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# Differentiating maximal and typical performance measures : the impact of ego depletion on measures of maximal and typical cognition

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A Dissertation

entitled

Differentiating Maximal and Typical Performance Measures:

The Impact of Ego Depletion on Measures of Maximal and Typical Cognition

by

Daniel B. Charek

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

Doctor of Philosophy Degree in Psychology

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July 2016

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An Abstract of  
Differentiating Maximal and Typical Performance Measures: The Impact of Ego  
Depletion on Measures of Maximal and Typical Cognition

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This study examines the cognitive correlates of ego depletion, the reduction of cognitive self-regulatory resources after engaging in volitional action, from the perspective of measures that are more and less defined by maximal performance criteria, in addition to investigating the association between different measures of cognitive process. It is argued that situations and testing procedures vary in the degree to which typical performance or maximal performance is expressed. The Rorschach, the Design Fluency subtest of the Delis-Kaplan Executive Functioning System (D-KEFS Design Fluency; Delis, Kaplan, Kramer, Buysch, Noens, & Berckelaer-Onnes, 2007), and the Judgment of Line Orientation Test (JOLO; Benton, Sivan, Hamsher, Varney, & Spreen, 1994) are proposed as measures varying in the degree to which they measure typical versus maximal cognitive performance. This perspective has implications regarding the ecological validity of neuropsychological measures and the utility of the Rorschach in the assessment of cognition. The present results also provide criterion validity evidence for several Rorschach variables indicative of cognitive sophistication. An experimental approach was utilized, with ego depletion serving as the independent variable. The ego

depletion paradigm holds that self-regulatory resources are finite and are transiently depleted when one engages in self-regulated behavior (Baumeister, Bratslavsky, Muraven, and Tice, 1998; Muraven, Tice, and Baumeister, 1998). It was anticipated that the greatest effects of depletion should be on cognition manifest on typical performance tasks because they offer the respondent greater latitude in establishing the task parameters, providing opportunity for the individual to mentally recharge cognitive reserves to a greater extent than cognition manifest on a maximal performance measure, which pulls for correct responding under conditions of clear structure. In the present study, it was anticipated that Rorschach measures of cognitive regulation and sophistication would be most sensitive to the impact of ego depletion, with the D-KEFS Design Fluency test demonstrating a more modest effect and the JOLO being relatively resistant to any effect. Participants were administered the three criterion measures in a group computer-facilitated setting with a counterbalanced administration schedule. To ensure consistent levels of depletion were maintained throughout the experimental session, testing was divided into four blocks and letter cancellation tasks were administered at approximately 15 minute intervals before each block. Proposed hypotheses were tested by independent samples t-tests and found no significant effect of ego depletion on any dependent criterion variable. As such, planned within-subjects focused contrast analyses were not run. Criterion validity correlations were computed examining the relationship between Rorschach cognition variables and other cognitive measures in the control group, with Rorschach variables demonstrating roughly equivalent validity effect sizes as those between other measures of cognition, ranging

from  $r = .25$  to  $.41$ . Implications, methodological limitations, and future directions are discussed.

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## **Chapter One**

### **Introduction**

The present research examines associations among different types of cognitive processing measures and the impact on them of ego depletion, which is the reduction of one's cognitive resources based on how much cognitive effort was already spent. The aim is to select visuospatial measures that are more and less defined by maximal performance criteria, which is the ability to perform cognitive tasks when clear expectations for success are provided. This research investigated cognition expressed on the Rorschach task, the Design Fluency subtest of the Delis-Kaplan Executive Functioning System (D-KEFS Design Fluency; Delis, Kaplan, Kramer, Buysch, Noens, & Berckelaer-Onnes, 2007), and the Judgment of Line Orientation test (JOLO; Benton, Sivan, Hamsher, Varney, & Spreen, 1994), anticipating that these measures would be interrelated, though in an experimental manipulation ego depletion would have its strongest impact on cognition that manifests in typical performance, what one *will do* of their own accord, rather than maximal performance, what one *can do* when asked. As part of this, Rorschach cognitive processing variables were situated within a neuropsychological framework to investigate the intercorrelations between Rorschach markers of cognitive sophistication and two standardized neuropsychological measures in the control condition, providing reasonable evidence for the criterion validity of these variables. This introduction begins with an overview of research and the theoretical rationale supporting the neuropsychological utility of variables derived from the Rorschach task. Following this overview, the nature of typical versus maximal performance measures is discussed, drawing from diverse literatures including industrial

organizational psychology and ecological validity in neuropsychology. Next, the rationale for included criterion measures and the basis for categorization as typical versus maximal performance measures are established. This is followed by a review of the ego depletion literature and a discussion of the present study's use of ego depletion as a mechanism for differentially impacting typical versus maximal performance. Finally, specific hypotheses and implications are presented.

### **The Rorschach as a Perceptual Problem Solving Task**

The Rorschach inkblots are among the most commonly used psychological assessment measures in clinical practice. Survey results indicate that the Rorschach is the fourth most administered test by practicing clinical psychologists and the eighteenth most utilized test by neuropsychologists (Camara, Nathan, & Puente, 2000) and more recent results suggest 54% of psychologists polled use the Rorschach in their clinical practice (Wright et al., 2016). Despite its frequent use, the Rorschach task remains a controversial assessment tool; Hunsely and Bailey (1999) stated, "the Rorschach has the dubious distinction of being, simultaneously, the most cherished and the most reviled of all psychological assessment tools" (p. 266). The literature regarding this controversy is substantial and discussing it in detail is beyond the scope of this project. The interested reader is referred to the following citations regarding the controversy (Board of Trustees of SPA, 2005; Hunsley & Bailey, 1999; Meyer & Archer, 2001; Mihura, Meyer, Bombel, & Dumitrascu, 2015; Mihura, Meyer, Dumitrascu, & Bombel, 2013; Wood, Garb, Nezworski, Lilienfeld, & Duke, 2015; Wood, Lilienfeld, Nezworski, & Garb, 2001; Wood, Nezworski, & Stejskal, 1996; Viglione & Hilsenroth, 2001), with the Mihura et al. meta-analyses providing the most definitive summary of the literature.

Mistaken perceptions regarding the nature of the Rorschach Inkblot task may be largely to blame for erroneous beliefs and misconceptions about the measure. For instance, many associate the Rorschach with Freudian theory, seeing it as the tool of psychoanalysts uncovering projected unconscious material. This view is inconsistent with empirical evidence; support for the role of projection in forming responses to tests such as the Rorschach is inconclusive at best (Exner, 1989; Weiner, 2003; see Bornstein, 2007 for a counterpoint). Frank (1949) initially proposed the term projective for characterizing tests that “induce the individual to reveal his way of organizing experience by giving him a field (objects, materials, experiences) with relatively little structure and cultural patterning so that the personality can project upon that plastic field his way of seeing life, his meanings, significances, patterns, and especially his feelings” (p. 402). From this perspective, it is the individual’s personality operating upon the stimulus material that *solely* determines the response or reported percept. The features of the stimulus itself are almost inconsequential. This view of the Rorschach method is at conceptual odds with the procedure utilized in developing the stimulus materials for the task. As explained by Exner (2000), the inkblots were not designed to be completely ambiguous. Although Hermann Rorschach, the test’s developer, began by folding over a page to create a symmetrical shape, he embellished upon the ambiguous symmetrical form to create distinct “critical bits” or suggestive elements within each inkblot. He also practiced with the inkblots and refined each one over a series of multiple iterations. The resulting stimuli are best characterized as semi-structured, promising potential utility in identifying individuals with perceptual problems.

Hermann Rorschach recognized that identifying percepts in the inkblots invoked a complex combination of psychological and neuropsychological operations that he believed reflected characteristic perceptual processes of the individual. Rorschach (1942) described the perceptual responding patterns of several clinical groups, including patients diagnosed with schizophrenia, organic brain disease (e.g., dementia), epilepsy, and mental retardation, as well as nonclinical individuals. After examining the responses of elderly individuals and patients classified as “organically impaired,” he proposed, “After a further period of development, it should be possible in almost every case to come to a definite conclusion as to whether the subject is normal, neurotic, schizophrenic, or has organic brain disease” (p. 120). On the basis of this early research, it is apparent that Rorschach recognized the potential utility of the task in distinguishing between groups on the basis of visual perceptual processing strategies and dysfunction. His artistic embellishment of the inkblots further indicates this goal; the critical inkblot features that people include in their responses allow perceptual accuracy to be assessed and the manner in which key structural features are utilized allows evaluation of visual analytic and conceptual integration strategies. Thus, the conceptual foundations for a visual perceptual problem solving framework were established early in the development of the inkblot task.

Following the publication of Rorschach’s *Psychodiagnostic*, several systems were developed for administering, scoring, and interpreting his inkblot task. Of these systems, Beck (1944) most notably expanded upon Rorschach’s research regarding the perceptual-cognitive processes operating when responses are identified and organized. Beck noted that the Whole (W) response, which occurs when an individual makes exhaustive use of

the inkblot in identifying a percept, was identified by Rorschach as a key marker of cognitive sophistication due to the organizational complexity thought to be involved in such responses. Observing that Whole responses occurred with noticeably greater frequency to certain inkblot figures, Beck (1933) developed a system for coding and interpreting organizational activity on the Rorschach. Conceptualizing organizational activity as a marker of intelligence, Beck administered Rorschach protocols to 39 “intellectually superior” individuals. In addition to coding Whole responses, instances in which the respondent identified distinct response elements and meaningfully related these distinct features were also coded. Four distinct types of integrative activity were identified, including synthesis of adjacent elements, synthesis of distant elements, synthesis of the white background with inked features, and a process called analysis-synthesis that was later dropped due to coding related complications and response infrequency. Based on the frequency of each type of organizational activity, Beck (1933) developed a weighting system indexing the organizational complexity of responses for each card, which he argued reflected the intellectual energy expended by the respondent in identifying percepts.

More recently, a renewed focus has been placed on understanding the Rorschach task from a perceptual problem-solving framework. With the introduction of Exner’s Comprehensive System (1979, 1993, 2003), the most valid aspects of the five major U.S. systems available at that time were integrated within a single system. Exner framed the Rorschach as an abstract problem solving procedure requiring the operation and integration of various psychological and cognitive functions in order to organize a stimulus field comprised of abstract and relatively well-defined stimulus material and

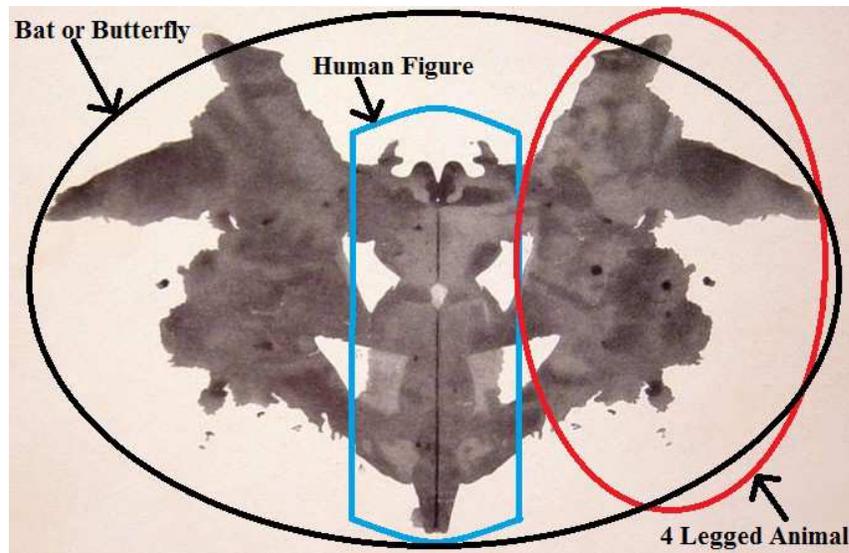
then communicate a final response to an examiner. Exner (2003) proposed a three phase response process defined by relatively independent perceptual and decision operations. In phase I, Encoding and Classification, respondents preliminarily scan the inkblot and encode features of the stimulus. Information stored in long-term memory is retrieved and the encoded stimulus material is evaluated against retrieved information. Potential answers are identified on the basis of this comparative process. Phase II, Rank Ordering and Discarding, involves rescanning the inkblot, with identified potential answers being evaluated and challenged relative to the presented stimulus material. Decisions are purportedly made on the basis of paired-comparison rankings and censorship. Exner characterized Phase II as the most complex in terms of executed psychological operations. In Phase III, Final Selection and Articulation, the respondent makes a final determination of which responses to select, and these are articulated to the examiner.

A perceptual problem-solving framework is maintained in the more contemporary Rorschach Performance Assessment System (R-PAS; Meyer, Viglione, Mihura, Erard, & Erdberg, 2011). R-PAS represents the most evidence-focused, internationally oriented approach to the Rorschach, with variables included on the basis of a comprehensive statistical analysis of the empirical literature (Mihura et al., 2013) and utilizing a large international reference sample. According to the R-PAS system, identifying a logical percept requires the respondent to examine a rich perceptual stimulus field of competing and contradictory visual likenesses, disregard information that cannot be organized, override illogical responses, and create a representation that can be articulated to the examiner in a coherent and understandable manner. The competing and contradictory nature of the various critical bits present in each inkblot largely account for the

complexity involved in identifying and constructing percepts. Although suggestive, the critical bits are inexact and incomplete representations. Thus, attending to one critical bit suggests one kind of response object, but the fit is imperfect. Attending to a separate critical bit suggests an alternative kind of object, but this object too reflects an imperfect match. Figure 1 illustrates this response dilemma by identifying several common response objects in prototypical locations. A significant challenge in completing the Rorschach task is organizing, evaluating, and deciding among multiple suggested yet imperfect response possibilities. This is a detailed process requiring the individual to continuously evaluate the inkblot features and organize them logically. On the basis of this response process, R-PAS characterizes the Rorschach as a multidimensional measure of performance, providing valuable information about the respondent's perceptual tendencies, cognitive motivation, intellectual capacity, thematic preoccupations, and mental representations.

As a task of perceptual problem-solving, the Rorschach task lends itself to neuropsychological applications, particularly when performance and results are interpreted in relation to underlying neurocognitive processes and mechanisms. Cross-disciplinary application of neuropsychological and personality assessment procedures might not be surprising given these disciplines share many assumptions, theories, and techniques for extrapolating from assessment results in attempting to understand human behavior (Lezak, Howieson, Bigler, & Tranel, 2012). In order to expand the utility of the Rorschach to neuropsychological contexts, a neuropsychological framework for understanding response behavior must be established, detailing the neuropsychological

processes and operations activated when a respondent identifies, organizes, and articulates Rorschach responses to an examiner.



*Figure 1.* Illustration of competing imperfect response possibilities at distinct inkblot locations. The location area circled on the right may be perceived as a 4 legged animal given the critical bits that look like legs connecting to the center area, though a 4-legged animal would not be consistent with the wing-like structures at the upper right of the figure. The centrally marked location may be perceived as one human-like figure given the critical bits that suggest legs at the bottom and arms at the top, though such an image would not be consistent with the bumps at the top of the figure where a head would typically reside. Alternatively, the entire inkblot may be seen as a bat or butterfly given the wing-like lateral features, though neither image would be consistent with the four internal regions that lack ink. Thus, all response objects are suggested by critical bits in their respective inkblot locations, but none are perfectly represented, thus requiring analytic, evaluative, and decision-making operations by the respondent to generate a response.

## **The Neuropsychological Operations of Rorschach Responding**

The fundamental demand of the Rorschach task is to examine a rich perceptual stimulus in an effort to identify and organize inkblot features into a coherent percept that can be articulated to an examiner. This task presumably requires the operation and integration of several neurocognitive processes, including attention and concentration, visual scanning, coding, object recognition, visual-perceptual organization, inhibition, associative memory, executive functioning, and language production, among others (Acklin & Wu-Holt, 1996; Exner, 2003; Lezak et al., 2012; Perry & Potterat, 1997). These neuropsychological functions are distributed throughout the brain, implicating areas such as visual recognition in the occipital lobe; visual attention, scanning, and visual processing circuitry distributed throughout occipital, temporal, and parietal cortices; structures involved in memory such as the hippocampus, thalamus, and basal forebrain; temporal lobe-localized language processing; and executive functions of the prefrontal cortex (Acklin & Wu-Holt, 1996; Perry & Potterat, 1997). Lesions to any of these areas may be associated with characteristic patterns of performance deficit in completing the Rorschach. For example, Luria (1980) described two search strategies employed by individuals with frontal lobe dysfunction; a chaotic approach in which material is seemingly attended to at random and a detailed approach in which a small element of the visual field serves as an extrapolation point. Either case would be characterized by specific observable patterns in attending to the inkblots during a Rorschach administration, allowing neuropsychologists to obtain meaningful information regarding the visual scanning abilities of the patient and potentially implicated areas of neurological deficit (Perry & Potterat, 1997).

Lezak et al. (2012) note four aspects of visual-perceptual activity that may be evaluated by the Rorschach: perceptual accuracy, integrative activity, perceptual reliability, and visual-perceptual processing speed. With regard to perceptual accuracy, recall that the Rorschach inkblots are best characterized as semi-ambiguous stimuli, artistically embellished with critical structural elements. As a function of this structure, certain responses are more or less perceptually accurate given the features present in the inkblot. The Form Quality variable is a Rorschach measure developed utilizing statistical data to determine the fit and normative frequency of specific response objects (Exner, 1979; Meyer et al., 2011). Another Rorschach variable, Popular, is coded for the most commonly identified responses for each card. Together, Form Quality and Popular provide a measure of perceptual accuracy and conventionality in completing the Rorschach task. Research indicates that the Rorschach protocols of individuals who have sustained brain damage evidence difficulty in differentiating between relevant and irrelevant stimuli, deconstructing a Whole response into its constituent parts, or synthesizing discrete elements into a unified Whole (Baker, 1956). These deficits significantly interfere with attempts to accurately organize perceptual information present in the inkblots. Empirical evidence for poor Form Quality and fewer Popular responses in cases of brain injury and organic brain disease has been found in several studies (Dörken & Kral, 1951; Ellis & Zahn, 1985; Perry et al., 1996; Piotrowski, 1937).

In certain cases of neurocognitive disease or brain injury, individuals' capacity for efficient perceptual processing is impaired, limiting patients' ability to attend to and process large amounts of perceptual material (Lezak et al., 2012). The Rorschach inkblots are perceptual stimuli with various color, shading, and structural features that

respondents may utilize in developing percepts. Empirical evidence indicates that in cases of impaired perceptual processing due to a neurological condition or brain trauma, individuals provide more simplistic protocols with responses generated from single perceptual features (Perry & Potterat, 1997). For example, individual who have sustained brain damage may provide responses that simultaneously incorporate structural and color features of the inkblots (Form-Color responses) with significantly less frequency than normal subjects (Ellis & Zahn, 1985), reflecting an inability to incorporate these two distinct pieces of visual input. Research also indicates that brain damaged respondents give relatively few responses for which the degree of ink saturation or shading is a significant factor contributing to percepts (Ellis & Zahn, 1985). The protocols of individuals diagnosed with or suspected of having dementia have also been found to evidence significantly fewer responses in which the respondent embellishes the inkblot with movement (Dörken & Kral, 1951; Insua & Loza, 1986).

Lezak et al. (2012) also note the Rorschach's sensitivity to disruptions in "perceptual reliability," which is the respondent's ability to trust or be confident in the accuracy of their perception. Patients with neurological impairment have been shown to express greater uncertainty in their responses relative to controls (Piotrowski, 1937). Certain neurocognitive conditions are also associated with decreased perceptual processing speed, which is evidenced by lengthier response latencies (Goldfried, Stricker, & Weiner, 1971). While this demonstrates additional aspects of Rorschach responding that are impacted by neurocognitive impairment, these domains of cognition are not being directly assessed in the present study.

Perceptual organizational tendencies on the Rorschach may also provide clinicians with valuable information in identifying hemisphere specific patterns of brain dysfunction. In most right-handed individuals, the right hemisphere preferentially processes global information while the left hemisphere attends to details (Delis, Kiefner, & Fridlung, 1988; Perry & Potterat, 1997). Although damage to either hemisphere results in some degree of general processing degradation, nuanced patterns of impairment often emerge for which the Rorschach seems well-suited to assess. As explained by Perry and Potterat (1997), in cases of posterior left hemisphere damage, the impaired ability to process the minor details of the inkblots results in an exaggerated number of Whole responses. For cards that are particularly difficult to organize as a Whole percept (e.g., Card IX), poor form quality is anticipated due to impaired processing of minor inkblot features. Conversely, in patients with brain damage localized to the right hemisphere, relatively few Whole responses are anticipated, with the majority of percepts extrapolated from small inkblot details. A condition known as hemineglect, a phenomenon of visual neglect in one half of the visual field usually indicative of right hemisphere damage, may also be evidenced on the Rorschach if the respondent attends almost exclusively to one half of the inkblot (Perry & Potterat, 1997).

Memory functions are also involved in Rorschach perception. The standard question when handing each inkblot to a respondent is “What might this be?” That question essentially asks the respondent to make an association between the inkblot stimulus and an object previously encountered and encoded in memory. Memory involves a complex cortical and subcortical network, with various functions distributed throughout the brain (Lezak et al., 2012). Damage or dysfunction to a specific region of

the memory network is often associated with characteristic neuropsychological behavior. As one example, the frontal lobes are key cortical regions for efficiently organizing information, a necessary condition for successful storage and retrieval (Stuss, Alexander, & Benson, 1997). Damage to this area of cortex is associated with Rorschach difficulties such as response perseveration (Perry & Potterat, 1997).

