain that level as steadily as possible until told to rest. Three 20-second trials were obtained, each separated by a 5-second rest. The segment with the greater range in force (determined by computing the force minima and maxima over the medial 80% of each segment) was subjected to quantitative analysis of error that includes low pass filtering (3 Hz cut-off) to remove any tremor component. Final analysis of force error involved obtaining the coefficient of variation (CV) from the mean and standard deviation of the force waveform. The force variability (FV) measure has been validated as a measure of dyskinesia in studies of spontaneous dyskinesias (Cortese et al., 2005) and is highly reliable (Caligiuri et al., 1997). Distributions of PQ-B and dyskinesia variables were examined for violation of normality assumptions and consistent with other recent studies utilizing the PQ-B (Loewy et al., 2011), were found to be skewed toward zero; non-parametric statistics were calculated as necessary. Spearman's correlation coefficients were used to examine the relationship between dyskinesia scores and PLEs, a Mann-Whitney U test was used to examine group differences in CV (between those who had and had not experienced a significant PLE), and a Pearson Chi-Square test was used to examine group differences in abnormal dyskinesia scores over 1.5 SDs.

3. Results

Results showed that among the 119 participants, 40% endorsed at least one item as present that was accompanied by distress or concern (distress ≥ 4). The most commonly endorsed items were: "feeling mistrustful or suspicious" (15.1%), "feel that other people are watching or talking about you" (12.6%), "confused at times whether something you experienced was real or imaginary" (9.2%), "had the sense that some person or force is around you, although you couldn't see anyone" (9.2%), and "worry at times that something may be wrong with your mind" (8.4%). Reports of auditory perceptual abnormalities, "Have you heard unusual sounds like banging, clicking, hissing, clapping, or ringing in your ears?" (3.4%), "Do you sometimes feel suddenly distracted by distant sound that you are not normally aware of?" (2.5%) were less frequent.

The mean force CV for quantitative dyskinesia scores was 5.2 and participants ranged in performance by 2.9 standard deviations. Signs of dyskinesia were positively associated with total PQB score (r= .16, p = .04) and with the total sum distress score (r = .18, p = .03).

We examined the differences in dyskinesia scores between the group with no significant PLE reported (60%) and the group with at least 1 significant experience (40%) using an independent t-test. Results were significant, $z = -1.99$ $p = .04$, suggesting that the group experiencing at least one PLE (average rank = 67.69) showed elevated dyskinesia scores when compared to the group that did not experience a PLE (average rank = 54.80). Notably, 14.5% of the PLE group showed a dyskinesia score at least 1.5 SD above the sample mean whereas 5.6% of participants in the non-PLE group scored above this mean. When examined using a Chi-Square test, results suggested that this discrepancy in cases represented a significant group difference, $\chi^2(1) = 2.73$, $p = .05$

4. Discussion

Results suggesting that a significant portion of the participants experienced a PLE accompanied with distress are consistent with earlier reports for this adolescent age group (Laurens et al., 2007), and support the notion of a continuum of psychosis (van Os et al., 2001). The present findings are the first to point toward an association between PLEs in the general population and a putative movement abnormality marker highly implicated in Axis-I psychosis (Cortese et al., 2005). This is particularly noteworthy for informing our understanding of neurobiological vulnerability on the non-clinical side of the psychosis continuum, as dyskinesias are believed to reflect an abnormality in striatal dopamine system (DeLong and Wichmann, 2007).

It is also notable that researchers have recently observed grey matter abnormalities and deficits in white matter integrity in adolescents who reported PLEs (Jacobson et al., 2010). These findings provide a context for understanding the present results, as researchers have begun to suspect that abnormalities in grey and white matter development affect multiple systems during the etiology of formal psychosis including basal ganglia circuits underlying movement (Mittal et al., 2010). This is also consistent with recent findings that adolescents with PLEs show impairments in receptive language, executive function, and motor skills (Blanchard et al., 2010).

This growing body of literature, and present findings that a larger percentage of the group reporting PLEs showed dyskinesia scores greater than 1.5 SD above the mean, suggests the possibility that individuals who experience PLEs and who also show a number of psychosis risk factors may represent those who are truly at risk for psychosis. Future longitudinal studies tracking outcome are necessary to test this idea. Because the present study is comprised of a undergraduate college sample (which may limit the generalizability of the findings), and does not explicitly test for formal psychotic disorders or control for factors that may effect movement functioning beyond ruling out nicotine users (e.g., medical disorders or medications), the present findings should be considered as preliminary until future studies control for these potential confounds and replicate the results in an unselected general population sample. However, it is unlikely that a subgroup of formally psychotic individuals accounted for the observed effect, as no subjects scored in the upper 45% of the possible attenuated symptom weighted distress score range of 0–105. The smaller effects in the present study (relative to the large effects noted in clinical psychosis populations) (Cortese et al., 2005; Mittal et al., 2008; Mittal et al., 2010) speak to the subtle underlying nature of neurobiological vulnerability on the non-clinical side of the spectrum. Taken together with the noted literature, present results suggest that a spectrum of basal ganglia vulnerability may also underlie the psychosis continuum.

