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Original Research

Intermittent degradation and schizotypy

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ABSTRACT

Intermittent degradation refers to transient detrimental disruptions in task performance. This phenomenon has been repeatedly observed in the performance data of patients with schizophrenia. Whether intermittent degradation is a feature of the liability for schizophrenia (i.e., schizotypy) is an open question. Further, the specificity of intermittent degradation to schizotypy has yet to be investigated. To address these questions, 92 undergraduate participants completed a battery of self-report questionnaires assessing schizotypy and psychological state variables (e.g., anxiety, depression), and their reaction times were recorded as they did so. Intermittent degradation was defined as the number of times a subject's reaction time for questionnaire items met or exceeded three standard deviations from his or her mean reaction time after controlling for each item's information processing load. Intermittent degradation scores were correlated with questionnaire scores. Our results indicate that intermittent degradation is associated with total scores on measures of positive and disorganized schizotypy, but *unrelated* to total scores on measures of negative schizotypy and psychological state variables. Intermittent degradation is interpreted as potentially derivative of schizotypy and a candidate endophenotypic marker worthy of continued research.

1. Introduction

From trial-to-trial within an experimental task, there is often marked fluctuation in the quality of a patient with schizophrenia's performance or what has been referred to as intermittent degradation (ID; Matthysse et al., 1999). For example, Belin and Rubin (1995) and Rubin and Wu (1997) demonstrated that distributions of eye-tracking performance scores for some schizophrenic subjects were best explained by two component distributions: one distribution that approximated that of normal subjects and another that was unique to patients with schizophrenia. This latter distribution was characterized by a lower mean and increased variance.

Informed by these reports, Matthysse et al. (1999) thoroughly explicated the ID process and outlined a strategy for its study. The main points of Matthysse et al.'s model can be summarized as follows:

1) Only some patients with schizophrenia are susceptible to ID.
2) In susceptible individuals, ID only occurs on some trials.
3) There are two types of ID indicators, inferential and direct. Inferential indicators include the presence of outliers in data sets, abnormalities in distributional shape, and evidence of transient abnormal performance from time series data. Direct indicators include measures of cortical activity that have high temporal resolution and the results of advanced statistical analysis, i.e. mixture modeling.
4) Finally, the authors suggest researchers follow a two-step strategy. First, robust inferential indicators of ID should be identified. Second, formal mixture modeling or direct measures should be used.

The importance of investigations of ID is threefold. First, such investigations move away from asking *if* patients with schizophrenia perform more poorly than controls on experimental tasks, to asking *why* their performance is inferior. That is, they can address whether impaired task performance results from a task deficit, ID, or a task deficit and ID. Second, given ID only affects *some* patients with schizophrenia, it may serve to identify a unique subgroup of patients. The reduction of the heterogeneity inherent to schizophrenia has been a vexing problem for over a century and identifying subgroups of patients who perform deviantly on laboratory tasks represents one means of gaining leverage on this problem (Lenzenweger, 2010). Finally, ID might serve as an endophenotype (Gottesman and Gould, 2003; Lenzenweger, 2013) for schizophrenia. Over the last two decades, endophenotypes have become a major focus of scientific inquiry as it is hoped they will serve to bridge the gap between the behavioral and genetic levels of analysis. A major challenge in identifying endophenotypes in people diagnosed with schizophrenia is that what appear to be endophenotypes in these populations may result from third variable confounds (e.g. symptom severity) associated with, but not necessarily inherent to the

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schizophrenia diathesis (Lenzenweger, 1998). One research strategy that allows for the circumvention of such issues is the study of schizotypy (Lenzenweger, 2010; Meehl, 1962, 1990); that is, studying persons at higher risk for schizophrenia.

In this study, we sought to determine the relationships between schizotypy and a novel inferential indicator of ID. This novel indicator, which captures exceedingly abnormal task performance by identifying outliers in time series data, conforms to Matthysse et al. (1999) general definition of ID ("the temporary substitution of a less efficient process of task performance", pg. 131) and their specific definition of an inferential indicator of ID. We hypothesized ID would be positively related to schizotypy and schizotypal features, and unrelated to psychological state variables (e.g., depression, anxiety).

2. Method

2.1. Subjects

110 State University of New York at Binghamton undergraduate students were recruited for participation. Enrollment in the study was open and as compensation, students received experimental credit in the psychology course of their choice. To purge the dataset of random and reckless responders, all subjects scoring 2 or greater on the Jackson Inventory (Jackson, 1984) were removed. After this was done, psychometric data for 92 subjects were available for analysis. Mean participant age was 19.52 ($SD = 1.54$), and the sample was predominantly female (68.5%) and Caucasian (64%). The study's experimental procedure was reviewed and approved by Binghamton's Institutional Review Board, and informed consent was obtained from all participants prior to their participation.