### **The Rorschach as a Neuropsychological Instrument**

Appendix A provides a detailed review of the empirical literature documenting the utility of the Rorschach task as a neuropsychological and neurodiagnostic assessment procedure. Among this literature, several empirical investigations are particularly relevant to the present research, demonstrating the utility of the Rorschach to differentiate individuals on the basis of cognitive ability and functioning.

The work of Piotrowski (1937) is among the earliest examples of research relevant in this regard. Piotrowski created and validated a list of ten signs for differentiating the Rorschach protocols of patients with organic disturbances of the central nervous system and non-organic patients. These signs are as follows: 1) providing fewer than 15 responses to the ten inkblots, 2) an average response time of more than one minute per response, 3) providing fewer than two movement responses on a protocol, 4) providing “color naming responses” in which the basic colors are identified with no attempt to extrapolate further, 5) achieving less than 70 percent good form responses, 6) providing fewer than 25% of Popular responses, 7) repeating the same response across several inkblots, 8) giving “impotent responses” in which the respondent provides a response despite recognizing its poor perceptual accuracy, 9) distrust of one’s responses and their own abilities to complete the task (termed Perplexity), and 10)

providing “automatic phrases” in which consistent phrases or statements are used repetitively in an indiscriminant fashion. Empirical investigation revealed the presence of five or more organic signs reliably discriminate patients with organic and non-organic neurological diagnoses (Piotrowski, 1937). The utility of Piotrowski’s signs have been replicated by other researchers in distinct patient populations (Brussel, Grassi, & Melinker, 1942; Rosenberg, Sorensen, & Christensen, 1995).

Patients with closed head injuries, or traumatic brain injury by current nomenclature, have also been investigated as a population demonstrating the utility of the Rorschach in differentiating individuals on the basis of cognitive functioning. Multiple researchers have demonstrated that patients with severe closed head injuries can be differentiated from non-clinical normative samples on the basis of several key variables, including fewer total responses; higher proportion of responses based on form alone (i.e., Lambda or F% scores); more vague and impressionistic responses (i.e., higher DQv or Vg); more reactive responding to color features (more percepts based solely on the color features of the inkblot [C], rather than integrating the stimulating color information within the perceptual parameters established by the inkblot structures [FC]); fewer perceptions of a tactile quality due to shading features (i.e., Texture response); and ineffective organization of features of the stimulus field (Ellis and Zahn, 1985; Exner, Colligan, Boll, Stischer, & Hillman, 1996).

More contemporarily, Perry, Potterat, Auslander, Kaplan, and Jeste (1996) investigated the utility of two approaches to using the Rorschach with patients diagnosed with dementia of the Alzheimer type. The first approach examined variables from the Comprehensive System that were identified on a theoretical basis. Several of these

variables are relevant to the present study, including Blends (which factor into Complexity in R-PAS), *Z* score (a marker of organizational activity), Developmental Quality Synthesized (an additional marker of organizational activity similar to Synthesis), and Movement Responses. The second introduced a new scale for evaluating linguistic errors and perseverations on the Rorschach. This scale was developed on a theoretical basis by considering the cardinal neuropsychological deficits involved in dementia of the Alzheimer type, as well as the discriminating features of the disorder (i.e., features that are characteristic of other neurological disorders and not expected in cases of dementia of the Alzheimer type). Results revealed the all theoretically identified Comprehensive System variables relevant to the present study, as well as the developed semantic and perseverative scale, differentiated patients with dementia of the Alzheimer type from controls.

In addition to analyzing Rorschach performance in cases of neurocognitive impairment and dysfunction, the correspondence between Rorschach performance and intact intellectual functioning has been examined. Factor analytic research has demonstrated significant correlations between Rorschach factors of cognition, particularly synthetic organization, and various measures of cognition (Wood, Krishnamurthy, & Archer, 2003; Zillmer and Perry, 1996). Several other researchers have demonstrated the correspondence of individual Rorschach variables, notably those indicative of productivity, synthetic activity, and response complexity (e.g., Blends), to correspond significantly with measures of intellect as assessed by the Wechsler scales of intelligence (Acklin & Fechner-Bates, 1989; Meyer, 2016; Wagner, Young, & Wagner, 1992).

The most comprehensive and systematic review of the Rorschach validity literature was performed by Mihura, et al. (2013) and provides meta-analytic evidence for several variable-criterion relationships relevant to the present research. A validity coefficient of  $r = .33$  for the Human Movement variable was obtained when evaluated by externally assessed criterion measures of mental abilities such as planning, imagination, and empathy. Synthesized responding as a marker of concept integration abilities achieved a validity coefficient of  $r = .37$ . Finally, a validity coefficient of  $.28$  was obtained for the variable-criterion relationship between Organizational Frequency and the ability to sustain cognitive effort. All reported validity coefficients achieved statistical significance.

### **Maximal versus Typical Performance and Measurement**

Among the first authors to address the nature of assessment procedures and the conditions under which data generalize was Cronbach (1960) in distinguishing between maximal and typical performance measures. According to Cronbach (1990), the fundamental distinction between these categories is that maximal performance measures assess what the individual “can do” while typical performance measures assess what the individual “will do.” Maximal performance measures assess individuals’ underlying capacities for the target construct. Such measurement requires clear communication of what is considered “good performance,” explicit instructions for how good performance is achieved, and conditions that foster maximal output. By contrast, typical performance measures assess what a person most often does across situations. Typical performance assessment procedures are generally more ambiguous with regard to what qualifies as good performance and nonability factors (e.g., personality, temperament, motivation,

etc.) are presumed to influence underlying performance and resulting measurement (Campbell, 1990).

Of note, Cronbach's initial conceptualization of typical performance measures included what are now referred to as performance-based measures and self-report measures of psychological functioning and phenomenon. More contemporary models of psychological assessment differentiate between self-reported and performance based characteristics (e.g., Bornstein, 2011; Meyer & Kurtz, 2006), as these methods of assessment have been shown to be only modestly correlated with one another (McGrath, 2008; Meyer & Archer, 2001; Mihura et al., 2013). Consistent with this conceptual distinction, the present research considers only performance-based tasks (i.e., things that people do when confronted with a task to perform), which is a more limited manner of conceptualizing "performance" relative to Cronbach's initial conceptualization.

Campbell (1990) proposed a model specifying that performance is a function of declarative knowledge, procedural knowledge, and motivation. According to this model, three choices define motivation output, the choice to exert effort, the choice of how much effort to exert, and the choice to persist in exerting effort. Variation in motivation is what primarily differentiates maximal and typical performance measures from this perspective (DuBois, Sackett, Zedeck, & Fogli, 1993). Maximal performance tests constrain the three motivational choices described above. Respondents may be asked to perform a behavior for a limited duration or be given clear instructions regarding performance expectations. In contrast, typical performance measures provide fewer constraints on the individual's choices regarding effort exertion and persistence. Although maximum and typical performance measures are described dichotomously here for purposes of clarity,

the reality is that measures are not defined by a true dichotomy but rather occur along a theoretical continuum of typical versus maximal performance on the basis of the motivational choice constraints associated with a measure. Similarly, real world environments and situations vary in imposed contextual constraints, such that certain life situations are likely more associated with maximal versus typical abilities. Theoretically, predictive relationship between the predictor assessment variable and the life outcome criterion variable is greatest when the assessment procedure and criterion behavior fall equivalently on these continua.

The industrial organizational psychology literature provides empirical support for the unique nature of maximal and typical performance measures on the criterion side of the equation of classifying job performance. Sackett, Zedeck, and Fogli (1988) examined the performance of individuals employed as supermarket cashiers, creating two groups comprised of current employees and new employees. Measures of maximum and typical job performance were devised. Maximum performance was assessed by presenting cashiers with shopping carts containing 25 standard items. Cashiers were informed they would be timed, that errors (e.g., items scanned twice) would be recorded, and they were instructed to focus equally on speed and accuracy. Typical job performance was assessed by data recorded unobtrusively by the cash register system. Items scanned per minute and voids per shift were designated as speed and accuracy variables respectively and these were evaluated on a per week basis, and no feedback was provided regarding these data. Correlations between maximum and typical performance measures revealed modest association, ranging from  $r = .11$  to  $.32$ , with three of the four correlation falling below  $r = .18$ . Thus, measures of typical and maximum performance did not yield highly

comparable information about the relative performance of cashiers (Sackett, Zedeck, & Folgi, 1988).

In a follow up study, DuBois et al. (1993) developed a performance prediction battery, utilizing the just described data as criterion measures. Seven domains relevant to cashier speed and accuracy were assessed, including recall, arithmetic computations, arithmetic operations, rule and code applications, object positioning, and clerical accuracy. The performance prediction battery was comprised of 15 maximum performance subtests (i.e., pencil-and-paper speeded tests of cognitive abilities), which when subjected to factor analysis, yielded a 4 factor solution defined by General Cognitive Ability, Numerical/Rule Application, Perceptual Ability, and Memory. Correlations revealed the maximum performance tests were more highly correlated with maximum speed than typical speed performance. The researchers also investigated the nature of predictor-criterion relationships on the basis of the type of register used by the employee (i.e., electronic register with manual entry of prices versus scanners). The rationale for analyzing results as a function of register type was the differing cognitive demands associated with operating an electronic register with manual entry versus scanner registers. Working with electronic registers requires cashiers to manually input prices and product codes while the primary cognitive task for a cashier working with scanner equipment is locating UPC codes and appropriately positioning them to be scanned. In the scanner sample, the maximal measure of general cognitive ability predicted maximum speed performance ( $r = .33$ ) better than typical speed ( $r = .26$ ). In the electronic register sample, the cognitive ability measures significantly predicted maximum speed performance ( $r = .21$ ) but did not predict typical speed performance at

all ( $r = .00$ ). Differences were also noted in predictions based on domain specific cognitive predictor variables, with the Perceptual Ability factor better predicting maximum speed to relative to typical speed in the scanner sample, and the Numerical/Rule Application factor better predicting maximum speed than typical speed in the electronic register sample.

The distinction between maximal and typical measures of performance on the basis of motivational choices and constraints is consistent with Wechsler's (1943) concept of non-intellective intelligence factors. Wechsler (1950) proposed that intelligent behavior cannot be accounted for solely by intellectual ability, regardless of how broadly ability is defined. He argued that intelligent behavior is a manifestation of the entire personality, of which intellectual ability is one component. Providing a practical example, Wechsler (1943) described the situation of two individuals with identical IQ scores (e.g., IQ = 70) who achieve distinct functional and life outcomes. This is not a controversial contention, the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2013) acknowledges the need to evaluate intellectual capacity and functional impairment independently, noting that individuals of similar IQ can experience varying levels of functional success. According to Wechsler (1950), intelligence consists not only of abstract reasoning, verbal capacities, spatial processing, and numerical abilities, but also the ability of the individual to adjust, adapt, and achieve. The latter abilities are argued to be individual differences of temperament and personality such as drive, persistence, will, and perseveration, rather than intellective capacities (Wechsler, 1950).

Taking academic achievement in the classroom as an index of typical performance (i.e., “what people actually do”), the academic achievement literature provides support for the role of non-intellective factors in intelligent behavior. The typical magnitude of correlation between IQ and GPA, a typical measure of academic achievement, ranges from .30 to .50 (Duckworth, & Seligman, 2005). By contrast, research consistently finds more robust correlations between test-based measures of academic achievement and IQ (.30 to .70; Jensen, 1998; Rhode & Thompson, 2007), as academic achievement tests represent a measure of academic attainment that is more maximal in nature relative to grades achieved over an extended period of time (Jensen, 1998; Rhode & Thompson, 2007). Many researchers agree that both cognitive and personality variables must be accounted for when predicting academic performance, and this likely accounts for the relatively suppressed correlations between GPA and IQ compared to IQ and test-based academic achievement (Chamorro-Premuzic & Furham, 2005; Rindermann & Neubauer, 2001). Laidra, Pullmann, and Allik (2007) investigated the predictive utility of intelligence as measured by the Raven’s Standard Progressive Matrices (SPM; Raven, 1981) and personality as measured by a translated version of the NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992). In a sample of Estonian schoolchildren, analyses were run with grade point average (GPA) as the criterion for academic achievement. Although IQ was the variable most strongly correlated with GPA, significant correlations were also obtained for the personality variables Openness, Agreeableness, Conscientiousness, and Neuroticism, the latter obtaining a significant inverse correlation. Regression analyses were also computed, with results revealing that

although intelligence was the single best predictor of GPA, 4 of the 5 personality traits also accounted for significant additional GPA variance

One conceptual issue should be noted in interpreting these results. Although academic achievement is discussed as a proxy for typical behavior due to it sampling an extended period of performance, several features of the academic setting are also consistent with maximal performance assessment conditions. GPA is primarily a composite of performance on tests and assignments that are relatively brief, provide clear directions and parameters, and are perceived to be important, thus resulting in significant effort expenditure. Given this, GPA-based academic achievement may be considered a variable falling somewhere more moderately along the maximal versus typical performance continuum, in which case, a certain degree of statistical overlap between IQ tests and academic achievement may be attributable to sharing characteristics of maximal performance measurement. Empirical evidence indicates decreased correspondence between IQ and criterion measures that are more purely “typical” in nature, such as smaller correlations between IQ scores and problems that are ambiguously defined (Pretz, Naples, & Sternberg, 2003) or measures of day to day intellectual effort (Ackerman & Heggestad, 1997).

The role of temperament characteristics and intelligent behavior has also been investigated. Intelligent behavior manifests in a variety of settings that may vary greatly in terms of stimulation demand. Given the implicitly evaluative nature of academic settings and the relatively high stakes associated with academic performance (e.g., future vocational placement), academic achievement is considered to index knowledge obtained in a highly stimulating environment. Temperament characteristics that augment

stimulation responsivity may play a key role in intelligent behavior and performance (Strelau, 1995). Eysenck and Eysenck (1985) also provide support for the role of responsiveness to stimulation in academic performance. In reviewing data on test performance, they found that across time, extraverts demonstrate superior performance in arousing situations while introverts perform relatively better on lengthy and monotonous tasks. This suggests temperamental factors moderate students' response to environmental stimulation, playing a key role in students' ability to obtain knowledge at school.

Ackerman (2014) argues for the importance of assessing domain specific acquired knowledge in understanding intelligent functioning. The Process, Personality, Interests, and Intelligence as Knowledge framework (PPIK, Ackerman, 1996) argues that domain specific knowledge is acquired by choice and this choice is a function of broad trait clusters, including interests, motivation, self-concept, and personality factors. The construct of "grit" or perseverance has also been found to overlap with important trait complexes related to domain knowledge (Duckworth, Peterson, Matthews, & Kelly, 2007). Research indicates that individuals scoring highly on measures of the trait complexes just described perform well in academic pursuits and achieve higher domain knowledge. Interestingly, these trait complexes have demonstrated positive correlations with traditional crystallized intelligence measures but minimal correlation with intellectual process abilities and capacities (Ackerman, 2014).

Perhaps the most contemporary perspective on maximum versus typical performance is neuropsychology's ecological validity literature. In defining ecological validity, Sbordone (1996) state the following:

Ecological validity can be defined as the functional and predictive relationship between the patient's performance on a set of neuropsychological tests and the patient's behavior in a variety of real-world settings (e.g., at home, work, school, community). This definition also assumes that demand characteristics within these various settings are idiosyncratic and fluctuate as a result of their specific nature, purpose, and goals. (p. 16)

Awareness of the need for ecologically valid neuropsychological instruments grew from the changing nature of neuropsychology as a field. Historically, neuropsychological assessment was concerned with diagnosing and localizing neuropathology on the basis of cognitive test performance (Spooner & Pachana, 2006). With the advent of neuroimaging techniques, detailed information regarding the location and extent of brain injury can be obtained without a lengthy neuropsychological battery in many cases. Although neuropsychological evaluations remain a key diagnostic tool for certain disorders (e.g., Alzheimer's disease; Derriner et al., 2002), the purview of neuropsychologists has expanded to encompass academic, occupational, rehabilitation, and forensic settings (Chaytor & Schmitter-Edgecombe, 2003; Wilson, 1993). Neuropsychology is increasingly concerned with predicting everyday functioning, yet limited empirical evidence exists demonstrating the utility of neuropsychological data for such purposes. Several authors have described characteristics of neuropsychological practice that may limit generalizability of test results, including the nature of the testing environment, the relatively limited sample of behavior obtained, and the highly structured nature of neuropsychological tests (Chaytor & Schmitter-Edgecombe, 2003; Sbordone, 1996; Franzen & Arnett 1997; Silver, 2000). In other words, there is a mismatch between

the neuropsychological tests, which are maximal performance measures, and day to day life functioning, which is a typical performance criterion. Long and Collins (1997) explain that these factors stem from neuropsychology's diagnostic roots. Because identification of specific lesions required assessment of individuals' maximal capacities, traditional neuropsychological practice takes place in a quiet setting with minimal distractions; the examiner is supportive and prompts as necessary; one-on-one instruction is provided; and tasks are typically brief, novel, clearly-defined, and performed one at a time (Chaytor & Schmitter-Edgecombe, 2003). Ecological validity differs in that the primary assessment question is what the patient does outside of the lab rather than what they can do in the artificial testing environment (Long, 1996). This distinction thus parallels that of Cronbach (1990) in differentiating between maximal and typical performance tests.

Researchers interested in the ecological validity of neuropsychology have investigated the relationship between test scores and measures of functional behavior. Two approaches to ecological validity have emerged; verisimilitude refers to the degree to which tests mimic the everyday cognitive demands of the patient's environment while veridicality refers to the degree to which tests relate empirically to measures of daily functioning (Sbordone, 2008). Typically, the verisimilitude approach involves the creation of tests specifically designed to approximate the environmental conditions, demands, and behaviors being generalized to<sup>1</sup>, while the veridicality approach involves

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<sup>1</sup> The verisimilitude approach attempts to create laboratory analogues of the behavior that is the target of prediction. Empirical evidence generally indicates improved accuracy in predicting everyday functioning using tests developed with verisimilitude (Chaytor & Schmitter-Edgecombe, 2003; Evans, Chua, McKenna, & Wilson, 1997). However, it should be noted that a conceptual ceiling exists regarding the degree to which verisimilitude tests can approximate typical functioning, given that these tests are administered in a maximal performance context.

statistical techniques investigating the relationship between traditional neuropsychological tests and measures of real-world functioning (Sbordone, 2008). In general, the empirical literature suggests that measures with verisimilitude are more related to everyday cognitive functioning than traditional neuropsychological tests (Chaytor & Schmitter-Edgecombe, 2003; Evans, Chua, McKenna, & Wilson, 1997) and that tests are generally related most strongly with everyday cognitive functioning in the same cognitive domain (i.e., a test of memory correspond most highly with measures of everyday memory functioning; Chaytor & Schmitter-Edgecombe, 2003; Makatura, Lam, Leahy, Castillo, & Kalpakjian, 1999; Ready, Stierman, & Paulsen, 2001). These results indicate that the more closely the conditions and nature of the testing procedure approximate specific real-world abilities and situations, the greater likelihood that real-world functioning can be accurately predicted (Sbordone, 2008).

### **The Present Study**

The present study investigates the neuropsychological properties of responding to the Rorschach task in the broader context of the typical versus maximal performance measurement framework. Traditionally, performance tasks of intelligence, academic achievement, and neuropsychological functioning have been conceptualized as maximal performance measures, as these measures offer examinees clear guidance regarding what is considered desirable performance, specific instructions for how to meet these expectations, and administration is conducted in a minimally distracting environment to facilitate optimal performance. By contrast, the Rorschach is viewed as a typical performance measure, as the examinee is tasked with taking the lead in establishing the task parameter, with the examiner providing little guidance with regard to what is

considered desirable performance. Although this dichotomous distinction between maximal and typical performance is useful as a theoretical constructs, this study proposes that classification of a single measure as typical versus maximal in nature is a matter of degree (i.e., there exists a continuum of maximal and typical performance rather than an absolute dichotomy). To this end, as previously described, two traditional neuropsychological measures believed to vary on this theoretical typical versus maximal performance continuum were selected, the JOLO and the Design Fluency subtest of the D-KEFS, and included as criterion measures.

These measures were identified and selected on the basis of a systematic review of available neuropsychological measures, based on theory, empirical evidence, and practicality. The textbook, *Neuropsychological Assessment* (Lezak et al., 2012) was consulted extensively in guiding decision making regarding test selection. Because the Rorschach is principally a visual perceptual problem solving task, only tasks that were primarily visual in nature were considered, eliminating fully verbal tasks. Additionally, the nature of this research required relatively brief tasks with specific time constraints to ensure all measures could be completed within a two hour experimental session. This effectively eliminated many other measures, such as tests with open-ended time limits (e.g., Rey Osterrieth Complex Figure, 1944), tests with lengthier administration times (e.g., Wisconsin Card Sorting Test), or tests that included multiple subtests to generate a composite score (e.g., WAIS Perceptual Reasoning Index). Additionally, the group computerized administration utilized in the present research necessitated selection of measures that could be readily translated to the group setting and utilize computer-facilitated instruction and administration procedures, while maintaining the integrity of

the test as much as possible. This required consideration of how readily response material could be utilized within the context of the experimental session or easily presented in a roughly equivalent manner on the computer screen, while also considering the ability of the computer software to accommodate characteristics of responding (e.g., tests that allow for self-correction were excluded due to software programming limitations). It was also necessary to select relatively affordable measures that could be administered completely via the MediaLab software or with minimal investment in purchasing the stimulus materials. This ruled out numerous measures, such as the D-KEFS Tower Test or the WAIS Block Design subtest. Finally, potential remaining measures were evaluated for the degree to which they differed along the maximal versus typical performance continuum. As described in further detail below, this decision was principally guided by consideration of the nature of the performance task, with attention paid to the degree to which participants were required to establish the task parameters, and in particular, generate the response possibilities.