Acknowledgments

Role of Funding

This work was supported by National Institutes of Health Grants R01MH094650 and MH087258-01 to Dr. Mittal.

There no acknowledgements.

References

Blanchard MM, Jacobson S, Clarke MC, Connor D, Kelleher I, Garavan H, Harley M, Cannon M. Language, motor and speed of processing deficits in adolescents with subclinical psychotic symptoms. Schizophr Res. 2010; 123(1):71–76. [PubMed: 20580205]

Caligiuri MP, Lohr JB, Rotrosen J, Adler L, Lavori P, Edson R, Tracy K. Reliability of an instrumental assessment of tardive dyskinesia: results from VA Cooperative Study #394. Psychopharmacol. 1997; 132(1):61–66.

Cortese L, Caligiuri MP, Malla AK, Manchanda R, Takhar J, Haricharan R. Relationship of neuromotor disturbances to psychosis symptoms in first-episode neuroleptic-naive schizophrenia patients. Schizophr Res. 2005; 75(1):65–75. [PubMed: 15820325]

DeLong MR, Wichmann T. Circuits and circuit disorders of the basal ganglia. Arch Neurol. 2007; 64(1):20–24. [PubMed: 17210805]

Hanssen M, Bak M, Bijl R, Vollebergh W, van Os J. The incidence and outcome of subclinical psychotic experiences in the general population. Br J Clin Psychol. 2005; 44(2):181–191. [PubMed: 16004653]

Jacobson S, Kelleher I, Harley M, Murtagh A, Clarke M, Blanchard M, Connolly C, O'Hanlon E, Garavan H, Cannon M. Structural and functional brain correlates of subclinical psychotic symptoms in 11–13 year old schoolchildren. Neuroimage. 2010; 49(2):1875–1885. [PubMed: 19770054]

Kelleher I, Cannon M. Psychotic-like experiences in the general population: characterizing a high-risk group for psychosis. Psychol Med. 2011; 41(1):1–6. [PubMed: 20624328]

Laurens KR, Hodgins S, Maughan B, Murray RM, Rutter ML, Taylor EA. Community screening for psychotic-like experiences and other putative antecedents of schizophrenia in children aged 9–12 years. Schizophr Res. 2007; 90(1–3):130–146. [PubMed: 17207968]

Loewy RL, Pearson R, Vinogradov S, Bearden CE, Cannon TD. Psychosis risk screening with the Prodromal Questionnaire-Brief version (PQ-B). Schizopren Res. 201110.1016/j.schres.2011.03.029

Loewy RL, Johnson JK, Cannon TD. Self-report of attenuated psychotic experiences in a college population. Schizophr Res. 2007; 93(1–3):144–151. [PubMed: 17459662]

Mittal VA, Neumann C, Saczawa M, Walker EF. Longitudinal progression of movement abnormalities in relation to psychotic symptoms in adolescents at high risk of schizophrenia. Arch Gen Psychiatry. 2008; 65(2):165–171. [PubMed: 18250254]

Mittal VA, Walker EF, Bearden CE, Walder D, Trottman H, Daley M, Simone A, Cannon TD. Markers of Basal Ganglia Dysfunction and Conversion to Psychosis: Neurocognitive Deficits and Dyskinesias in the Prodromal Period. Biol Psychiatry. 2010; 68:93–99. [PubMed: 20227679]

Quik M, Cox H, Parameswaran N, O'Leary K, Langston JW, Di Monte D. Nicotine reduces levodopa-induced dyskinesias in lesioned monkeys. Ann Neurol. 2007; 62(6):588–596. [PubMed: 17960553]

van Os J, Hanssen M, Bijl RV, Vollebergh W. Prevalence of psychotic disorder and community level of psychotic symptoms: an urban-rural comparison. Arch Gen Psychiatry. 2001; 58(7):663–668. [PubMed: 11448373]

Walker EF. Developmentally moderated expressions of the neuropathology underlying schizophrenia. Schizophr Bull. 1994; 20(3):453–480. [PubMed: 7526447]

Table 1

Participant Demographics, Dyskinesias, and Psychotic-like Experiences

Characteristics	
Gender	
Males	52(43.7 %)
Females	67(56. 3%)
Total	119
Age	
Mean/SD	19.6(1.8)
Parent Education	
Mean Years	15.4 (1.7)
Dyskinetic Movements	
Mean Coefficient of Variation/SD	5.2(2.9)
Psychosis-Like Experiences [a]	
Total: Mean/SD	4.4(3.6)
Distress Score: Mean/SD	11.1(11.2)

[a] Prodromal Questionnaire-Brief (PQ-B): For all questions endorsed “Yes” (0–21 items), participants rate the level of distress (0–5); the weighted distress score is the sum total of these scores.