2.2. Measures

2.2.1. Psychometric schizotypy

Four measures of schizotypy were administered: the Perceptual Aberration (PAS; Chapman et al., 1978), Magical Ideation (MIS; Eckblad and Chapman, 1983), Revised Social Anhedonia (RSAS; Chapman et al., 1995), and Physical Anhedonia (PA; Chapman et al., 1995) scales. The PAS is a 35-item true-false measure of body image and perceptual aberrations. The MIS is a 30-item true-false measure of belief in forms of causation that by conventional standards are invalid. The RSAS is a 40-item true-false scale measure of schizoidal indifference, withdrawal, and asociality. The PA scale is a 61-item true-false measure of one's ability to derive pleasure from sensory experience. The reliability and validity of these scales as measures of schizotypy is strongly supported (Chapman et al., 1982; Chapman et al., 1995; Lenzenweger, 2010).

2.2.2. Schizotypal Personality Questionnaire

The SPQ (Raine, 1991) is a 74-item true-false questionnaire that assesses features of DSM-III-R's schizotypal personality disorder (SPD) (American Psychiatric Association [DSM-IV-TR], 1983). The internal consistency and test-retest reliability of the SPQ are excellent and deviance on the SPQ has been shown to identify people with SPD (Raine, 1991).

2.2.3. Psychological state measures

Participants completed the State-Trait Anxiety Inventory (STAI; Form Y, Spielberger, 1983), Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), and Beck Depression Inventory-II (Beck et al., 1996). The STAI is a 40-item true-false self-report inventory that assesses state and trait anxiety. The PANAS, is 20-item self-report measure utilizing a five-point Likert-type scale to measure the intensity of positive and negative affect. The BDI-II is a 21-item self-report measure utilizing a four-point Likert-type scale that measures depressive symptoms over the past two weeks. Each of these scales is used widely and a large body of literature exists to support their reliability and validity (Beck et al., 1996; Crawford and Henry, 2004; Speilberger, 1983; Sprinkle et al., 2002; Storch et al., 2004; Watson et al., 1988).

2.2.4. Jackson Inventory

The Jackson Inventory (JI; Jackson, 1984) is a 14-item True-False measure that assesses random, reckless, or invalid responding. This measure includes items like "At times when I was ill or tired, I have felt like going to bed early" and "Driving from New York to San Francisco is generally faster than flying between these cities" which, when a participant is responding validly to questionnaire items, should all be answered in one direction. Scores above 2 on the JI are considered an indication of an invalid response style and grounds for participant removal from further analyses.

2.2.5. Demographic and participant health history

Demographic data, and information about participant health history and use of nicotine, alcohol, and psychiatric medication were collected using two author-generated forms.

2.3. Procedure

Questionnaires were completed at computer workstations. Questionnaire items were combined, randomized, and presented in a unique order for each participant in *Superlab 4.0* (Abboud et al., 2006). Along with the subject's answers, participant reaction times were also recorded. Reaction time precision for keyboard responses on a Macintosh CPU running Superlab 4.0 is 8–12 milliseconds. Participants answered 435 questions and this took, on average, 30 minutes. Subjects completed the study in a well lighted, climate-controlled, and quiet room. No subjects were interrupted during their participation and no extraneous, intermittent, or loud noises occurred while subjects were participating. Additionally, subjects were monitored through a one-way mirror to ensure compliance with the demands of the protocol.

2.4. Intermittent degradation

Given that our study focused on individual differences, we had to develop a novel quantitative measure of ID that was in accord with Matthysse et al. (1999) definition ("the temporary substitution of a less efficient process of task performance", pg. 131). When this definition is dissected, it becomes clear that ID is an intra-individual transient deviation from normal task performance and thus, to accurately represent ID one must differentiate normal performance from deviant performance for each individual in isolation. To do this, we converted participant's raw reaction times to normal scores using their mean and standard deviation and then counted the number of standard scores greater than or equal to three. To remove item-level characteristics that may have influenced participant reaction times, we took two steps. First, prior to converting raw reaction times to normal scores, reaction time was regressed on Flesch-Kinkaid Grade-Level and Reading Ease scores (Kincaid et al., 1975) and the residuals from this regression were then used to create the *z*-scores described above. This regression removed the effect of item reading difficulty on reaction times. Second, the number of instances of ID was determined for each item, the mean and standard deviation for ID across items was calculated, and items with abnormally high instances of ID were removed. This resulted in seven items being eliminated from analysis. The elimination of these items removed the effect of item-specific features other than reading difficulty on total ID scores. Thus, our measure of ID was a *count variable* of the number of times a person had a reaction time three standard deviations or more away from their mean after correcting for various item-level characteristics that may have led to prolonged reaction times.