The JOLO is a measure of visuospatial perception. The task is purely visual and asks respondents to identify two lines from a fanned out array that match two partial target line segments. Identifying the correct answer requires evaluation of the angular orientation of presented lines. The JOLO represents a straightforward task with explicit instructions and clear expectations regarding good versus bad performance. The sole task of the respondent is to look at a set of lines and identify those that match amongst a limited number of response options. The test instructions provide clear performance parameters and the respondent must do very little to adhere to specified parameters provided basic attention is maintained. Of particular note, the JOLO provides all

response possibilities to the examinee; as a multiple choice test, they simply choose the options from a given array they believe to match the target stimuli. All of these criteria are characteristic of maximal performance tests in which choices regarding where to focus effort resources are limited (Campbell, 1990; DuBois et al., 1993). In evaluating the degree to which conditions of the JOLO approximate real-world situations, it is difficult to imagine an individual being confronted with a situation in which performance is largely determined on the basis of pure basic visuospatial orientation accuracy. Even in situations where such accuracy is critical (e.g., driving a vehicle), numerous other cognitive operations are active, such as motor coordination, attention, etc. This too provides a rationale for characterizing the JOLO as a maximal performance instrument.

The D-KEFS Design Fluency test is a visual-motor measure of respondents' ability to generate unique designs within the framework of specified rules. Three trials are administered in order of increasing difficulty, with the final trial requiring inhibitory control and set-shifting. The D-KEFS Design Fluency test is a measure of visuospatial problem solving and executive functioning. It requires respondents to generate novel designs connecting dots that are in a fixed arrangement while observing specified rules. The test consists of 3 conditions (Filled Dots, Empty Dots Only, and Switching); each condition is associated with a unique set of rules. In the Filled Dots trial, participants are given a series of 35 boxes containing a fixed array of 5 black filled dots and they are instructed to draw unique designs by drawing 4 lines that connect the dots. The Empty Dots Only trial presents participants a fixed array of 35 boxes containing 5 filled and 5 open dots and asks participants to construct unique designs drawing 4 lines connecting only open dots. The most challenging condition, the Switching trial, presents a fixed

array of 35 boxes containing 5 filled and 5 empty dots and participants must draw unique 4 line designs while alternating between empty and filled dots. The test requires several operations, including cognitive fluency and inhibitory control (Delis, et al., 2007). Although clear instructions and rules are provided, and the respondent is aware of the performance criterion (i.e., number of novel designs created), the measure does not provide the respondent with specific response options. Instead, the fixed arrays limit the number of potential response options, but it is the responsibility of the examinee to generate novel responses that meet the overarching criteria specified. The respondent not only makes choices regarding response possibilities, but also how to divide and exert effort among several tasks (e.g., monitoring for rule violations, set-shifting, generating designs, etc.), choosing their response strategy (e.g., a careful and slow pace to verify rule adherence, a quick pace which may sacrifice response accuracy). As opposed to the clearly established parameters in a singularly focused task such as the JOLO, D-KEFS Design Fluency places greater responsibility on the respondent to generate and observe response parameters. Conceptually, D-KEFS Design Fluency also more closely approximates the typical demands of the environment relative to the JOLO. As described by Mitchell and Miller (2008), “Design Fluency is a measure of one’s ability to generate unique designs within the framework of a set of rules, mimicking the cognitive fluency that is required in daily life to generate novel responses while maintaining focus on a desired goal” (p.685).

There is empirical precedent for characterizing executive functioning tests as typical performance measures. For instance, it has been found that the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson et al., 1996), an executive

functioning measure designed from an ecological validity framework, is positively correlated with clinician ratings of everyday adaptive functioning (Norris & Tate, 2000). Process based scores achieved by children on the Rey-Osterrieth Complex figure were found to be correlated with parent ratings of academic achievement, developmental status, and adaptive ability (Davies, Field, Andersen, & Pestell, 2011). Other research has indicated that a brief screen of executive functioning better predicts functional ability than a brief screen of general cognitive capacity (Grigsby, Kaye, Baxter, Shetterly, & Hamman, 1998; Royall, Palmer, Chiodo, & Polk, 2004). Perhaps most relevant to the present discussion is the work of Mitchell and Miller (2008) who found that a composite measure of D-KEFS executive functioning significantly predicted clinician ratings of functional ability, and that Design Fluency was the individual subtest providing the second largest predictive value following the D-KEFS Tower Test.

The Rorschach task, as previously described, is a perceptual problem solving task in which the respondent answers the question “What might this be?” in relation to a series of 10 semi-ambiguous inkblot stimuli. Percepts are coded for organizational complexity, perceptual accuracy, and determining features, among other things. Of the measures in the present study, the Rorschach is clearly the least structured, with the only clear instructions provided to the respondent being the recommendation to provide two or maybe three responses to each card. To an even greater extent than the D-KEFS Design Fluency test, this places responsibility on the examinee to establish the parameters of the task. Responsibility for generating response possibilities lies almost entirely on the examinee, as the very nature of the task is to formulate two to three response options with the only limiting factor imposed by the task is the inherent structure of the semi-

ambiguous inkblots. Further, the open-ended nature of the task and the suggestive but imperfect structure of the inkblots provide the respondent little information regarding what constitutes good performance. Conceptually, the nature of the Rorschach task approximates everyday behavior in that performance involves attending to a rich perceptual field, analyzing the field for critical bits, integrating relevant information while disregarding extraneous features, making attributions about ambiguous material, and verbally explaining oneself. Individuals frequently make attributions about environmental stimuli on the basis of an analysis and synthesis of visual information. Empirical evidence indicates that Rorschach performance is related to typical functioning, with Rorschach Complexity accounting for significant variability in measures of functional ability and social skill capacity after controlling for neurocognitive functioning (Moore, Viglione, Rosenfarb, Patterson, & Mausbach, 2013).

As is highlighted above, key differences in the design and demand characteristics of these measures allow them to be placed along the maximal-typical performance continuum. In particular, attending to the degree to which respondents are responsible for generating the response options for completing the task, in addition the overall responsibility of the respondent to establish the task parameters and their problem solving set, offers the opportunity to evaluate the relative maximal versus typical nature of the selected measures.

The rationale for categorizing the criterion measures along the maximal versus typical performance continuum is supported by the industrial organizational literature. Recall that Campbell's (1990) proposed model of performance specifies that declarative knowledge, procedural knowledge, and motivation determine performance behavior, and

three choices defined motivation, 1) the choice to exert effort, 2) the choice of how much effort to exert, and 3) the choice to persist in that level of effort. DuBois et al. (1993) expanded Campbell's model to encompass criterion behavior, specifying that the motivational aspect of performance is the key factor differentiating typical and maximal performance situations and measures. Maximal performance occurs when the three motivational choices are constrained, such that maximal performance tests are relatively brief, provide clear expectations that performance is being monitored, and contain sufficient structure that the respondent understands what constitutes good performance. By contrast, typical performance measures often involve lengthier tasks that require individuals to maintain performance over a longer duration (an issue principally relevant to the industrial organizational psychology literature) while imposing less structure, with the resulting ambiguity regarding performance expectations requiring the individual to impose characteristic ways of responding (an issue particularly salient to the psychological assessment literature, including the present study).

Neuropsychology's ecological validity research provides additional justification for characterizing the criterion measures as maximal versus typical in nature. From this literature, it is concluded that the relationship between assessment measures and everyday functioning is contingent upon the degree to which response behavior and contextual demands of the assessment procedure approximate behavioral and contextual characteristic of the individual's everyday life (Evans, Chua, McKenna, & Wilson, 1997; Chaytor & Schmitter-Edgecombe, 2003). In the area of ecological validity, this has led to the development of tests with verisimilitude that are designed to closely model real world situations. Although none of the measures in the present study were designed from

a verisimilitude framework, each can be evaluated for the demand characteristics inherent to the testing procedure and the degree to which these mimic demands in daily life.

### **Ego Depletion: Literature Review and Use in the Present Study**

To test the assumption that a straightforward, highly structured, and time-limited traditional neuropsychological measure such as the JOLO captures maximal performance capacity, while less-structured and ambiguous assessment procedures such as the Rorschach, and to a lesser extent, D-KEFS Design Fluency, better capture typical intelligent behavior, an experimental approach was employed. Recently, there has emerged a developing interest in utilizing experimental methods to enhance understanding of assessment principles and instruments. In an influential paper on the concept of validity, Borsboom, Mellenbergh, and Heerden (2004) challenged readers to reconsider the concept of construct validity. The authors proposed that validation research should move away from multitrait-multimethod correlation matrices (Campbell & Fiske, 1959) and concern itself instead with experimentally demonstrating the causal relationship between underlying constructs and scores on the instruments intended to measure them. Rather than focusing on the pattern of convergent and discriminant correlations between a target test and a series of criterion measures, this approach to validity encourages researchers to attend to the causal relationship that is present in the construct-assessment relationship. The mechanism by which the underlying attribute exerts its causal effect on the measurement procedure is the response process; i.e., the psychological operations that are activated and engaged to generate the response behavior that is coded or scored on the instrument. Construct validity is achieved when it is

demonstrated that variation in the underlying attribute causes theoretically predicted variation in the scores on the assessment procedure.

From this perspective, experimental techniques are critical tools in enhancing understanding of assessment measures and their obtained data. Although the existing literature investigating the typical versus maximal performance issue is typically correlational in nature, the present research investigates this issue from an experimental perspective, determining whether criterion measures are impacted in a theoretically predicted manner. Specifically, the ego-depletion paradigm was utilized and its impact on JOLO, D-KEFS Design Fluency, and Rorschach scores were analyzed. The rationale for utilizing the ego depletion paradigm follows a brief description of this experimental procedure and associated research support.

The concept of ego depletion has its foundations in the social-cognition literature. The ego depletion paradigm can be understood in the context of the strength model of self-control (Baumeister, Vohs, & Tice, 2007). This model proposes volitional action and acts of self-regulation (e.g., inhibiting an automatic response in favor of goal directed behavior) draw from a limited reservoir of mental energy. Using an anatomical example, Baumeister et al. (2007) liken self-control to muscular activity. Similar to performance impairment due to muscular fatigue after exertion, self-control “fatigues” an underlying mental system, impairing performance on subsequent acts requiring self-regulated cognition and action. It should be noted, however, that ego depletion as classically conceptualized is not synonymous with mental fatigue, but rather is a phenomenon specific to the domain of self-regulatory control and action (Baumeister et al, 1998). While subjective fatigue appears to be a component of being in an ego depleted state

(Finkel et al., 2006; Hagger, Wood, Stiff, & Chatzisarantis, 2010), research suggests the effect is specific to engaging in previous self-regulatory action rather than simply a consequence of being fatigued (Vohs, Glass, Maddox, & Markman, 2010). The ego depletion paradigm provides a means for actively manipulating this self-control system and observing the impact on performance. The paradigm is simple and intuitive and, at the time of developing this study, was associated with a robust empirical literature evidencing the effect. Participants are asked to complete a task requiring them to override a response in favor of a more regulated response, which is an act of self-control that depletes ego resources. Following depletion, participants are provided a subsequent task in which they are again expected to respond in a regulated manner. It is predicted that performance on this second task is undertaken with fewer resources, impairing regulatory performance.

A substantial literature exists documenting the efficacy of the ego depletion paradigm, indicating the administration of a depletion task does indeed result in impaired performance on a subsequent task involving cognitive control (Baumeister, Bratslavsky, Muraven, and Tice, 1998; Muraven, Tice, and Baumeister, 1998; Burkley, 2008; Gailliot, Plant, Butz, & Baumeister, 2007; Fischer, Greitemeyer, & Frey, 2007). A meta-analysis of 83 studies documenting this effect was replicated with a variety of depleting tasks and dependent measures (Hagger et al., 2010). For example, Baumeister et al. (1998) found that forcing oneself to eat radishes instead of chocolates (a “counterattitudinal choice”), attempting to suppress emotions while viewing a film, or performing a detailed letter cancellation task led to decreased performance in subsequent tasks requiring self-control. Muraven et al. (1998) similarly found a consistent effect of depletion regardless of

whether the depleting task was in the affective or cognitive domain. In their meta-analysis, Hagger et al. (2010) found medium to large effect sizes across depletion task spheres, including controlling impulses (e.g., Stroop Task), controlling attention (e.g., focusing attention on a film subject and disregarding words appearing onscreen), and cognitive processing (e.g., difficult solvable anagrams). The impact of depletion on performance was also observed across multiple criterion domains, including impulse control (e.g., persistently holding closed a handgrip), social processing (e.g., attitudes toward persuasive arguments), and cognitive processing tasks (e.g., performance on difficult arithmetic problems), with medium to large effect sizes of  $d = .71$ ,  $.69$ , and  $.60$  respectively (Hagger et al., 2010).

Although more recent multi-lab replication research (Hagger et al., 2015) and multiple studies from a single lab (Tuk, Zhang, & Sweldens, 2015) have challenged the robustness of the earlier reported meta-analytic findings, ego depletion effects were obtained by this author in a previous study investigating its impact on Rorschach cognitive processing variables (Charek, Meyer, & Mihura, 2015). Following a letter cancellation task, participants completed a group computer-facilitated Rorschach administration. Experimental groups differed in the nature of the letter cancellation task administered. Specifically, the control condition completed a simple cancellation procedure that could be completed with minimal effort, while the experimental condition was administered a cancellation procedure requiring adherence to complex rules necessitating significant regulatory control. Experimental sessions were led by an examiner following a script and no more than 10 participants were run in a single session. The impact of depleted self-regulatory resources on Rorschach variables indicative of

regulated and sophisticated processing was examined. Results displayed in Table 1 (next page) indicate Synthetic Whole Responses, Space Integration, and Weighted Sum of Color were impacted in the theoretically predicted direction following ego depletion, and variables unrelated to regulated cognitive processing were unaffected (Human Content, Personal Knowledge Justification, Popular). Table 2 provides descriptions for each of these variables, with the exception of Personal Knowledge Justification, which is coded when a respondent utilizes personally-relevant information to justify a response. Obtained effect sizes were slightly smaller than those reported in the Hagger et al. (2010) meta-analysis, which was attributed in part to the nature of the computer-based group Rorschach administration utilized in the study.

Table 1

*Descriptive statistics, independent samples t-test results and Cohen's d effect sizes for hypothesized effects and supplemental analyses comparing the depleted and control groups.*

Type of Variable/Variable Name	Control Group		Depleted Group		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>				
Target Rorschach Variables								
Synthesis %	.25	.16	.21	.13	1.34	95	.184	0.28
<b>Synthetic Whole Responses %</b>	<b>.16</b>	<b>.13</b>	<b>.11</b>	<b>.10</b>	<b>2.31</b>	<b>95</b>	<b>.023</b>	<b>0.48</b>
<b>Space Integration %</b>	<b>.11</b>	<b>.08</b>	<b>.08</b>	<b>.07</b>	<b>2.32</b>	<b>95</b>	<b>.022</b>	<b>0.48</b>
Vagueness %	.03	.05	.04	.05	0.74	95	.464	0.15
Color Dominance Proportion	.47	.31	.54	.27	0.74	36	.465	0.25
Incongruous Combination 1 %	.06	.06	.08	.07	1.46	95	.148	0.30
Fabulized Combination 1 %	.02	.04	.01	.02	1.63	66.95	.107	-0.40
Composite Sophistication	.29	.97	-.23	.83	2.90	95	.005	0.60
Theoretically Unrelated Rorschach Variables								
Human Content Response %	.25	.10	.24	.10	0.37	95	.713	0.07
Personal Knowledge Justification %	.01	.02	.01	.01	0.76	95	.450	0.16
Popular %	.20	.08	.17	.09	1.27	95	.206	0.27
Substitutes for the Rarely Calculated Color Dominance Proportion								
Color Dominance Proportion 2	.08	.10	.13	.14	1.89	93.87	.062	0.39
<b>Weighted Sum of Color %</b>	<b>.07</b>	<b>.07</b>	<b>.10</b>	<b>.09</b>	<b>2.09</b>	<b>94.35</b>	<b>.039</b>	<b>0.43</b>

*Note:* Control Group *n* = 43, Depleted Group *n* = 54 for all analyses other than the Color Dominance Proportion, which required at least three Color responses to be computed. For this variable, Control Group *n* = 13, Depleted Group = 25. Composite Sophistication is derived from a refined list of hypothesized markers of complexity after reverse coding necessary variables. Cohen's *d* was computed from the t-test results, not the group *M*s and *SD*s. Bolded variables indicate those utilized in present study.

## Hypotheses

In the present study, the ego depletion paradigm was utilized in an effort to differentiate maximal and typical performance measures. According to Wechsler (1943, 1950), non-intellective factors account largely for the disparity between performance on maximal capacity tests and real world outcomes. Maximal performance tests index absolute underlying ability, but personality and temperamental factors determine when and the extent to which these capacities are expressed. Drawing from the maximal versus

typical performance perspective, Wechsler proposed that we have underlying abilities (“what we can do”) but non-intellective attributes are key factors in determining what we actually will do. Wechsler (1950) identified drive, persistence, will, and perseveration as key non-intellective factors, which all include components of self-regulatory control. Empirical evidence has also found that variables such as “grit,” self-control, and emotional regulation are key factors in moderating the relationship between intelligence and behavior or they comprise a unique factor in factor analytic research of performance behavior (Duckworth et al., 2007; Alexander, 1935; Hundal & Singh, 1971; MacCann, Joseph, Newman, & Roberts, 2014). Unlike the artificial environment of the testing laboratory, in everyday life individuals are inundated with competing stimuli and distractions, requiring mechanisms to override and inhibit reactions to certain stimuli to achieve task-oriented behavior. This demands significant self-regulatory control, and individual differences in self-regulatory ability lead certain individuals to be more successful in navigating this environment effectively.

It is anticipated that the greatest effects of depletion should be on cognition manifest on typical performance tasks because they offer the respondent greater latitude in establishing the task parameters, providing opportunity for the individual to mentally “coast” and recharge cognitive reserves more than cognition manifest on a maximal performance measure, which pulls for correct responding under conditions of clear structure. In the present study, it was hypothesized that performance on assessment measures purported to capture typical intellectual behavior (i.e., Rorschach and to a lesser extent D-KEFS Design Fluency) would be significantly impacted by administration of an

ego depleting manipulation, while performance on the JOLO, a more fully maximal performance measure, would be largely unaffected.

One could argue for expecting a more limited impact of ego depletion on typical performance measures due to there being fewer externally defined task demands for them, such that behavior during those tasks would not differ much from how it would naturally be, as opposed to the clear expectations of maximal performance measures that demand performance and thus are more likely to be sensitive to the impact of depleted self-regulatory capacity. However, the present research emphasizes the requirement of participants to establish the task parameters and response possibilities in typical performance tasks, offering them the opportunity to take an approach that facilitates mental “coasting” and resource replenishment. Such latitude is not offered in the case of maximal performance tasks, as the task itself clearly establishes where motivation and energy are to be directed. In much the same way, typical performance in everyday life involves a host of opportunities and options to the individual regarding where to direct energy, motivation, and resources and how to mentally recoup when one is depleted.

JOLO performance was operationalized by total correct line orientation matches and D-KEFS Design Fluency by the difference between total novel designs under the Switching condition and total designs during non-switching trials, providing an index of performance under the most challenging, demanding, and regulated condition. Several Rorschach variables were analyzed, including Synthetic Whole Response (W-Sy), Space Integration (SI), Vista (V), Weighted Sum of Color (WSumC), Human Movement (M), and Complexity. Table 2 provides a description of each Rorschach variable and a rationale for the hypothesized effects. It should be noted that variables being investigated

in the present study differ some from those targeted by Charek et al. (2015). This decision is in part influenced by results of that study, in addition to the expanded range of variables coded in the present study. Specifically, WSumC was selected over the Color Dominance Proportion after WSumC was found to be more sensitive to ego depletion, W-Sy and SI were retained after yielding significant results, and Sy, Vg, and Incongruous Combination were omitted due to low base rate or nonsignificant findings. Fabulized Combination responses were omitted due to these responses reflecting perceptual and conceptual lapses, but simultaneously necessitating synthetic activity. All R-PAS variables were coded in the present dataset, though in Charek et al. (2015) only those listed in Table 1 were coded. This allowed for the inclusion of Complexity as a target variable in the present study as an overall composite of protocol complexity, rather than the Composite Sophistication variable used previously. Vista and Human Movement were added as new variables based on the rationale articulated in Table 2. To demonstrate effect specificity and discriminant validity, several Rorschach variables unrelated to cognitive regulation and sophistication were also coded, including Space Reversal (SR)<sup>2</sup>, Popular (P), and Sum of Human Content (SumH). In sum, hypotheses are as follows.

- 1) Fewer W-Sy, SI, V, and M responses; higher WSumC scores, and lower Complexity in the Rorschach protocols of ego depleted participants are anticipated, indicating less organized and sophisticated processing and greater reactivity to bright stimulating environmental features. Theoretically

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<sup>2</sup> In R-PAS, a distinction is made between Space Integration and Space Reversal based on response process differences and evidence that they have different correlates. The purpose of coding Space Reversal as a theoretically unrelated variable is to assess the validity of this distinction.

unrelated Rorschach variables (SR, P, and Sum of Human Content) should not be impacted by ego depletion.

- 2) D-KEFS Design Fluency performance is expected to be impaired significantly in the ego depleted participants. It was anticipated that ego depleted participants would generate fewer novel designs overall but particularly during the challenging Switching trial, resulting in lower Switching minus Non-switching difference scores relative to controls.
- 3) JOLO performance is not expected to be impacted to a significant degree given that judgment of line orientation is believed to reflect a straightforward maximal ability measure that may be less sensitive to self-regulatory resource variability.
- 4) In comparing the impact of ego depletion across the three criterion measures, it was anticipated that JOLO performance would be least impacted while Rorschach performance would be most impacted. It is anticipated that D-KEFS Design Fluency would be impacted slightly less than the Rorschach, but to a greater extent than JOLO performance.

Table 2

*R-PAS variable description and inclusion rationale.*

Variable Name	Description of Variable	Rationale for Hypothesized Effect
<b><i>Target Rorschach Variables: Expected Less Frequently in the Depleted Group</i></b>		
<b>Synthetic Whole Responses (W-Sy)</b>	Responses making exhaustive use of the inkblot while integrating two or more distinct object features.	Combinatory and integrative processing while comprehensively evaluating presented stimuli reflects sophisticated processing.
<b>Space Integration (SI)</b>	Responses integrating the white background with the inkblot.	Complex form of synthetic processing in which perceptual set is expanded to incorporate and integrate the background white space (i.e., both figure and ground).
<b>Vista (V)</b>	Shading features of the inkblot contribute to a three dimensional perception.	Involves a perceptual perspective taking process and is a complicated percept to identify and explain.
<b>Human Movement (M)</b>	Envisioning human movement, experiences, or activities in inkblot percepts.	Because inkblots are static stimuli, envisioned movement reflects a cognitive elaboration by the respondent that takes time and reflective capacity to generate.
<b>Complexity</b>	Overall index of complexity of processing that measures differentiation, integration, and productivity.	Complexity reflects overall “psychological activity” present in a protocol. Correlated with age, education, and IQ (Meyer et al., 2011).
<b><i>Target Rorschach Variable: Expected More Frequently in the Depleted Group</i></b>		
<b>Weighted Sum of Color (WSumC)</b>	General index of respondent’s attentiveness to the bright chromatic color features of the inkblots.	Index of responsiveness to stimulating inkblot features, which may reflect a reactive and receptive rather than regulated approach to the task.
<b><i>Theoretically Unrelated Rorschach Variables</i></b>		
<b>Space Reversal (SR) without Integration</b>	Reflects a perceptual reversal of the typical figure and ground relationship such that an object is perceived in the white cardstock that forms the background for the inkblot.	Thought to index oppositionality or independence striving rather than a sophisticated manner of processing.
<b>Popular (P)</b>	Coded for the responses to each card provided most frequently by the normative sample.	Reflects conventional interpretations and the ability to perceive obvious perceptual cues.
<b>Sum of Human Contents (SumH)</b>	Total number of human or human-like response objects perceived.	Reflects an awareness of or interest in people.

Charek et al. (2015) found that self-reported achievement striving served as a moderator for the effect of depletion on target Rorschach variables. Regression analyses were conducted to evaluate whether a similar moderating relationship exists in the present data. The ego depleting letter cancellation task can be conceptualized as a maximal performance task, with clear correct answers, explicitly established parameters for achieving “good” performance, and response possibilities limited by the stimulus materials (i.e., the letter cancellation sheets). Given this, it was anticipated that high achievement striving individuals would engage more fully in the ego depleting letter cancellation task, producing a larger depletion effect as observed by the Rorschach task, which lacks clear achievement demands and cues and represents the most typical performance task. An interaction effect is anticipated, with individuals in the control condition low in self-reported achievement striving demonstrating lower scores on target variables of cognitive sophistication and higher scores on spontaneous reactivity. In the depletion condition, the reverse pattern is anticipated, reflecting a greater effect of ego depletion due to high engagement with the maximal performance letter cancellation procedure.

In addition to investigating hypotheses regarding the effect of ego depletion, the control group data in this research can add to the existing literature by examining the extent to which target Rorschach variables correlate with measure of cognitive ability. As reviewed in Appendix A, previous research has demonstrated correspondence of Rorschach measures of cognitive sophistication with measure of intelligence (e.g., Acklin & Fechner-Bates, 1989; Allison & Blatt, 1964), particularly the synthetic Whole response (W-Sy) and Space Integration (Acklin & Fechner-Bates, Charek et al. 2015). More

contemporarily, Meyer (2016) demonstrated that in a clinical sample of children, Rorschach variables indicative of perceptual accuracy and complex perceptual problem solving were correlated with measures of general intellectual ability, as well as specialized neuropsychological measures of perceptual accuracy and synthesis (JOLO, Trail Making Test A and B, Rey-Osterrieth Complex Figure, Bender Gestalt, and Beery Visual Motor Integration). Although there are complications in examining the control group data as criterion validity evidence given the deviance from standardized administration procedure (i.e., group computer-facilitated administration, interspersing of straightforward letter cancellation tasks at three points during Rorschach administration), these data can still contribute to the existing Rorschach literature regarding the validity of Rorschach markers of cognitive sophistication. It was anticipated that target Rorschach variables indicative of cognitive sophistication, including Synthetic Whole Responses, Space Integration, Vista, Human Movement, and Complexity would demonstrate positive correlations with other measures of visuospatial cognitive functioning and the magnitude of these correlations would be roughly equivalent to those between cognitive measures of visuospatial processing.

## Chapter Two

### Methods

#### Participants

Data collection involved recruitment of University of Toledo undergraduate students enrolled in introductory psychology courses via the Sona System research recruitment portal. A priori power analysis indicated 128 participants (64 in each group) were required to obtain significant between group differences for the impact of ego depletion on each criterion variable when anticipating effect sizes slightly larger than those obtained in the Charek et al. (2015) ego depletion study ( $d = .40$ ), given modifications that were made to the methodology to enhance the effect of ego depletion (independent samples t-test, power = .80, alpha = .05, 2-tailed, for  $d = .50$ ). Because a focused contrast was also planned to analyze the relative influence of ego depletion across the three criterion measures in the depletion condition, a power estimate was computed utilizing a repeated measures model, given criterion measures are expected to be correlated within subjects (i.e., there would be some individual differences in the impact of ego depletion that is consistently expressed across all measures). Hagger et al. (2010) report relevant results for determining anticipated effect sizes for this analysis. Specifically, meta-analytic results indicate that the average effect of ego depletion on cognitive criterion measures is  $d = .48$ , with a larger effect reported for criterion measures simultaneously incorporating cognitive and affective constructs ( $d = .69$ ). Similarly, larger effect sizes for ego depletion were reported for complex criterion measures ( $d = .65$ ) than simplistic criterion measures ( $d = .35$ ). Given these results, I anticipated a difference of two to three tenths of a standard deviation between the JOLO and the

Rorschach variables, which translates into a Cohen's  $f$  statistic of about .15. A priori power analysis indicates 73 participants would be needed to detect an effect of this size ( $f = .15$ ; repeated measures ANOVA, power = .80, alpha = .05, 1 group, 3 measures, correlation among dependent measures = .5). Given that the power analysis for independent samples t-tests indicated 64 participants would be needed in both the experimental and control groups, a minimum of 128 total participants were recruited and split evenly between groups. Because 73 participants were necessary to detect the anticipated small to medium within subjects differences on tasks, additional participants were included in the experimental group once the minimum number of 64 participants were obtained in each condition by administering one additional experimental session.<sup>3</sup> Recruitment materials for the experimental and control condition were identical. Inclusion criteria included the ability to type responses at a computer terminal and be able to view instructions and images presented on an overhead and a computer screen. Students were awarded extra credit for participation.

A total of 76 University of Toledo undergraduate student contributed data to the experimental sample. Seven protocols were eliminated due to the participants failing to provide a complete Rorschach protocol (i.e., not providing responses to all ten cards), yielding a final experimental sample of 69 participants ( $M$  Age = 19.40, 41 males, 25 females). The control sample consisted of 70 participants, of which four participants were eliminated due to contributing incomplete Rorschach protocols ( $M$  Age = 19.36, 24 male, 45 female).

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<sup>3</sup> Note, the  $f$  value used in the power calculations is for an omnibus F-test and I planned to examine a linear contrast. Should the linear contrast be present, there would be even more power to detect it. Stated differently, keeping power at .80, if the expected linear pattern was present across assessment tasks, with 73 participants there would be power available to detect an effect even smaller than  $f = .15$ .

## **Procedure**

Data for the control and experimental conditions were collected concurrently, with alternating experimental sessions between groups, such that either the experimental or control condition was run every other session. Data were collected in a group format with a maximum number of 10 participants per testing session. Three undergraduate students were recruited and trained to run testing sessions, but ultimately, the majority of experimental sessions were administered by this author. To facilitate the presentation of instructions, a PowerPoint slideshow was prepared and displayed by projector at the front of the room to visually illustrate the instructions as they were described (slides interfaced with the script described below). The research software MediaLab by Empirisoft was utilized for data collection. The PowerPoint was designed to orient participants to the computer software and explain the procedures for completing the letter cancellation task, Rorschach, D-KEFS Design Fluency, and JOLO. To assure consistency in administration, a script was created and followed verbatim by the experiment administrator during each research session. Separate scripts were created for the experimental and control condition. These scripts were identical with the exception of 2 key differences that are described below.

In the experimental condition, informed consent was obtained, followed by a detailed introduction to the experimental procedure. A key feature of this scripted introduction was dialogue intended to induce an expectation that the letter cancellation task would require participants to exert substantial cognitive effort and that subsequent performance would be impaired as a result. The inclusion of this dialogue is based on research suggesting the effect of depletion is dependent upon the individual's implicit

theories regarding cognitive resource depleatability and subsequent impairment due to resource limitations (Job, Dweck, & Walton, 2010). Participants were told *“You will complete a task that is specifically designed to use up your mental resources and then work through various assessment measures. Research suggests that we have a limited amount of cognitive energy and that certain tasks, like those I will ask you to work on today, use this energy. As our level of mental energy decreases, it becomes more difficult to work on other tasks requiring cognitive effort. To sum it up, you have a limited amount of mental resources available at a given time, and the “depletion” tasks we ask you to complete will use up these resources. When fewer resources are available, mental tasks become more difficult. In this context, we expect the depletion tasks to make performance on the following tests more difficult.”*

In the control condition, the review of informed consent was also followed by an introduction to the experimental procedure, although this introduction was designed to induce a different expectation regarding the letter cancellation task. Participants were told *“You will complete a letter cancellation task in addition to responding to various assessment measures. This letter cancellation task is not designed to be particularly difficult and as such, will not require you to invest a large amount of cognitive effort. Therefore, it is not anticipated that completion of the letter cancellation task will have any impact on subsequent task performs, in this case, the assessment measures.”* This dialogue was intended to convey that cognitive resources would not be depleted by the control task and that subsequent performance would not be impaired. Consistent with Job et al. (2010), this theoretically decreased any potential performance impairment as a function of the control task.

The second difference in the scripts for the experimental and control conditions concerned the instructions for the letter cancellation procedure. The control script presented a simplified version of the cancellation task while the experimental script described the difficult ego depleting version. The instructions for each version of the task are described in detail in the materials section below.

## **Materials**

**Group computer-facilitated Rorschach.** All three criterion measures in the present study (Rorschach, D-KEFS Design Fluency, and JOLO) were collected in a group setting using computer-aided administration procedures. Although this is not standard for any of the measures, effort was made to approximate standard administration guidelines as closely as possible given the computerized group setting. The Rorschach group administration utilized in this study is believed to represent one of the most sophisticated attempts to translate standardized administration procedures to the group setting (for alternative group administration examples, see Bornstein, Bonner, Kildow, & McCall, 1997; Harrower-Erickson & Steiner, 1943; Munroe, 1945). For instance, in the present research, each participant was provided a stack of 10 facedown Rorschach cards and asked to pick up and examine each card during the Response and Clarification Phases. This is an improvement over previous Rorschach data collection efforts that relied on inkblot images projected at the front of the room. Because a fundamental principle in Rorschach testing is that the examinee takes the lead, standardized administration permits respondents to manipulate the cards and change the orientation in which they are viewed. This offers examinees 4 different perspectives from which to view the card. The present group administration was also designed to obtain 2 to 3 responses for each card, a number

that has been identified as the “sweet spot” regarding the ideal amount of responses in a meaningful record (Meyer et al., 2011).

The group computer-facilitated Rorschach administration was based on procedures previously described by Horn, Meyer, and Mihura (2009), updated by Hsiao, Meyer, Mihura, and Horn (2011; see [http://psychology.utoledo.edu/showpage.asp?name=psych\\_assess\\_pub](http://psychology.utoledo.edu/showpage.asp?name=psych_assess_pub)), and adapted specifically for the ego depletion paradigm by Charek et al. (2015). A standardized Rorschach administration is conducted in two phases; the Response Phase in which the responses are provided and a Clarification Phase in which the location and key determining features of the responses are identified. In a traditional Rorschach administration, responses are provided to all 10 cards before the examinee explains their responses during the clarification phase. The present research maintained this structure; participants provided responses to all 10 cards and subsequently clarified those responses in the order in which they were provided.

During the Response Phase, participants were asked to provide two or three responses to the question “What might this be?” for each of the ten Rorschach cards. The request for two or three responses complies with R-Optimized administration procedures that were developed in response to consistent research findings indicating the number of responses provided in a protocol confounds the interpretation of many variables when the protocol is excessively lengthy or overly brief (Meyer, 1992; Wood, Nezworski, & Stejskal, 1996). The R-Optimized procedure employs a “prompt for two, pull after four” approach, targeting the optimal response range of about 18-27 responses (Meyer et al., 2011). To best approximate R-Optimized procedures given the group computer-

facilitated setting, the following instructions were presented to participants by the experimenter.

*There is a set of 10 Rorschach cards in front of each of you on the stand. At this point, I don't want you to touch the cards. After the letter cancellation task, you will pick up and view the first card. It is very important that you pick up and hold onto the card while you are deciding on your responses. Your task will be to use all or part of the inkblot and answer the question "What might this be?" You will have 1 minute and 30 seconds to view the card and to type 2 ... or possibly 3, responses on the computer in the textboxes.*

In addition to these instructions, the computer program displayed three separate text fields for each card that participants used to type<sup>4</sup> their responses. The prompt “What might this be?” appeared above each field. All text fields required at least one character to be entered before advancing to the next field. Participants were instructed to enter the letter “x” in the Response 3 text field if they were unable to identify a third response. While responding, a timer embedded in the instructional PowerPoint was displayed at the front of the room, allowing participants to pace themselves.

Following completion of the response phase, participants began the clarification phase of the Rorschach. The clarification phase was introduced with the following scripted instructions.

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<sup>4</sup> At present, the impact of typing Rorschach responses rather than presenting them orally has not been empirically investigated. Of particular interest in the context of the present research is the possibility that requiring participants to type their responses instead of simply stating them orally to an examiner represents a substantially depleting task itself. The ego depletion literature suggests that individuals can either conserve regulatory resources when anticipating additional volitional action (Muraven, Shmueli, & Burkley, 2006) or exert effort despite depleted ego resources if sufficiently motivated (Muraven & Slessareva, 2003). If both groups are conserving ego-resources in anticipation of typing additional responses to 10 cards or persevering in spite of depleted resources, the magnitude of effect may be decreased.

*I am now going to explain how to finish the second half of the Rorschach. For this next phase you will be clarifying the responses you gave earlier on the Rorschach Cards in the beginning. Don't worry, your previous answers were saved and they will be displayed on your computer for you to review. The goal now is for you to help me see what you saw because as much as possible I want to be able to see the things you saw just like you did.*

*In the "Location Sheets" folder, you will find a packet with miniature versions of the inkblots labeled "Location Sheets." You can take them out as we will use them for this phase. First, while looking again at the inkblot, you will read the responses you typed previously. Then you will use textboxes on the screen to describe in more detail what there is in the inkblot that makes it look like that to you. Finally, you will use the location sheets to indicate where the things you saw were located.*

The instructional PowerPoint was utilized to visually demonstrate each step of the clarification phase. Each response was clarified in a two-step process designed to obtain more precise clarifications after Charek et al. (2015) found that many respondents only provided location-based clarification when a one-step Clarification was utilized. Participants were first presented a MediaLab screen containing their verbatim response and a text field within which they were instructed to "Describe what features in the inkblot make it look the way it does." After typing their clarifications regarding what made the inkblot look the way that it did, participants clicked ahead and were instructed by MediaLab and the experiment administrator to mark the location sheet. There were ten location sheets that each contained three miniature images of one inkblot and these images were used to identify and label critical features of each response. Participants

provided a complete clarification for each response (i.e., typing the associated clarification and then marking the location sheet) before moving to the next response. Three minutes were provided to clarify each card (1 minute per response, 15 seconds for marking location sheets, 45 seconds for typing clarifications). A timer was displayed at the front of the room allowing participants to pace themselves while clarifying responses. A total administration time of 55 minutes, including presentation of all instructions, was allotted for the Rorschach.

**Group D-KEFS Design Fluency.** The D-KEFS Design Fluency test is a measure of executive functioning in which the respondent is tasked with generating as many novel designs as possible for connecting dots while observing specified rules during a 60-second interval. Responses are provided on D-KEFS Design Fluency Response Booklets. The test is comprised of three conditions, Filled Dots, Empty Dots Only, and Switching.

As described previously, in the Filled Dots condition, the response form was a horizontally oriented series of 35 boxes arranged in a 7 x 5 table. Each box contained 5 black dots arranged in a fixed pattern. After instructing participants to retrieve the D-KEFS Design Fluency Response Booklet from the supplemental folder, the researcher led them through three initial trial by saying the following. *“On the front page of your response booklet, there are three squares, each with dots inside. I want you to make a different design in each square by connecting dots and always using straight lines. I’d like you to make the designs using only four straight lines to connect the dots. Make sure each line you draw starts at a dot and ends at a dot. Also, make each line touches at least one other line at a dot.”* The examiner then showed a PowerPoint slide displaying

two dots. The PowerPoint slide included an animation that illustrated the task to participants. While showing the animation, the researcher said, *“See how these two lines touch at this dot? It’s okay if your lines cross each other, and it doesn’t matter whether or not your designs can be named. Do you have any questions?”* After answering any questions, the examiner instructed participants to complete the three practice items and walked around the room to verify proper completion. Once all practice items were completed, the researcher instructed participants to turn to the response page and say, *“When I say begin, draw as many different designs as you can. You will have 60 seconds before I tell you to stop. Remember to use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start at the top left square and work across the page. When you finish one line, move back to the far left and begin the next line. Ready? Begin.* 60 seconds were provided for completion. In standardized D-KEFS administrations, a summary of the instructions for each condition are displayed to the examinee as they complete the test. These instructions were displayed on the overhead projector at the front of the room, as well as on participants’ individual computer screens

In the Empty Dots Only trial, the response form was a horizontally oriented series of 35 boxes arranged in a 7 x 5 table. Each box contained 5 filled dots and 5 empty dots arranged in a fixed pattern. After all participants turned to the appropriate page of practice items in their response booklet, and this was verified by the researcher, the researcher said, *“Look at the three squares labeled ‘practice.’ Each square has ten dots. Five of the dots are filled and five of them are empty. I want you to make a different design in each square by connecting only empty dots. That is, don’t touch the filled dots; just connect the empty dots. Like before, use only four straight lines and make each line*

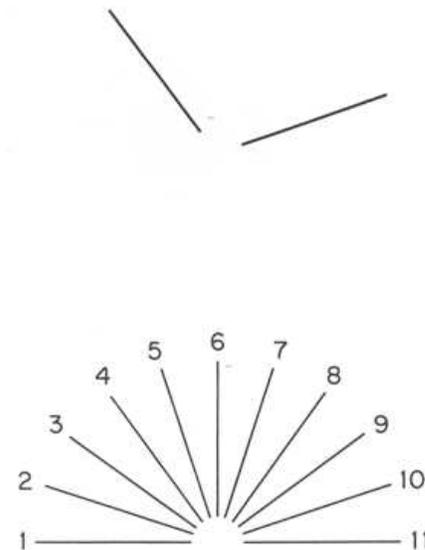
*touch at least one other line at a dot. Do you have any questions?"* After answering any questions, the researcher instructed participants to complete the practice items and walked around the room to verify accurate completion. Once all practice items were completed, the researcher said, *"When I say begin, draw as many different designs as you can. You will have 60 seconds before I tell you to stop. Remember to use four straight lines to connect only empty dots, without touching any filled dots. Like before, make each line touch at least one other line at a dot. Start at the top left and go across the page. When you finish a line, go back to the far left and begin the next line. Ready? Begin."* Again, reminder instructions were displayed at participants' computers and on the overhead.

The response form for the Switching condition was a horizontally oriented series of 35 boxes arranged in a 7 x 5 table. Each box contained 5 filled dots and 5 empty dots in a fixed pattern, similar to those in the Empty Dots Only condition, although the fixed pattern of dots is different in this condition. The researcher introduced the Switching trial by directing participants to the practice page and saying, *"Look at the three squares labeled 'practice.' Each square has ten dots inside. Five of the dots are filled and five of them are empty. Like before, I want you to make a different design in each square by using four straight lines and making each line touch at least one other line at a dot. But now, I want you to draw lines, switching each time from an empty dot, to a filled dot, to an empty dot, to a filled dot. You can start with either an empty or a filled dot. Do you have any questions?"* After answering any questions, the researcher instructed participants to complete the practice items and walked around the room to verify accurate completion. Once all practice items were completed, the researcher said, *"When I say begin, draw as*

*many different designs as you can. You will have 60 seconds before I tell you to stop. Remember to use four straight lines to connect an empty dot to a filled dot, to an empty dot, to a filled dot. Make each line touch at least one other line at a dot. Start at the top left and go across the page. When you finish a line, go back to the far left and begin the next line. Ready? Begin.*” Instructions reminding participants of the rules were displayed at participants’ computers and on the overhead. After the Switching trial was complete, participants were instructed to return their response booklet to the supplemental folder. Administration time was roughly 8 minutes including trial completion, instructions, practice items, and orienting participants to the record form.

**Group computerized Judgment of Line Orientation (JOLO).** As previously described, the JOLO is a 30-item visual perception measures in which the respondent must choose which lines from a fanned array of 11 lines oriented at 18-degree intervals at the bottom of the display match the spatial orientation of two line fragments at the top of the display. See Figure 2 for an image of the stimulus material. In the present study, a group computerized administration procedure was employed. In an effort to conserve administration time, a shortened form of the JOLO, consisting of the 15 odd-numbered items from the test’s Form V (the test is available in two Forms, Form H and Form V) was administered. Empirical evidence demonstrates relative equivalence of this short-form. Woodard et al. (1996) compared the scores of 15-item Form V short forms (i.e., odd-item short form, even-item short form) and found scores were comparable. High correlations between full Form V scores and doubled odd-item Form V short-form scores were also obtained ( $r = .92$ ). Using archival data, Mount, Hogg, and Johnstone (2002) found a large association ( $r = .93$ ) between Form V odd-item short form scores and Form

V full scores. The researcher read the following instructions to participants; these instructions were also displayed on the participants' computer screens: "*You will be shown figures to make judgments about. See these two lines? [Screen displaying the first practice item] Which two lines in the bottom figure are in exactly the same position and point in the same direction as the two lines in the top figure? Type the numbers of the lines, (01 through 11).*" Participants were presented 5 practice items and all practice items were completed prior to beginning the 15 test items. Following completion of the practice items, the researcher read the following scripted instructions to introduce the scored test items. "*Now we are going to do more of these, except now the lines that you see in the top figure will be shorter, because part of the line has been erased. Identify which two lines in the bottom figure are pointing in the same direction as the lines in the top figure. Do so by clicking to select the correct numbers.*" Scanned images of the JOLO items were displayed on each participant's computer screen. The JOLO is published in a spiral-bound book and standard administration procedures dictate that the book is laid flat on a table in front of the examinee, with the top page containing the two line fragments displayed above the array of potential choices. Scans were displayed in a consistent manner. Each JOLO item was presented one at a time and participants made their selections utilizing a click-based multiple choice interface. Ten seconds were provided for each response and the researcher displayed a timer at the front of the room, allowing participants to pace themselves. Total administration time was 5 minutes including presentation of instructions.



*Figure 2.* Sample Judgment of Line Orientation item.

**Mini-IPIP Five-Factor Personality Model Measure.** The Mini-IPIP Five-Factor Personality Model Measure was developed as a 20-item version of the IPIP-FFM measure (Donnellan, Oswald, Baird, & Lucas, 2006). It has been demonstrated to possess acceptable psychometric properties (Donnellan, et al., 2006) and appropriate factor structure (Cooper, Smillie, & Corr, 2010). Each of the five personality subscales are defined by 4 items. The five personality factors and example items are as follows; Extraversion (I am the life of the party), Agreeableness (I sympathize with others' feelings), Conscientiousness (I get chores done right away), Neuroticism (I have frequent mood swings), and Intellect/Imagination (I have a vivid imagination). This measure was administered following the collection of informed consent and prior to beginning the experimental procedure, though these scales were not associated with any specific hypotheses for the research.

**International Personality Item Pool (IPIP) Achievement-Striving and Self-Efficacy Facets of Conscientiousness.** Participants completed the 10-item Achievement-Striving and Self-Efficacy facets of Conscientiousness from the International Personality Item Pool (<http://ipip.ori.org/>; Goldberg et al., 2006). Items on the Achievement-Striving facet assess the propensity to exert resources towards goal-directed pursuits so it was considered a reasonable measure to determine if self-reported dispositional self-control moderates the impact of ego depletion. Sample items include “Work hard,” “Plunge into tasks with all my heart,” and “Do more than what's expected of me,” and they were rated on a 5-point scale (*very inaccurate* to *very accurate*). Items on the Self-Efficacy facet assess one’s sense of confidence and ability to perform well across situations. Sample items include “Complete tasks successfully,” “Know how to get things done,” and “Don’t see the consequences of things,” and they were rated on the same 5-point scale as was described from Achievement-Striving. These scales possess adequate psychometric properties and corresponds with Achievement-Striving and Self-Efficacy as assessed by the NEO-PI-R (Goldberg, 1999).

**Letter cancellation task: Experimental condition.** For the ego depletion task, participants were provided 4 pages of text from a scientific journal article on Fibromyalgia. This subject matter was chosen for two reasons; 1) it seemed unlikely material to distract participants’ attention from completing the cancellation task and 2) the subtle mention of fatigue throughout the article was hoped to heighten the effect of depletion through priming. The cancellation task was presented with the following instructions. *“The task is to work as quickly as you can to cross all the letter “e”s on a page. However, you also have to follow a set of specific rules. There are 4 rules. First,*

*if the e is located next to another vowel, don't cross it out. Second, if the e is one extra letter away from another vowel, don't cross it out. Third, cross out every letter "E" that is a capital letter, regardless of where other vowels are located. Fourth, cross out every letter "e" that ends a sentence, regardless of where other vowels are located. For this task, only consider the letters A, E, I, O, and U as vowels. Also, we ask that you disregard spaces, numbers, punctuation, and symbols in the letter sequences."* The experimenter then presented and described several examples of when a cancellation would or would not be made using the instructional PowerPoint presentation. This task is a modified version of the procedure utilized in Study 4 of Baumeister et al.'s (1998) classic paper on the ego-depletion paradigm. To ensure participants actually engaged in the depleting task, written records were checked and coded for accuracy and productivity (total letters scanned).

**Letter cancellation task: Control condition.** Rather than the fibromyalgia material provided to the experimental condition, the control condition was provided 4 pages from an article discussing a statistical topic. Participants completed a simplified version of the cancellation task administered to the experimental group in which they drew a line through every letter e they encountered. No limitations for cancellations were imposed. This represented a simple, nearly automatic task that requires very little resource allocation because the participant is not actively overriding automatic impulses or engaging in regulated processing to fulfill specified rules. Such a control task is identical to that used in previous research (e.g., Baumeister et al., 1998).

### **Experimental Sequence**

After participants were introduced to the experiment and all participant questions had been answered, the study procedure began. One complicating feature in the present design was determining the appropriate ego depletion dosing protocol. One option was to present a letter cancellation task (ego depleting in the experimental condition, non-depleting in the control condition) immediately preceding each criterion measure. This approach was deemed problematic due to significant variability in the length of administration time associated with the criterion measures. Specifically, the Rorschach spanned 55 minutes of each experimental session, while the D-KEFS Design Fluency and JOLO administrations lasted 8 and 5 minutes, respectively. An alternative approach, and the one ultimately utilized in this research, was to administer a letter cancellation task roughly every 15 minutes, ensuring a consistent level of ego depletion is maintained throughout the experimental session. To accomplish this, the experimental procedure was divided into four blocks with a letter cancellation task preceding each block. Because the combined administration time for the D-KEFS Design Fluency and the JOLO was roughly 13 minutes, those measures were clustered into a single block. This block was counterbalanced (i.e., 50% of the administrations were sequenced JOLO then D-KEFS Design Fluency, 50% of the administrations were sequenced D-KEFS Design Fluency then JOLO) to ensure the letter cancellation task did not always precede the same test. Due to its lengthy nature, the remaining letter cancellation tasks were administered corresponding to Rorschach “administration landmarks” that occur roughly every 15 minutes. Specifically, the 15-minute response phase was preceded by a letter cancellation task, a letter cancellation task was administered immediately before the Clarification Phase, and a final letter cancellation task was administered before providing

clarifications for the second set of 5 cards (3 minutes are provided to clarify each card, for a total of 15 minutes per 5 cards). Given this approach, 4 possible administration sequences existed that were cycled through in scheduled order.

- 1) Letter Cancellation, Rorschach Response Phase, Letter Cancellation, Rorschach Clarification Cards I-V, Letter Cancellation, Rorschach Clarification Cards VI-X, Letter Cancellation, JOLO, and D-KEFS Design Fluency.
- 2) Letter Cancellation, Rorschach Response Phase, Letter Cancellation, Rorschach Clarification Cards I-V, Letter Cancellation, Rorschach Clarification Cards VI-X, Letter Cancellation, D-KEFS Design Fluency, and JOLO.
- 3) Letter Cancellation, JOLO, D-KEFS Design Fluency, Letter Cancellation, Rorschach Response Phase, Letter Cancellation, Rorschach Clarification Cards I-V, Letter Cancellation, and Rorschach Clarification Cards VI-X.
- 4) Letter Cancellation, D-KEFS Design Fluency, JOLO, Letter Cancellation, Rorschach Response Phase, Letter Cancellation, Rorschach Clarification Cards I-V, Letter Cancellation, and Rorschach Clarification Cards VI-X.

This dosing protocol was designed to maintain consistent levels of self-regulatory resource depletion through the duration of the experimental session. One potential criticism of this approach is that the experimental group undergoes three ego depletion tasks during the Rorschach compared to one ego depletion task split between the other two criterion measures. Although this may reflect a legitimate concern, the potential dose-response disparity created if administering letter cancellations on a per-test rather

than fixed time schedule was deemed more problematic. To ensure maximal levels of ego depletion upon initiating the subsequent measure, all instructions, demonstrations, and practice items for the task immediately following the letter cancellation task were presented and completed prior to administration of the letter cancellation tasks.

Following cancellations, the examiner briefly reviewed instructions and then prompted participants to begin the appropriate test. Consistent with the procedure utilized by Charek et al. (2015), the first two letter cancellation tasks lasted for 8 minutes and the second two spanned 6 minutes, as it was assumed a sufficient level of depletion had been established and the third and fourth task were “booster” depletions. Total administration time was approximately 110 to 120 minutes (55 minutes Rorschach, 5 minutes JOLO, 8 minutes D-KEFS, 28 minutes letter cancellation, 10-20 minutes general instruction, completing self-report measures, debriefing, answering questions, etc.).

### **Data Coding**

Prior to conducting any coding, all Rorschach protocols were de-identified with regard to ID number and condition by assigning a random identification number using the SPSS random number generator. This identification number was physically placed over the originally assigned condition and ID number on the location sheets using a Post-It Note and these location sheets were then electronically scanned so that all coding decision were made by raters blind to condition. Correspondingly, an Excel file was generated containing the typewritten responses given to the Rorschach, removing the originally assigned condition and ID number, displaying only the randomly assigned identification number. All data utilized for statistical analyses, with the exception of interrater reliability data, was coded by this author. To allow for the computation of the

Complexity composite variable, and to facilitate the use of this data set for future research, protocols were coded for all R-PAS variables, including those not being targeted in the present research. To allow for the analysis of interrater reliability, this author and a second trained coder independently coded 30 randomly selected Rorschach protocols, which ultimately comprised the Rorschach reliability dataset. Prior to coding reliability protocols, four rounds of calibration coding were conducted, with each round involving both coders completing five predetermined protocols and identified discrepancies being discussed and ultimately resolved via collaborative discussion between both coders and this dissertation's committee chair, Gregory Meyer. The discrepancy-resolved protocols were included in the final dataset utilized for all statistical analyses. Similarly, two trained coders independently coded 30 randomly selected D-KEFS protocols. These protocols comprised the D-KEFS reliability dataset. After computing interrater reliability, coding discrepancies were identified and resolved and the resulting coding was included in the final dataset.

To allow for follow-up exploratory analyses, the Rorschach protocols for all individuals who completed the Rorschach first in the experimental sequence were recoded, utilizing only information articulated in the response phase for the first five cards. This was intended to capture the most immediate effect of ego depletion on the measure proposed to most capture typical performance.

Additionally, participants' performance on the letter cancellation tasks in the control and experimental condition was coded for total letters scanned, omission errors (every letter "e" that should have been crossed out but was not), and commission errors (any cancellation that was made but violated specified rules). To facilitate coding of the

letter cancellation sheets, templates were created for each page, indicating correct cancellations and the cumulative number of letters scanned in each line. These were created by the first author and then reviewed by a second trained coder. Discrepancies were resolved and the final templates were printed on transparencies and utilized as overlays for coding.

### **Variable Computation**

The Rorschach variable Weighted Sum of Color is an index of general attentiveness to color and it is calculated using the equation  $(.5 \times FC) + (1 \times CF) + (1.5 \times C)$ . FC (Form Color) reflects responses that include color but are primarily determined by form features of the inkblot. CF (Color Form) responses are those in which both color and form contribute to the final percept, although color plays a more prominent role. C (Pure Color) are responses determined purely based on color features without consideration of the inkblots structure.

Although overall D-KEFS Design Fluency performance was expected to be lower in the depleted group, the primary variable for analysis was indexed by the difference between total novel designs under the Switching condition and total designs during the two non-switching trials. Standard D-KEFS scoring computes a Contrast Scaled Score to quantify the difference in these conditions, with lower scores equating to worse relative performance on the Switching task. Contrast Scaled Scores were computed in the present study, consistent with standard D-KEFS procedure. JOLO performance was measured by total correct responses across items. Additionally, a composite cognitive ability measure was computed, giving equal weight to the D-KEFS Filled Dots, Empty Dots, and Switching conditions and the JOLO. This composite was computed by converting each

variable to z-scores, taking the mean on the three D-KEFS conditions, and then the mean of that mean and the JOLO z-score.

For the letter cancellation task, computed variables included total numbers of letters scanned, total letters scanned correctly (total letters scanned – omission errors – commission errors), total omission errors, total commission errors, omission error rate (omission errors/total letters scanned x 100), and commission error rate (commission errors/total letters scanned x 100). All self-reported trait variables, including achievement striving, self-efficacy, and Big 5 Personality Traits were computed by taking the mean score for all scale responses after reverse coding appropriate responses.

### **Planned Statistical Analyses**

Two sets of statistical analyses were planned with regard to the maximal versus typical performance hypotheses. First, to determine whether ego depletion was successful (i.e., whether performance on hypothesized measures was impacted by ego depletion), independent samples t-tests were planned and implemented for all hypothesized variables.

Next, to test whether the impact of ego depletion was stronger on tests of typical performance than tests of maximal performance, a within subjects focused contrast analysis was planned for the mean scores from the depleted condition. Due to criterion measures not sharing an equivalent metric, all scores needed to be converted to z-scores. Several Rorschach variables of cognitive sophistication are being investigated in this study. For the focused contrast analysis, it was necessary for all Rorschach variables to be averaged after converting them to z-scores and reversing the direction of effect for the Weighted Sum of Color. It was anticipated that the impact of ego depletion on cognitive

performance would be most pronounced on typical performance measures rather than maximal performance measures. In the context of this study, ego depletion was expected to impair Rorschach performance to the greatest extent, followed by performance on D-KEFS Design Fluency. Less impaired performance was anticipated for JOLO performance. In a between subjects analysis, non-linear focused contrast weights can be assigned to variables on the basis of theory, allowing for the specification of precise anticipated models. Conceptually, the proposed hypotheses reflect a weighting scheme in which the Rorschach receives a weight of -2, D-KEFS Design Fluency a weight of -1, and JOLO a weight of 3, reflecting the substantially larger effect expected on typical performance measures. Unfortunately, a between subject analysis would not be possible with the present data given that the same participants completed all three dependent measures. A fair amount of shared variance between measures was anticipated, as it was likely that certain individuals would be more or less impacted by the ego depletion effect<sup>5</sup>, which will be captured across criterion measures. To account for this, a repeated measures model was planned to address the within subjects correlation across tasks. A limitation of this approach, however, is that the repeated measures model does not allow for a non-linear contrast with researcher specified weights. Instead, a polynomial contrast was planned with fixed linear weights of -1, 0, and 1 applied to the Rorschach, D-KEFS Design Fluency, and JOLO, respectively. Although this equal spacing between tasks is not optimally consistent with the hypothesis that the Rorschach variables and D-

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<sup>5</sup> Stable individual differences in self-regulation have been reported (Tangney, Baumeister, & Boone, 2004; Mischel, Shoda, & Rodriguez, 1992) and evidence suggests that regular exercises in self-regulation can increase self-regulation capacity and “endurance” (Baumeister, Gailliot, DeWall, & Oaten, 2006).

KEFS Design Fluency will be more impacted than the JOLO, it retains the expected order of ego depletion's impact on tasks and correctly occurs in a within subjects design.

With regard to the validity analyses, a correlation matrix was generated analyzing the relationship between target Rorschach variables and cognitive variables, including the JOLO Score, Filled Dots SS, Empty Dots SS, Switching SS, Mean D-KEFS Designs Across Trials, D-KEFS Contrast SS, Cancellation Letters Scanned, Cancellation Omission Errors, Cancellation Omission Percent, Cancellation Commission Errors, and Cancellation Commission Percent.

Charek et al. (2015) found that self-reported achievement striving served as a moderator for the effect of depletion on target Rorschach variables. Regression analyses were planned to evaluate whether a similar moderating relationship exists in the present data. Regressions were structured with the Rorschach variables as the criterion, condition and mean-centered achievement striving as first order effects, and the product of the first order variables as the interaction effect entered into the equation as the final step.

## Chapter Three

### Results

#### Rorschach Coding Reliability

For purposes of calculating interrater reliability, intraclass correlations of exact agreement for a single rater were computed for each target variable in the 30 randomly selected protocols. These correlations are displayed in Table 3. All intraclass correlations were .72 or higher. Traditionally, ICC values from .60 to .74 are considered indicators of “good” reliability and values above .74 are considered to indicate “excellent” reliability (Cicchetti, 1994; Fleiss, 1981). The Vista score is rare and it was not coded by either rater in the 30 protocols; as such, its reliability was undefined.

Table 3

*Intraclass correlations obtained from Rorschach reliability coding (N = 30).*

<b>Variable Name</b>	<b>Intraclass Correlation</b>
Synthetic Whole (W with Sy)	.80
Space Integration (SI)	.76
Vista (V)	*
Human Movement (M)	.80
Complexity	.92
Weighted Sum of Color (WSumC)	.86
Sum of Human Content (SumH)	.90
Personal Knowledge Justification (PER)	.72
Space Reversal Without Space Integration (SR w/o SI)	.84
Popular (P)	.94

*Note.* \* = Intraclass correlation not available due to no instances of the target variable in reliability dataset.

#### D-KEFS Reliability Coding

Coded D-KEFS variables for each of the three conditions included Set Loss Errors, Repeated Designs, and Total Correct, which allowed for the computation of the Total Correct Standard Score for each condition, as well as the Contrast Scaled Score.

Intraclass correlations of exact agreement for a single rater were computed for each variable scored, as well as the standard scores. These correlations are displayed in Table 4. All intraclass correlations were above .74, which would be considered “excellent” reliability.

Table 4

*Intraclass correlations obtained from D-KEFS reliability coding (N = 30)*

<b>Variable Name</b>	<b>Intraclass Correlation</b>
Filled Dots Set Loss	.75
Filled Dots Repeated Designs	1.0
Filled Dots Total Correct	.99
Filled Dots Scaled Score	.99
Empty Dots Set Loss	1.0
Empty Dots Repeated Designs	.99
Empty Dots Total Correct	.99
Empty Dots Scaled Score	.99
Switching Set Loss	.99
Switching Repeated Designs	.95
Switching Total Correct	.99
Switching Scaled Score	.99
Contrast Scaled Score	.78

### **Number of Responses**

Although not a target variable, Charek et al. (2015) found a significant difference in total number of Rorschach responses (R) between groups. Unexpectedly, participants from the depleted condition in that sample provided more responses relative to the control group. Because all of the targeted variables are correlated with R, all analyses conducted in that study utilized percentage scores, taking the raw frequencies and dividing by the number of responses. An independent samples t-test revealed that the two groups in the present study did not differ significantly regarding the number of responses provided per protocol,  $t(133) = 1.04, p = 0.30$ , Control  $M = 24.15, SD = 3.23$ ,

Depleted  $M = 23.57$ ,  $SD = 3.31$ . Despite the lack of significant difference between groups in response rate, all variables were also computed as percentage scores to maintain consistency with Charek et al. (2015). For all of the subsequently reported findings, analyzing target variables as raw frequencies versus percentage scores resulted in no appreciable difference with regard to statistical significance or magnitude of effect size. Given this, all results are reported using raw frequencies. This decision was made based on theory, as R represents a marker of productivity, which can be an element of the other Rorschach markers of cognitive effort and ability that should not be partialled.

### **Participant Characteristics**

Participants' self-reported personality characteristics, as assessed by the Mini-IPIP Five-Factor Personality Model Measure and the Achievement-Striving and Self-Efficacy Facet Scales from the International Personality Item Pool, were analyzed by independent samples t-tests to determine whether groups differed on any personality trait. No significant differences between groups were obtained, suggesting groups were roughly equivalent with regard to self-reported Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism, Achievement-Striving, and Self-Efficacy.

### **Hypothesized Effects**

#### **Initial correlations investigating validity of Rorschach cognition variables.**

Using data from the control group, target Rorschach variables were correlated with other measures of cognitive ability, including the JOLO, D-KEFS Design Fluency, and letter cancellation task. Although the cancellation task was not presented as a test of cognitive ability, the total number of letters processed is a measure of information processing speed, much like the Cancellation task on the Wechsler IQ scale. Results are displayed in

Tables 5 through 9, with criterion validity data for each measure presented as a unique table, and Rorschach variables anticipated to evidence convergent (Table 5) and discriminant (Table 9) patterns of association presented separately. These tables also report the mean correlation coefficient for each table. Note that Table 5 does not report results for WSumC because this variable is traditionally interpreted as an index of the extent to which emotions influence thoughts and experiences (Mihura et al., 2015), rather than a marker of cognitive sophistication, per se. WSumC was not significantly correlated with any of the cognitive functioning measures.

As is evident across Tables 5 through 8, there is a general pattern of association between the Rorschach variables of cognitive sophistication and the alternative cognitive measures of visuo-perceptual processing ability. Interestingly, the total number of letters scanned achieved the largest mean correlation of all measures and it is correlated with several Rorschach and D-KEFS variables. Surprisingly, the D-KEFS Contrast Scaled Score was not significantly correlated with any other cognitive variables, though the fluency measures were. The JOLO was correlated with one Rorschach variable and the D-KEFS fluency measures. Overall, each of the four measures has validity coefficients in the .25 to .40 range with other cognition variables and the mean correlation coefficients ranged from .16 to .21.

Table 5

*Correlations of target Rorschach variables (displayed in columns) and criterion measures of cognitive functioning (displayed in rows) utilizing only data from control group participants.*

Rorschach ( $M r = .16$ )

	W-Sy	SI	V	M	Complexity
JOLO	-.01	<b>.41</b>	.05	.04	.12
Filled	.04	.19	.07	.12	.17
Empty	.16	<b>.25</b>	<b>.33</b>	.17	<b>.28</b>
Switch	.09	<b>.30</b>	<b>.28</b>	.07	.23
Total	.11	<b>.28</b>	<b>.25</b>	.14	<b>.25</b>
Contrast	-.04	.06	.08	-.13	-.05
# Scanned	<b>.36</b>	.08	.12	<b>.27</b>	<b>.36</b>

*Note.* Bolded coefficients are statistically significant at the  $p < .05$  level. For Rorschach variable abbreviations, see Table 2. JOLO = total Judgement of Line Orientation score, Filled = age-based standard score for D-KEFS Filled Dots condition, Empty = age-based standard score for D-KEFS Empty Dots condition, Switch = age-based standard score for D-KEFS Switching condition, Total = sum of correct designs across D-KEFS conditions, Contrast = standard score accounting for D-KEFS Switching performance relative to Filled and Empty Dots performance, # Scanned = total letters reviewed across four letter cancellation trials.

Table 6

*Correlations of total JOLO score (displayed in column) and criterion measures of Rorschach cognitive sophistication and measures of cognitive functioning (displayed in rows) utilizing only data from control group participants.*

JOLO ( $M r = .18$ )

	JOLO
W-Sy	-.01
SI	<b>.41</b>
V	.05
M	.04
Complexity	.12
WSumC	-.12
Filled	<b>.34</b>
Empty	<b>.29</b>
Switch	<b>.41</b>
Total	<b>.39</b>
Contrast	.04
# Scanned	.17

*Note.* Bolded coefficients are statistically significant at the  $p < .05$  level. For Rorschach variable abbreviations, see Table 2. JOLO = total Judgement of Line Orientation score, Filled = age-based standard score for D-KEFS Filled Dots condition, Empty = age-based standard score for D-KEFS Empty Dots

condition, Switch = age-based standard score for D-KEFS Switching condition, Total = sum of correct designs across D-KEFS conditions, Contrast = standard score accounting for D-KEFS Switching performance relative to Filled and Empty Dots performance, # Scanned = total letters reviewed across four letter cancellation trials.

Table 7

*Correlations of D-KEFS Design Fluency variables (displayed in columns) and criterion measures of Rorschach cognitive sophistication and measures of cognitive functioning (displayed in rows) utilizing only data from control group participants.*

D-KEFS ( $M r = .16$ )

	Filled	Empty	Switch	Total	Contrast
W-Sy	.04	.16	.09	.11	-.04
SI	.19	<b>.25</b>	<b>.30</b>	<b>.28</b>	.06
V	.07	<b>.33</b>	<b>.28</b>	<b>.25</b>	.08
M	.12	.17	.07	.14	-.13
Complexity	.17	<b>.28</b>	.23	<b>.25</b>	-.05
WSumC	.05	.08	.00	.05	-.08
JOLO	<b>.34</b>	<b>.29</b>	<b>.41</b>	<b>.39</b>	.04
# Scanned	.16	<b>.25</b>	<b>.29</b>	<b>.26</b>	.07

*Note.* Bolded coefficients are statistically significant at the  $p < .05$  level. For Rorschach variable abbreviations, see Table 2. JOLO = total Judgement of Line Orientation score, Filled = age-based standard score for D-KEFS Filled Dots condition, Empty = age-based standard score for D-KEFS Empty Dots condition, Switch = age-based standard score for D-KEFS Switching condition, Total = sum of correct designs across D-KEFS conditions, Contrast = standard score accounting for D-KEFS Switching performance relative to Filled and Empty Dots performance, # Scanned = total letters reviewed across four letter cancellation trials.

Table 8

*Correlations of total letters scanned on letter cancellation task (displayed in column) and criterion measures of Rorschach cognitive sophistication and measures of cognitive functioning (displayed in rows) utilizing data only from control group participants.*

Visual Scanning ( $M r = .21$ )

	# Scanned
W-Sy	<b>.36</b>
SI	.08
V	.12
M	<b>.27</b>
Complex	<b>.36</b>
WSumC	.18
JOLO	.17
Filled	.16
Empty	<b>.25</b>
Switch	<b>.29</b>
Total	<b>.26</b>
Contrast	.07

*Note.* Bolded coefficients are statistically significant at the  $p < .05$  level. For Rorschach variable abbreviations, see Table 2. JOLO = total Judgement of Line Orientation score, Filled = age-based standard score for D-KEFS Filled Dots condition, Empty = age-based standard score for D-KEFS Empty Dots condition, Switch = age-based standard score for D-KEFS Switching condition, Total = sum of correct designs across D-KEFS conditions, Contrast = standard score accounting for D-KEFS Switching performance relative to Filled and Empty Dots performance, # Scanned = total letters reviewed across four letter cancellation trials.

Table 9

*Correlation of Rorschach variables selected to establish discriminant validity (displayed in columns) and criterion measures of cognitive functioning (displayed in rows) utilizing data only from control participants.*

Rorschach Discriminant Validity ( $M r = -.02$ )

	SR w/o SI	P	SumH
JOLO	-.11	-.18	-.01
Filled	-.10	-.10	-.05
Empty	-.05	-.11	.15
Switch	.04	-.15	.08
Total	-.05	-.13	.06
Contrast	.17	-.02	.05
# Scanned	-.04	-.13	.23

*Note.* For Rorschach variable abbreviations, see Table 2. JOLO = total Judgement of Line Orientation

score, Filled = age-based standard score for D-KEFS Filled Dots condition, Empty = age-based standard score for D-KEFS Empty Dots condition, Switch = age-based standard score for D-KEFS Switching condition, Total = sum of correct designs across D-KEFS conditions, Contrast = standard score accounting for D-KEFS Switching performance relative to Filled and Empty Dots performance, # Scanned = total letters reviewed across four letter cancellation trials.

**Effects of ego depletion.** To verify the effect of ego depletion, independent samples t-tests were conducted to determine whether the intervention effected the target variables as expected. On the Rorschach, it was anticipated that ego depleted participants would provide fewer Synthetic Whole, Space Integration, Vista, and Human Movement responses; achieve a lower Complexity scores; and provide more color responses as reflected by the Weighted Sum of Color. Rorschach variables that are theoretically unrelated to cognitive sophistication (Space Reversal without Space Integration, Popular Responses, and Sum of Human Content) were not expected to differ between depleted and control participants. On the D-KEFS, it was anticipated that ego depleted participants would achieve lower Contrast Scaled Scores, indicating relatively poorer performance on the challenging Switching trial in comparison to the Filled and Empty Dots conditions. Performance was not expected to differ between groups on overall JOLO performance, the most maximal performance measure included. Prior to running statistical analyses, descriptive statistics were computed to verify statistical assumptions and two variables were found to have skew  $> 2$ . Square root transformations were applied to correct skew and these variables were analyzed alongside non-skew corrected variables. Analyses utilizing skew corrected variables did not differ and in Table 6 non-corrected variables are reported as a result.

However, as is evident in the table, no significant differences were found between groups for any of the target variables. Because no impact of ego depletion was observed,

indicating the manipulation did not operate as intended, planned focused contrast analyses were not conducted.

Table 10

*Independent samples t-test results and effect sizes (r) for target variables as a function of ego depletion.*

Variable Name	Control		Depleted		<i>t</i>	<i>p</i>	<i>r</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
W-Sy	4.17	3.20	3.70	2.68	0.93	.36	.08
SI	2.15	1.77	1.70	1.39	1.67	.10	.14
V <sup>a</sup>	.12	.37	.10	.35	.54	.75	.03
M	3.67	2.56	3.90	2.65	-0.52	.61	-.05
WSumC	2.19	2.10	1.91	1.82	0.84	.40	-.07
Complexity	67.67	19.56	66.20	16.55	0.47	.64	.04
SR <sup>a</sup>	.24	.58	.25	.76	-0.03	.97	.00
P	4.61	1.95	4.97	2.11	0.58	.30	.09
SumH	5.38	2.83	5.38	2.52	0.00	1.00	.00
JOLO	26.49	3.22	26.32	3.18	0.30	.76	.03
D-KEFS Contrast	11.27	2.02	11.12	2.59	0.39	.70	.03

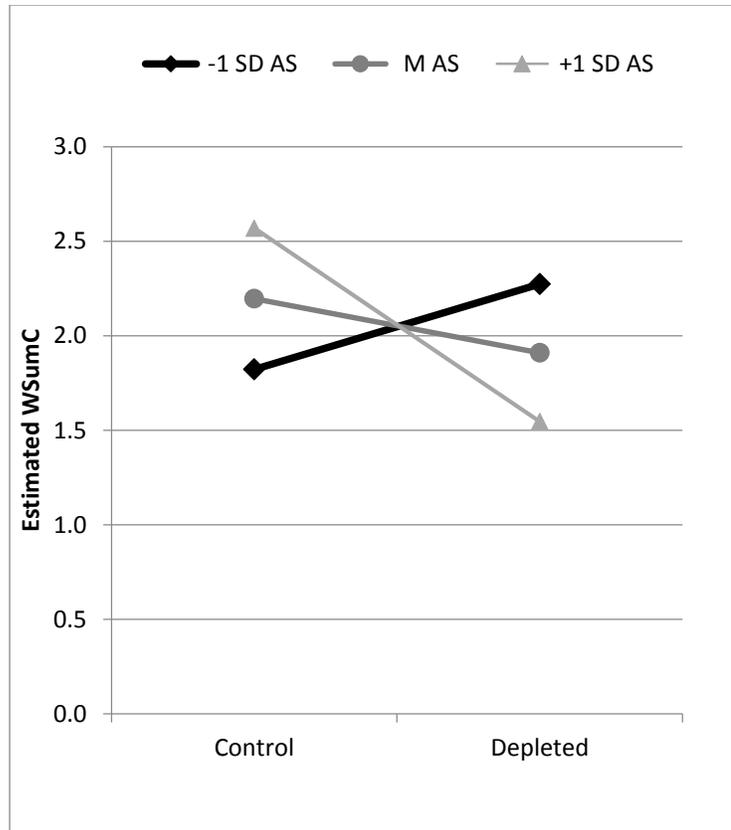
Note. For all variables, control condition  $n = 66$  and depletion condition  $n = 69$ . W-Sy = Synthetic Whole Responses, SI = Space Integration, V = Vista, M = Human Movement, WSumC = Weighted Sum of Color, SR = Space Reversal without Space Integration, P = Popular, SumH = Sum of Human, JOLO = Total JOLO Score, D-KEFS Contrast = Design Fluency Contrast Scaled Score. For variables expected to differ, the effect size  $r$  was given a positive sign when mean differences were in the expected direction and a negative sign when they were not.

<sup>a</sup> Variables with significant skew were corrected by a square root transformation and this was found to have no impact on analyses. As such, the non-transformed variable results are reported here.

Surprisingly, our control and experimental samples varied drastically in the composition of male and female participants, with 37.9% female participants in the experimental condition and 65.2% in the control condition. Additionally, as Table 5 indicated, performance on the Rorschach was correlated with cognitive ability measures. Thus, ANCOVA analyses were conducted to explore whether the impact of ego depletion on Rorschach target variables might be more evident after controlling for gender and visuo-perceptual cognitive ability, with the latter defined by the composite perceptual

ability variable, computed by aggregating JOLO and D-KEFS Design Fluency performance, weighing the contribution of each measure equally. These analyses did not substantively impact results (i.e., non-significant findings did not become significant or vice versa and the change in p-value and effect size magnitude was relatively small).

**Moderation analyses: Self-reported Achievement Striving.** Before conducting moderation analyses, Achievement Striving items were recoded with zero as the scale midpoint to avoid needing to create a centered variable. The scale score was computed as the mean across all items, after reverse scoring items as necessary. Regression analyses were structured with target Rorschach variables as the criterion, Condition and Achievement Striving as first order effects, and the product of the first order variables as the interaction effect entered into the equation last. The interaction was not significant for any target Rorschach variable, with the exception of Weighted Sum of Color, which revealed a significant interaction ( $R^2$  Change for the interaction term = .034,  $p = .03$ ,  $\beta = -.38$ ;  $R$  for full equation = .20 with  $\beta$ s for Condition and Achievement Striving = .22 and .19, respectively) in the direction opposite of what was anticipated. Specifically, those high in self-reported Achievement-Striving gave more color responses in the control condition and less in the depleted condition. By contrast, those low in Achievement-Striving gave less color in the control condition and more in the depleted condition. This relationship is illustrated in Figure 3 below.



*Figure 3.* Simple slopes illustrating the interaction of condition and Achievement-Striving on Weighted Sum of Color. Simple slopes for Achievement Striving at its centered M and one SD below and above the M.

### Exploratory Analyses

**Order based effect of ego depletion.** To investigate whether the depletion effect might have been present but short-lived, the impact of ego depletion was examined only for the first block of measures administered in the experimental sequence. Stated differently, to determine whether the non-significant findings for depletion reflect the manipulation “washing out” over the course of the lengthy experimental session, independent samples t-tests were conducted looking only at those participants administered either the Rorschach first or the D-KEFS or JOLO first in the experimental

sequence. Although these analyses use only about half of the participants and thus reduce power, independent samples t-tests revealed no significant differences between groups on any target variable, with obtained t-values ranging from .017 to 1.489, p-values ranging from 0.142 to 0.986, and Cohen's *d* effect sizes ranging from 0.01 to 0.40. Follow-up ANCOVA analyses controlling for gender and visuoperceptual ability also yielded nonsignificant results.

#### **Impact of ego depletion on the Response Phase of the first 5 Rorschach cards.**

To evaluate the most immediate effect of ego depletion on the measure proposed to be most indicative of typical performance, the Rorschach data was recoded utilizing only information provided by participants in the response phase for the first five cards. Only those individuals who were administered the Rorschach first in the experimental sequence were included in this data set. Independent samples t-tests were computed for all target Rorschach variables. Near significant between group differences were found for Space Integration, with the depleted participants providing fewer responses relative to non-depleted controls  $t(55) = 1.90, p = .062, r = .26$ ; with Control  $M = .11, SD = .32$  and Depleted  $M = .00, SD = .00$  (i.e., there was no SI in the Depleted group). No significant between group differences were found for any other target Rorschach variable.

**Impact of ego depletion on the Response and Clarification Phase of the first 5 Rorschach cards.** Although the analysis just described allowed for the evaluation of the most immediate impact of ego depletion on Rorschach responding, it provided a somewhat artificial index of response complexity and sophistication, as the Clarification Phase is ultimately the phase of responding designed to illicit information regarding why a response looks the way that it does. It is this aspect of responding that typically yields

information relevant for coding several of the target variables. As such, an additional exploratory analysis was conducted taking the coded Response and Clarification Phase for Cards I through V for those administered the Rorschach first. Independent samples t-tests revealed no significant differences between depleted and control groups for any of the target Rorschach variables.

**Letter cancellation performance.** To examine the extent to which letter cancellation performance was determined by ability versus motivation and effort, the visuoperceptual ability composite score was correlated with Total Letters Scanned and the number of omission and commission errors, with square root transformations applied to the latter two variables to correct for skew. These results are displayed in Table 7 below. Given the relatively modest association between visuoperceptual ability and letter cancellation performance, motivation and effort were assumed to significantly contribute to letter cancellation performance.

Table 11

*Correlations of Composite Visuoperceptual Ability with Letter Cancellation Performance.*

	Letters Scanned	Omission Errors	Commission Errors
Control Condition	<b>.25</b>	-.02	-.14
Depleted Condition	.17	-.05	<b>-.23</b>

*Note.* Bolded coefficients are statistically significant at the  $p < .05$  level.

Regression analyses were then conducted to determine whether any interaction occurred as a function of effort put forth during the letter cancellation procedure. Theoretically, motivation and effort on the cancellation task in the easy control condition should lead to minimal decrements in cognition on the criteria, and may even carry over

to some extent to higher cognition on a typical performance task. Motivation and effort on the cancellation task in the difficult depletion condition should lead to large decrements in cognition, particularly on a typical performance task. The total number of letters scanned was taken as an indicator of motivation and effort on the letter cancellation task. The commission error rate was also analyzed, as it potentially offered an indicator of taxed effort, although this variable admittedly varied greatly between the two conditions, complicating its interpretative value.

Regression analyses were structured with specific target Rorschach variables as the criterion, gender and perceptual cognitive ability entered into the equation first as covariates, Condition and the letter cancellation variable (Total Scanned or Commission Error Rate) as first order effects, and the product of the first order variables as the interaction effect entered into the equation last. The Commission Error Rate variable yielded no significant interactions.

Results were significant and generally consistent with expectations for Synthetic Whole response and Complexity when looking at Total Numbers Scanned as a moderator. For Synthetic Whole ( $R^2$  Change for the interaction term = .035,  $p = .03$ ,  $\beta = -.62$ ;  $R$  for full equation = .28 with  $\beta$ s for Condition and Total Scanned = .72 and .42, respectively), as illustrated in Figure 4, those who scanned more letters gave fewer W-Sy in the depleted condition relative to controls. However, those who scanned fewer letters during the cancellation task gave fewer W-Sy in the control condition, as was anticipated, but slightly more of these responses in the depleted condition, a somewhat unexpected finding. Said differently, Total Letters Scanned and W-Sy were positively correlated in the control condition, as shown in Table 5, but not correlated in the depleted condition.

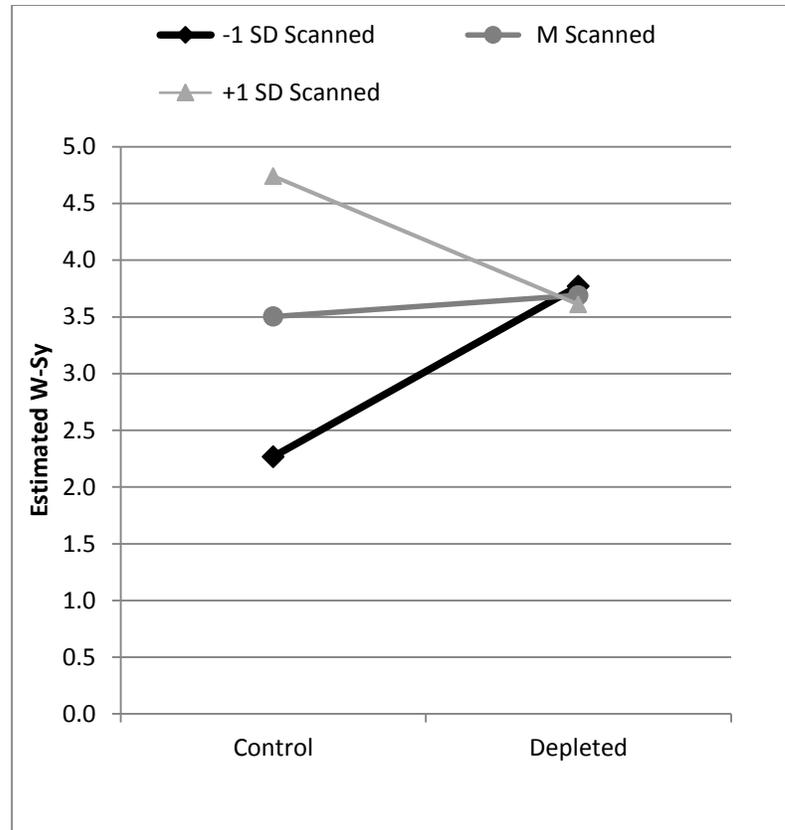
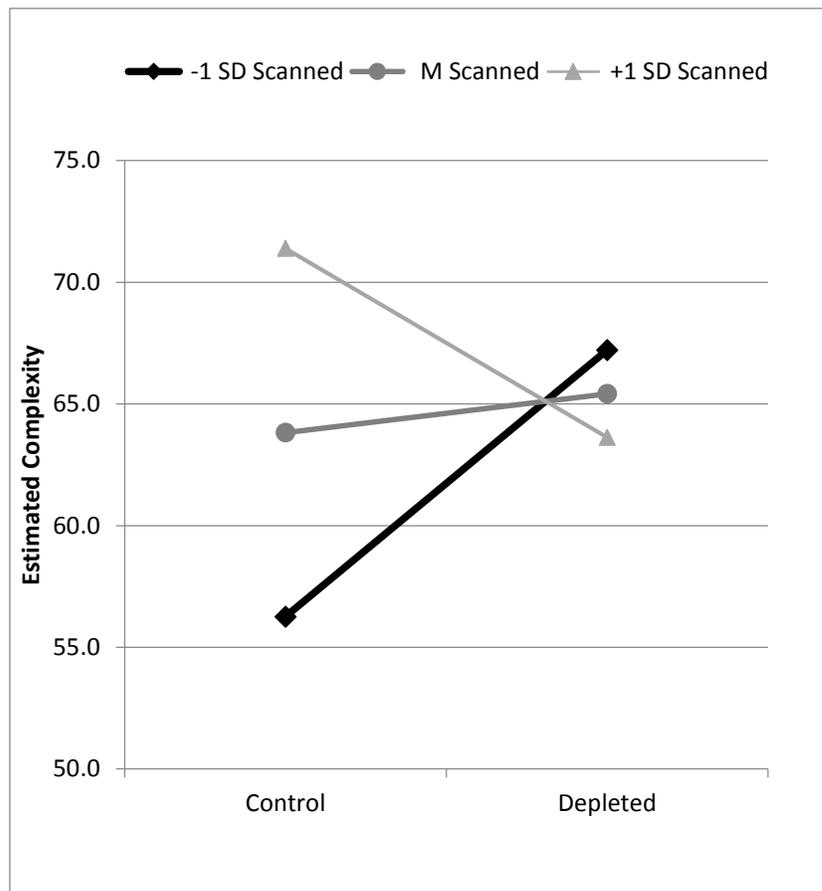


Figure 4. Simple slopes illustrating the interaction of condition and Total Letters Scanned on Synthetic Whole responses. Simple slopes for Total Letters Scanned at its M and one SD below and above the M.

For Complexity ( $R^2$  Change for the interaction term = .047,  $p = .012$ ,  $\beta = -.72$ ;  $R$  for full equation = .28 with  $\beta$ s for Condition and Total Scanned = .84 and .42, respectively), as illustrated in Figure 5, participants who scanned more letters in the control condition were higher in Complexity but were more average in the depleted condition. Those who scanned fewer letters in the control condition were low in Complexity but were relatively average in the depleted condition. Stated differently, in the control condition, scanning was positively correlated with Complexity (Table 5), while there was no relationship in the depleted condition. Both sets of interaction results

reported here reflect the total number of letters scanned during the cancellation task in the control condition being associated with Rorschach markers of cognitive sophistication, while unexpectedly, this relationship evaporates in the depletion condition, with the expected pattern of significantly poorer performance with more letters scanned not being obtained.



*Figure 5.* Simple slopes illustrating the interaction of condition and Total Letters Scanned on Complexity. Simple slopes for Total Letters Scanned at its M and one SD below and above the M.

Regressions were also conducted for the neuropsychological measures as criterion variables; specifically, total JOLO score and mean performance across D-KEFS trials.

The visuoperceptual ability composite was removed as a covariate but the equation was otherwise structured identically to that described above. No significant interaction effects were found.

## **Chapter 4**

### **Discussion**

This research sought to examine associations among different types of cognitive processing measures and the impact on them of ego depletion from the perspective of measures that are more and less defined by maximal performance criteria. Specifically, cognition as expressed on the Rorschach, the Design Fluency subtest of the Delis-Kaplan Executive Functioning System, and the Judgment of Line Orientation Test was evaluated after completing an ego depleting or control letter cancellation task, anticipating the effect of ego depletion would have its strongest impact on cognition that manifests in typical performance rather than maximal performance. One aspect of this research involves situating Rorschach cognitive processing variables within a neuropsychological framework. In doing so, these data additionally offered the opportunity to investigate the intercorrelations between Rorschach markers of cognitive sophistication and two standardized neuropsychological measures, as well as cognitive efficiency as measured by the letter cancellation task, providing criterion validity evidence for these variables. It was hypothesized that performance on the Rorschach, the assessment measure purported to capture behavior most indicative of typical intellectual behavior, would be impacted to the greatest extent by administration of an ego depleting manipulation. Performance on the JOLO, a simple and purported maximal performance measure, was expected to be largely unaffected. The D-KEFS Design Fluency test shares several characteristics with maximal performance measures, but it also requires the respondent to establish the task parameters (e.g., identify a problem solving strategy) and generate the response options.

Given this, it was anticipated D-KEFS Design Fluency performance would be impacted to a greater extent than the JOLO, although less than the Rorschach.

Because the control group in this study was administered a simple and relatively straightforward version of the letter cancellation procedure, little impairment of self-regulatory capacity was anticipated and this group therefore provides reasonable data for investigating the statistical association between Rorschach measures of cognitive sophistication and cognitive measures of visuo perceptual processing. In considering the correlation matrix displayed in Table 5, a clear pattern of association is present, with all significant correlations in the direction anticipated. Although the letter cancellation task is not a standardized neuropsychological measure, as are the D-KEFS Design Fluency and JOLO, it roughly approximates a processing speed and visual scanning task like the Cancellation subtest from the WAIS-IV. Of note, with the exception of WSumC, all target Rorschach variables evidenced criterion validity with at least one, and often times multiple cognitive measures of visuo perceptual processing. Further, the magnitude of association between Rorschach measures and cognitive measures was roughly equivalent to the magnitude of association between the individual cognitive measures (e.g., JOLO with D-KEFS Total Designs). Also of note, those Rorschach variables selected as markers of discriminant validity, which were theoretically unrelated to cognitive sophistication (i.e., SR w/o SI, P, and Sum H), evidenced no statistically significant correlations with cognitive measures. This is an important aspect of the present study, as it adds to the body of literature establishing the criterion validity of Rorschach variables of cognitive complexity (Acklin & Fechner-Bates, 1989; Allison & Blatt, 1964; Meyer, 2016; Zillmer & Perry, 1996).

In particular, the correlational data presented here empirically addresses the decision made by the R-PAS authors (Meyer et al., 2011) to distinguish between two types of white space response believed to capture distinct perceptual phenomenon. Exner's Comprehensive System (2003) included only a single overarching category for handling responses that incorporated the background white space of the card. However, examinees can potentially use that white space in one of two ways when providing responses. The white space may be integrated with the inked area in forming a percept, as captured by the Space Integration code. Alternatively, a respondent can reverse figure and ground, providing a response that utilizes the white and treats the inked area as a backdrop. Because examinees typically understand the "this" in the question "What might this be?" to indicate the inkblot rather than the white card it is printed on, it is believed Space Reversals capture potentially creative resistance or opposition to the implicit instruction of the task. This phenomenon is quite distinct from the sophisticated integration captured by Space Integration. The decision to differentiate Space Integration and Space Reversal in R-PAS was based primarily on this fundamental difference in response process (Meyer et al., 2011), although there is some empirical data to support the decision. It has been found that Space Reversal, but not Space Integration, is related to Necker cube reversals in an experimental task (Bandura, 1954). Research also suggests that Space Integration, but not Space Reversal, is related to level of education, a proxy for cognitive sophistication (Dumitrascu, Mihura, & Meyer, 2011). These two codes have also been shown to be uncorrelated (Meyer et al., 2011). However, due primarily to historical precedent, both types of space responses are included in the current R-PAS Complexity equation. The present data clearly demonstrate associations between

Space Integration responses and neuropsychological measures of visuoperceptual accuracy and visuoperceptual processing and problem solving. In fact, Space Integration is the Rorschach variable most consistently related to the various criterion measures of cognition in this dataset. By contrast, Space Reversal in the absence of Space Integration is clearly not associated with performance on measures of visuoperceptual processing, providing clear evidence for the discrete nature of these variables. In addition to providing additional empirical evidence supporting the theoretically-based decision to differentiate between Space Integration and Space Reversal responses, these data suggest there may be utility in revising the Location, Space, and Object Quality component of the R-PAS Complexity equation to include only Space Integration responses, excluding pure Space Reversal responses.

Unexpectedly, the ego depletion manipulation utilized in the present study did not operate as intended, with no significant differences found between groups for any of the dependent measures. This is a puzzling finding, as there exists a fairly substantial literature establishing the robustness of the ego depletion phenomenon (Baumeister et al., 1998; Hagger et al., 2010). Additionally, the present research was designed as a follow-up study to Charek et al. (2015), which utilized a similar methodology, albeit with fewer dependent measures included, and found significant between group differences with some medium sized effects. In an effort to enhance the impact of ego depletion, the ego depleting letter cancellation task was modified relative to Charek et al. The cognitive regulation requirement was the same, requiring participants to avoid crossing out the letter e if it was next to or one extra letter away from another vowel. However, to enhance the automaticity of the basic instruction to cross out the letter e, participants

were told to disregard the exception to the general rule if the letter e was a capital letter or the last letter in a sentence. In other words, they would cross out all letter es that were capitalized or ending a sentence and all letter es that were elsewhere so long as the e was not next to or one letter away from another vowel.

Given these modifications, it is particularly confusing that the experimental intervention had no impact on any of the dependent variables. As is illustrated in Table 12, which presents the mean target variable score divided by the mean number of responses to present information in a manner consistent with Charek et al. (2015), the depleted group in the present research was not impacted to a greater extent relative to the Charek et al. (2015) depleted group. Further, there is not a clear pattern suggesting that both groups in the present research were depleted by the overall experimental procedure relative to the Charek et al. (2015) control sample.

There are several possible explanations for the overall lack of effect from ego depletion. Recent research has raised the possibility that engaging in multiple self-regulatory tasks may offset the effect of ego depletion (Converse & DeShon, 2009; Xia, Dang, Mao, & Liljedahl, 2014). For example, Xia, Dang, Mao, and Liljedahl (2014) conducted a three group experimental design with a sample of Chinese students. In this study, a “three task group” was administered two consecutive ego depleting tasks preceding the dependent measure, a “two task group” completed a neutral task, followed by a depletion task and the dependent measure, and the control group completed two non-depleting tasks followed by the dependent measure. For all groups, the dependent variable was the number of Chinese idioms that could be identified, beginning with five Chinese characters. Participants were permitted to persist in this task as long as they

chose. As anticipated, the researchers found a significant difference in the number of idioms identified by controls participants relative to those in the two task group, with control participants providing significantly more responses. However, they also found that participants in the three task group provided more idioms relative to the two task group, and there was no statistical difference between the three task group and the control group on performance, suggesting the effect of ego depletion was offset by administration of consecutive depleting tasks.

Table 12

*Means for Rorschach variables commonly investigated in Charek et al. (2015) and the present research, presented as ratios with the target variable divided by the mean number of responses in each group.*

	<b>Charek et al., 2015</b>		<b>Present Research</b>	
	Control Group	Depleted Group	Control Group	Depleted Group
Target Rorschach Variables				
<b>Synthetic Whole Responses %</b>	<b>.16</b>	<b>.11</b>	<b>.17</b>	<b>.16</b>
<b>Space Integration %</b>	<b>.11</b>	<b>.08</b>	<b>.09</b>	<b>.07</b>
<b>Weighted Sum of Color %</b>	<b>.07</b>	<b>.10</b>	<b>.09</b>	<b>.08</b>

Several theories have been proposed to account for this finding, including learned industriousness, which states that individuals can learn the level of effort required to respond to the demands of a current situation adaptively (Eisenberger, 1992), and adaptation-level theory, which suggests people can develop different internal standards for performance based on previous experiences of adapting to task demands (Eisenberger, Masterson, & McDermit, 1982). From these perspectives, one may become primed to anticipate and therefore exert a high level of effort when confronted with multiple challenging ego depleting tasks or develop internal standards of exerting high levels of

effort in response to the demands of the challenging situation. Although the present research did not employ a consecutive depletion task manipulation, multiple depleting tasks were administered while also completing dependent measures requiring cognitive regulation. Given this, supplementary analyses were conducted to investigate whether the effect of ego depletion essentially diminished over the course of multiple doses of ego depletion. The experimental methodology employed in the present study was designed to control for potential effects of administration order, presenting dependent measures in a counter balanced order. If the effect of ego depletion became less perceptible for measures administered in the latter half of the experimental session, this might account for the lack of significant findings. Several steps were taken to investigate this possibility.

First, to investigate whether the anticipated effect of ego depletion was present following administration of the initial depletion task as measured by the experimental block that immediately followed it, statistical comparison of ego depleted and control participants were conducted, looking at performance on measures administered during the first block of the experimental session. Second, Rorschach performance was compared between control and depleted participants that received the Rorschach first, looking only at the Response and Clarification Phases for the first five cards. Third, the Rorschach data were recoded, considering only information provided in the Response Phase for the first five cards for individuals administered the Rorschach first, providing the purest index of the impact of depletion immediately after the ego depletion intervention was administered. The analyses revealed limited clarifying information, with the only near significant results being a possible trend when comparing performance

between groups for only the material provided in the Response Phase for the first five cards, such that Space Integration tended to be provided less frequently in the depleted condition relative to controls. Overall, these findings do not provide convincing evidence that the manipulation dissipated with subsequent depleting tasks.

Another consideration is the sheer number of depleting and dependent tasks included within the experimental session. The ego depletion literature suggests that individuals can conserve regulatory resources when anticipating additional volitional action (Muraven, Shmueli, & Burkley, 2006). Although participants were not told explicitly how many tasks they would be asked to complete, there were several indicators that participants would complete several tasks over the course of the experimental session. For instance, participants were provided 3 different folders with materials they were informed would be utilized over the course of the experiment. Further, all participants received 4 pages for cancellations and were instructed to use only one page for each round of cancellation. The expected length of the experiment – nearly two hours – was clearly communicated to participants, they were informed of how long they had to complete each component of the study as they worked, and a tight timeline was maintained by the research administrator, all of which may have communicated there was additional material to come. There was also more explicit communication of there being multiple tasks to be completed by participants, such as statements that participants were completing the “first part” or “first half” of the Rorschach or being informed there would be two dependent tasks completed during the experimental block including the D-KEFS Design Fluency and JOLO tests. These aspects of the experimental script and research

design may have sufficiently communicated to participants there was additional material to come, prompting them to conserve self-regulatory resources.

Another consideration in understanding the lack of ego depleting effect in the present research concerns the pace maintained by the researcher leading each experimental session. In contrast to the Charek et al. (2015) methodology, which spanned 105 minutes, offering 15 minutes of leniency for participants to complete dependent measures, the present study effectively consumed the entire 120-minute time slot, necessitating that the researcher leading each experimental session maintain a strict pace, pushing participants to complete their responses in the allotted time. Although data were not kept regarding the number of participants requiring additional time to complete their Rorschach responses in the Charek et al. (2015) study, this author conducted all experimental sessions in that study and anecdotally recalls allotting extra time for at least one participant in nearly every experimental session. Although this may have simply reflected participants adopting a slower pace given a lack of urgency established by the experiment administrator, the pace in the present study may have also led participants to adopt a more succinct and straightforward approach to responding, providing basic response and clarification details without elaborating on more nuanced response features that might lead to coding of additional relevant material due to perceived time constraints.

It should also be noted that the Charek et al. (2015) study required that all participants fast for three hours preceding the evaluation due to uncertainty in the literature at the time the study was designed regarding whether blood glucose level contributed to the ego depletion effect. Because empirical evidence has subsequently

suggested blood glucose levels do not account for ego depletion (Kurzban, 2010), this requirement was removed from the present study. However, this may have had an unanticipated impact on participants that elected to participate in the present study. Specifically, because the 3-hour fast requirement was clearly indicated to participants when registering for the previous study, and participants almost uniformly reported adhering to this requirement, the sample may have been biased towards participants who were motivated to participate in the experiment and willing to endure the aversive and challenging demands of ego depletion. Given the nature of the letter cancellation task and the lengthy study requirements in the Charek et al. (2015) and present research designs, obtaining participants that differed with regard to motivation and determination could significantly impact obtained results.

Another potential explanation for the lack of ego depleting effect from the letter cancellation task is that a sufficient amount of time was not spent to deplete self-regulatory resources to a degree that would be measurable by the dependent criteria. According to the strength model of regulatory control, the theory underlying the ego depletion paradigm, ego resources are finite and progressively depleted in proportion to the amount of self-regulatory control exerted (Baumeister et al., 1998; Vohs, Baumeister, & Schmeichel, 2012), which suggests the effect might not be observed if sufficient time is not dedicated to depleting resources. This explanation is believed unlikely to account for the present findings for a few reasons. First, Charek et al. (2015) utilized the same ego depletion dosing strategy (i.e., two eight-minute depletion tasks, followed by two six-minute depletion tasks) and obtained significant between group differences. In addition, in Hagger et al.'s (2010) meta-analysis, the duration of depletion tasks in minutes was investigated as a continuous moderator of the overall ego-depletion effect across available literature. A linear regression analysis, with the ego depletion effect size as the

dependent variable and task duration as an independent predictor, weighted by the inverse variance of each effect size, yielded only a small effect size ( $\beta = .11, z = 1.79$ ), suggesting the length of depletion task is a relatively small contributor to the overall magnitude of the effect.

A more concerning possible explanation is the current state of empirical evidence for the ego depletion paradigm across the literature. A recent meta-analysis, published subsequent to the proposal of this dissertation, questioned the state of the overall evidence regarding ego depletion. By including unpublished data and applying regression techniques based on funnel plots of the estimated effect size in each study against study precision, as indexed by the reciprocal of the sample size, this meta-analysis concluded that significant “small study bias” exists in the ego depletion literature (Carter, Kofler, Forster, & McCullough, 2015). Small study bias refers to the increased likelihood of improbably high effect sizes relative to sample size in studies comprising the reviewed literature. This represents a form of publication bias, such that journal editors and reviewers may be predisposed to accept studies that achieve statistical significance, achieving larger effect sizes relative to their sample size. The authors ultimately conclude there is very little evidence that ego depletion is a legitimate phenomenon as it is currently defined and empirically evaluated, challenging the notion that self-regulatory capacity functions as a finite psychological resource.

Further complicating the literature is a recent, multi-lab, pre-registered, replication study offering additional evidence questioning the ego depletion paradigm. Twenty-three laboratories tested 2,141 participants utilizing a standardized ego depletion protocol and found a small effect size with confidence intervals encompassing zero

(Hagger et al., 2015). Baumeister and Vohs (2015) commented on this finding, indicating the standardized methodology utilized to induce ego depletion in this replication study was problematic, leading to the lack of significant findings. However, they acknowledged that it is necessary to systematically reestablish the empirical evidence for ego depletion.

Finally, in their commentary regarding the multi-lab replication study, Baumeister and Vohs (2015) raise an issue regarding the nature of the letter e cancellation task utilized in the present research. In their commentary, Baumeister and Vohs (2015) state:

The manipulation is a computerized version of what is called the e-crossing procedure. This procedure was originally created as a laboratory version of a common self-control task, namely breaking a habit. Self-regulation is typically understood as altering and overriding responses. The e-crossing task works because participants first establish a habit (of using a pencil to cross out every e on a page of text) and then must override these habitual responses when more complex rules are introduced. Self-regulation is invoked when the participant sees an e and experiences the impulse to cross it off — and then must restrain that impulse. The Sripada and RRR studies skipped the initial key step of establishing a habit. RRR participants simply pressed a button to indicate whether each word has an e that is not adjacent to another vowel. Without first instilling the habit, there is nothing to override. This may be a difficult cognitive judgment task, but no impulse is overridden, contrary to the nature of self-control tasks. (p. 1)

The letter e procedure that the authors refers to is the paradigm utilized in the present research and modeled after Experiment 4 in the Baumeister et al. (1998) study.

However, when describing their methodology at that time, Baumeister et al. (1998) stated:

Participants then completed the regulatory-depletion task. Each was given a typewritten sheet of paper with meaningless text on it (a page from an advanced statistics book with a highly technical style) and told to cross off all instances of the letter e. For the participants assigned to the ego-depletion condition, the task was made quite difficult, requiring them to consult multiple rules and monitor their decisions carefully. They were told that they should only cross off an e if it was not adjacent to another vowel or one extra letter away from another vowel (thus, one would not cross off the e in vowel). Also, the photocopy of the stimulus page had been lightened, making it relatively difficult to read and thus further requiring close attention. In contrast, participants in the no-depletion condition were given an easily legible photocopy with good contrast and resolution, and they were told to cross off every single e with no further rules or stipulations. (p. 1260)

Based on this description, the experimental group was not asked to first complete a task where they crossed out every letter e before being told to complete the depleting task of crossing out the letter e except when specific restrictions apply. At best, it appears confusion has existed regarding this experimental procedure throughout the literature, as the multi-lab replication study employed a methodology consistent with Baumeister et al.'s (1998) description and the manipulation utilized in the present research, failing to include a preliminary, straightforward letter e cancellation task to establish a habitual response prior to administering the depleting letter e cancellation

task. Although Baumeister's recent comments (Baumeister & Vohs, 2015) might suggest the ego depletion manipulation utilized in the present research was not maximally effective, this explanation seems limited in fully accounting for the lack of findings, as the paradigm employed in the current study was also utilized by Charek et al. (2015) and has yielded significant results when utilized in a similar manner by other researchers (Sripada, Kessler, & Jonides, 2014). A comprehensive explanation for the lack of ego depleting effect in the present research remains elusive and may reflect some combination of the possibilities raised above.

### **Methodological Limitations**

These findings are somewhat limited by methodology, particularly as a result of the group computerized or computer-facilitated administration procedure used in collecting Rorschach and JOLO data. The potential impact of this method of administration on obtained results is less certain for the JOLO, as to the knowledge of this author, there is not a tradition in neuropsychology of collecting data with this measures in a group, computerized format. Such a tradition does exist for the Rorschach. In fact, there is a longstanding tradition in Rorschach research of using group administration methods to facilitate data collection (e.g., Bornstein, Bonner, Kildow, & McCall, 1997; Harrower-Erickson & Steiner, 1943; Munroe, 1945). Although it is true that results obtained from orally delivered protocols collected during one-on-one (examiner-examinee) testing sessions better generalize to standard Rorschach practice, administering the Rorschach necessitates a fair investment of time, which can make conducting efficient research difficult. As described in the Methods section, relative to previous group based Rorschach data collection efforts, the administration procedure employed in the present

study represent a sophisticated and highly structured attempt to translate standardized administration guidelines to the group research setting. The lack of examiner inquiry during the Clarification Phase represents the most limiting feature of this administration procedure. The inability to inquire regarding coding ambiguities made certain coding decisions particularly difficult. As an example, Ritzler and Nalsenik (1990) found that when protocols were collected without clarification, the means for several Rorschach variables were reduced, including Sum of Color, a relevant variable to the present study. By contrast, Form responses were coded with greater frequency in protocols that lacked clarification, which has implications for the Complexity variable investigated here. Although a clarification phase was a component of the present study's administration procedure, no clarifying questions were asked by an examiner to target specific coding ambiguities. This may have introduced coding imprecision, potentially introducing a source of statistical noise that could obscure the ability to find an effect.

Another methodological limitation involves the lack of self-reported affect states designed to serve as manipulation checks. Although some have questioned the utility of subjective mood and affect states to indicate depletion of self-regulatory resources (Baumeister & Vohs, 2015), the literature provides some support for self-reported fatigue in particular as an indicator of the subjective experience of ego depletion (Charek et al., 2015; Hagger et al., 2010). Because no effect of ego depletion was obtained in the present study, a measure of self-reported fatigue, such as the PANAS-X Fatigue subscale (Watson & Clark, 1994), in addition to other subjective affect states, such as attentiveness and frustration, may have been helpful in understanding the manner in which participants experienced the ego depletion intervention and control task.

The lack of verbal intelligence measures included in the present study represents an additional potential limitation. As initially conceived, the present research intended to position various measures involving visuoperceptual processing along a continuum of typical versus maximal performance, utilizing the ego depletion manipulation. Although measures of verbal intelligence might seem conceptually out of place from this perspective, the failure of the ego depletion manipulation, coupled with the promising findings from the criterion validity correlation matrix presented in Table 5, render the association between Rorschach indicators of cognitive sophistication and neuropsychological measures among the more interesting findings in the present research. The Rorschach task not only provides a sample of complex visuoperceptual problem solving but also a sample of verbal behavior, and achieving certain scores requires the examinee to articulate complex information with clarity. Not surprisingly, researchers have found associations between measures of verbal intelligence and Rorschach scores of cognitive sophistication, and these have been equivalent to and sometimes greater than the correlations between Rorschach scores and measures of visuoperception (Meyer, 2016; Wood et al., 2003). The inclusion of verbal intelligence measures would have enabled this study to contribute to this literature.

### **Implications and Future Directions**

The present results provide clear evidence of association between Rorschach indicators of cognitive sophistication and cognitive measures of visuoperceptual processing ability. Not only does this provide criterion validity evidence for the target cognitive variables included here (with the exception of WSumC, which is considered a measure of receptivity and reactivity rather than a measure of cognition per se), but also

points to the utility of the Rorschach in understanding the cognitive characteristics of the individual being assessed in clinical settings. Further, this evidence highlights the importance of clinicians considering the cognitive functioning of examinees when interpreting data obtained via the Rorschach.

Further, as previously described, these data provide clear empirical support for the decision by the R-PAS authors to differentiate between the Space Integration and Space Reversal code. Given the multiple significant correlations between Space Integration and cognitive measures of visuo perceptual processing, in the absence of any significant association between Space Reversal and cognitive measures, consideration should be paid to revising the R-PAS Complexity equation to exclude Space Reversal responses provided in the absence of Space Integration.

These findings also introduce important questions regarding the robustness of the ego depletion effect and the conditions under which the paradigm manifests. This is particularly important given the current state of the ego depletion literature, as described above. Utilizing a similar methodology, albeit with fewer dependent measures, a precursor to the present study obtained medium sized effects, while no significant results of depletion were found presently. These findings in the context of other recent research questioning the robustness of the ego depletion effect (e.g., Carter et al., 2015; Hagger, et al., 2015) suggest the need to continue ongoing, systematic attempts to evaluate the existing literature and understand this phenomenon in the laboratory.

Given this, in combination with the contradictory findings of Charek et al. (2015) and the present research, it would be ideal to conduct a multipart follow-up study attempting to replicate previous findings and determine whether the lack of findings in

the present research reflects a cancelling out of the depletion effect due to the numerous elements included, a statistical anomaly, or some alternative explanation. Specifically, it would be ideal to initially conduct a replication of the Charek et al. (2015) findings, utilizing the clarified letter e cancellation procedure described by Baumeister and Vohs (2016), and interspersing these within the Rorschach administration at the same interval and duration as structured in the original study. In a second study, this same modified letter e cancellation procedure would be utilized, with the structure of the experimental methodology for the current study otherwise maintained. If the same pattern of results were obtained (i.e., depletion observed in Study 1 and no results in Study 2), it would suggest the addition of additional dependent cognitive tasks and the resulting pace of administration accounts of the discrepant effect of depletion. Alternatively, if an effect of ego depletion is now found in both groups, it would support Baumeister and Vohs' contention that a habit has to be induced before it can be overridden and would allow the proposed continuum of maximal versus typical performance as defined by the JOLO, D-KEFS Design Fluency Test, and Rorschach to be evaluated.

Another potential follow-up study would involve a between subjects design rather than the within subjects design utilized here. Specifically, separate research sessions would be conducted investigating the relative impact of ego depletion on each of the three criterion measures, with participants undergoing the ego depletion manipulation and subsequently completing only one of the criterion measures. This would provide a purer indication of the impact of ego depletion on the Rorschach, DKEFS Design Fluency, and JOLO, removing the potential obscuring factor of including multiple components and criterion measures within a single experimental session.

Although the results of the present study are somewhat disappointing with regard to the lack ego depletion effect and resultant inability to directly address the typical versus maximal performance issue, it is still believed the conceptual and theoretical points discussed in this manuscript's introduction represent important areas of consideration. The issue of typical versus maximal performance has been increasingly discussed recently, particularly in the personality assessment literature more broadly and Rorschach research more specifically. In a recent special issue of *Rorschachiana* titled *Neuroscience and the Rorschach*, multiple authors directly address the nature of maximal versus typical performance measures, commenting on the implications of this conceptualization for interpreting assessment data (Meyer, 2016; Muzio, 2016). This perspective emphasizes the need to consider the nature of the response process in the microcosm of the assessment task in combination with the activities that these behaviors are most likely to generalize to. This holds important implications for the external validity of clinical assessment and reflects a departure from the tradition of principally being concerned with the internal validity of assessment measures and techniques.

It was hoped the present research would prove useful in addressing the clinical implications of ego depletion given the nature of neuropsychological practice. It is quite common for neuropsychologists to conduct lengthy evaluations, often spanning several hours. While breaks are typically offered, it is not uncommon for patients to work for multiple hours without interruption. Given this, understanding the impact of ego depletion on various neuropsychological measures may prove useful in structuring evaluations and interpreting obtained data. Unfortunately, due to the failure of the ego depletion manipulation in the present research, clear recommendations cannot be made

regarding whether ego depletion disproportionately effects certain types of measures (e.g., maximal versus typical).

It was hoped that the present research would address the relationship between self-regulation and neurocognitive executive functioning by observing the impact of depleted self-regulatory resources on a measure of executive functioning (D-KEFS Design Fluency). Unfortunately, the lack of ego depletion observed in the present study prevents the direct addressing of this question. Several researchers have noted areas of conceptual overlap between self-regulation or self-control and neurocognitive executive functioning. Executive functioning has been defined in a number of ways, but many authors describe these functions as the higher order cognitive processes of inhibition, organization, and planning that control and coordinate other cognitive functions towards goal directed activity (Barkley, 2001; Ettenhofer, Hambrick, & Abeles, 2006; Mitchell & Miller 2008). Rothbart, Sheese, and Posner (2007) noted neuroanatomical overlap between the executive attention network and the network associated with temperamental effortful control, with both functions activating the lateral prefrontal cortex and the anterior cingulate gyrus in neuroimaging studies. Research also provides evidence for correspondence between parental report of temperamental effortful control and laboratory tests of executive attention and inhibition (Gerardi-Caulton, 2000; Rothbart, Ellis, Rueda, & Posner, 2003). Baumeister, Schmeichel, and Vohs (2007) describe self-regulation as a trait-like ability to alter one's own responses and inner states, typically in the form of overriding one response in favor of a more regulated and goal-directed response. These authors go on to describe self-regulation as the "executive function of the self," although they elaborate this to reflect an overall emotional self-monitoring and control system that

is only loosely related to the cognitive executive functions described in neuropsychological terms. Barkley (2001) proposed an evolutionary perspective of executive functions and self-regulation that argues executive functions are the general class of self-directed actions that are necessary for self-regulation. He elaborates that in lower species, impulsivity and reactivity are not “problems” but rather the “default state.” The nervous systems of lower species learn from contingencies of reinforcement and determine behavior based on stimulus-response relationships. The need to exercise self-control and delay immediate reward in favor of future goal directed activity is largely unique to humans. From this perspective, self-regulation and the neural networks involved have evolved in response to situational demands that made impulsiveness and lack of self-control a problem for humans. He implicates the executive functions and human’s highly developed frontal lobes as the evolutionary response to self-regulatory requirements. In contrasting Baumeister et al.’s (2007) view that executive functions and self-regulation are conceptually similar but only loosely associated, with Barkley’s (2001) perspective that executive functions are the very mechanism underlying self-control, it is apparent that the relationship between these constructs remains unclear. This issues remains an important area of future empirical investigation.

## **Conclusion**

Principally, the present research intended to examine selected cognitive correlates of ego depletion from the perspective of measures that are more and less defined by maximal performance criteria. A contention of this study is that cognition is expressed in varied ways, and from this perspective, it was anticipated that ego depletion, would have its strongest impact on cognition that manifests in typical performance rather than

maximal performance. Unfortunately, primary analysis, as well as supplementary follow-up analyses, revealed quite clearly that the ego depletion manipulation was not successful in producing the intended effect.

Nevertheless, this research did reveal findings that contribute meaningfully to the literature. Specifically, within the control group, several Rorschach variables indicative of cognitive sophistication were situated within a neuropsychological framework, with resulting correlations revealing validity coefficients ranging from .25 to .41 for Space Integration, Synthetic Whole Responses, Human Movement, Vista, and Complexity with cognitive measures of visuo-perceptual processing. This magnitude of association is equivalent to that obtained when correlating the various cognitive measures included in the present study with one another. This finding is consistent with those obtained in previous research and further establishes the validity of Rorschach markers indicative of cognitive processing.

Finally, this study provides another meaningful contribution towards integrating and aligning Rorschach research with other domains of psychology, specifically neuropsychology and social-cognition. Research of this type enhances the empirical support for the Rorschach while simultaneously contextualizing Rorschach research within the broader social-cognitive and neuropsychological literatures. Such cross-disciplinary work enhances the understanding of psychological methodologies and allows disparate areas of psychology to mutually benefit from empirical findings.

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## Appendix A

### **Literature Review: The Rorschach as a Neuropsychological Instrument**

Researchers have investigated the utility of Rorschach responses in discriminating patients with specific neurological conditions from normal controls. Piotrowski (1937) created and validated a list of ten signs for differentiating the Rorschach protocols of patients with organic disturbances of the central nervous system and non-organic patients. These signs are as follows: 1) providing fewer than 15 responses to the ten inkblots, 2) an average response time of more than one minute per response, 3) providing fewer than two movement responses on a protocol, 4) providing “color naming responses” in which the basic colors are identified with no attempt to extrapolate further, 5) achieving less than 70 percent good form responses, 6) providing a percent of Popular responses that is below 25, 7) repeating the same response across several inkblots, 8) giving “impotent responses” in which the respondent provides a response despite recognizing its poor perceptual accuracy, 9) distrust of one’s responses and their own abilities to complete the task (termed Perplexity), and 10) providing “automatic phrases” in which consistent phrases or statements are used repetitively in an indiscriminant fashion. Initial empirical findings comparing the Rorschach protocols of 18 patients with central nervous system dysfunction, 10 cases with non-neurological disturbances, and 5 conversion cases indicated that the presence of five or more organic signs reliably discriminates patients with organic and non-organic diagnoses (Piotrowski, 1937).

Subsequent research has investigated the utility of Piotrowski’s ten organic signs. Examining 16 patients from a military population, diagnostic agreement on the basis of clinical evaluation (including a clinical interview; physical examination; serological,

urine, and blood tests; and X-rays) and Rorschach results was analyzed. Piotrowski's signs served as the basis for Rorschach based diagnostic decisions regarding organic dysfunction. Diagnosed conditions included psychoneurosis, postconcussion syndrome, constitutional psychopathic inferiority (a military term for psychopathic personality), schizophrenia, and malingering. Diagnostic agreement was obtained for 15 of the 16 cases, with 1 case diagnosed as psychoneurosis on the basis of Rorschach data and postconcussion syndrome following clinical evaluation (Brussel, Grassi, & Melinker, 1942).

A study conducted in Denmark (Rosenberg, Sorensen, & Christensen, 1995) investigated the neuropsychological and Rorschach characteristics of individuals identified as carriers of the Huntington's disease (HD) gene through genetic testing. Performance of 14 carriers was compared to that of 19 non-carriers on neuropsychological measures including Trail Making B, Wechsler Adult Intelligence Scale Block Design, Wechsler Memory Scale Story Recall, Luria's Pictogram Test, California Verbal Learning Test, Ruth Andersen's Visual Gestalts, as well as the Rorschach. Carriers of the HD gene performed significantly more poorly than non-carriers on all neuropsychological measures. For the Rorschach, 71.4% of the carrier population provided "meager protocols" (protocols with fewer than 12 responses) relative to 26.3% in the non-carrier population, and 35.7% of the protocols from the carrier population contained more than 5 Piotrowski's signs while zero protocols from the non-carrier population achieved more than 5 of these signs. Both findings represent statistically significant group differences.

As the literature regarding the neuropsychological deficits unique to specific central nervous system conditions expands, researchers have further explored the neuropsychological correlates of Rorschach perception unique to specific neurological conditions. Perry, Potterat, Auslander, Kaplan, and Jeste (1996) investigated the utility of two approaches to using the Rorschach with patients diagnosed with dementia of the Alzheimer type. The first approach examined variables from the Comprehensive System that were identified on a theoretical basis. The second introduced a new scale for evaluating linguistic errors and perseverations on the Rorschach. This scale was developed on a theoretical basis by considering the cardinal neuropsychological deficits involved in dementia of the Alzheimer type, as well as the discriminating features of the disorder (i.e., features that are characteristic of other neurological disorders and not expected in cases of dementia of the Alzheimer type). Utilizing Barr, Bilder, Goldberg, Kaplan, and Mukherjee's (1989) scale for classifying semantic, syntactic, phonemic, and perseverative errors on the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), the authors incorporated information from a taxonomy of perseverations proposed by Sandson and Albert (1984). The final scale is divided into two broad categories, semantic errors, (e.g., paraphasic errors, word-finding problems, stilted speech) and perseverative errors. Five classes of perseveration are specified, including mechanical perseverations (reporting the same object without elaboration, such that the response does not appear to be in relation to the stimuli), content perseverations (reporting that the response object is the same as one seen previously), phonemic perseverations (repetition of phonemic or morphemic features of a previous response), stuck-in-set perseverations (repetitive use of a framework or strategy for resolving the task of identifying responses),

and thematic perseverations (the reappearance of a specific content or theme without elaboration despite appearing to respond to inkblot features). Results revealed the theoretically identified Comprehensive System variables (with a few noteworthy exceptions described below) and the developed semantic and perseverative scale both differentiated patients with dementia of the Alzheimer type from controls. The authors note two non-significant differences between groups with regard to Comprehensive System variables. Specifically, Comprehensive System defined Perseverations (thought to reflect severe neurological impairment) and Deviant Verbalization (linguistic errors) did not differentiate the two groups<sup>6</sup>. According to the authors, this reflects the insensitivity of these Comprehensive System variables to the neuropsychological impairments specific to the disorder of dementia of the Alzheimer type. By contrast, results indicated the theoretically derived scale of linguistic deficits and perseverative errors reflected neuropsychological behavior characteristic of Alzheimer type dementia, such as semantic paraphasia, word finding circumlocution, superordinate category use, thematic perseverations, and phonemic perseveration (Perry et al., 1996).

Subsequent qualitative evidence has been reported for the utility of the linguistic and perseverative scale just described for use with other neurological populations. Perry and Potterat (1997) present a critical analysis of two case studies, comparing the Rorschach protocols of a 71-year-old, right-handed, Caucasian man with dementia of the Alzheimer Type and a 62-year-old, right-handed, Caucasian man diagnosed with

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<sup>6</sup> There appear to be problems with Perry et al.'s (1996) data for these variables. Based on Comprehensive System coding criteria and the criteria specified for the linguistic and perseverative error scale, it is not possible for patients to have the number of paraphasias reported in the study with so few Deviant Verbalizations. It also is not possible to have the number of content and mechanical perseverations reported without any Perseverations.

Wernicke-Korsakoff Syndrome with associated cerebral atrophy of the frontal lobes. Perry and Potterat (1997) discuss Rorschach results in relation to the unique neuropsychological characteristics of each patient's diagnosis. Specifically, dementia of the Alzheimer type is associated with language-related deficits (paraphasic errors, circumlocution, and word finding difficulties), visuospatial disruption, and significant memory impairment characterized by problems encoding new information and recalling information due to rapid memory degradation (Lezak et al., 2012, Perry & Potterat, 1997). The Rorschach protocol of the 71-year-old Alzheimer's patient evidenced these disorder-specific characteristics. Poor visual accuracy was evidenced by low Form Quality and relatively few Popular responses. Additionally, utilizing the theoretically developed scale for neurologically-based linguistic errors and perseverations (Perry et al., 1996), the patient committed a large number of word finding and paraphasic errors, in addition to providing frequent thematic and phonemic perseverations. Contrasting this protocol with that of the 62-year-old Wernicke-Korsakoff Syndrome patient, some key and theoretically predicted differences emerged. Most notably, the hallmark feature of this patient's protocol was the inability to recall any responses provided during the initial phase of the Rorschach administration. When provided responses were read back verbatim, the patient insisted that he had not provided the read responses. This evidences anterograde amnesia that is a key feature of Wernicke-Korsakoff Syndrome. This protocol also demonstrated confused and disorganized logic, with evidence for fluid thinking and confabulation. This too is consistent with Wernicke-Korsakoff Syndrome. Utilizing the linguistic and perseveration scale (Perry et al., 1996), there were few instances of linguistic errors and speech was generally lengthy and fluent, a key contrast

relative to the protocol of the patient with dementia of the Alzheimer type. When the patient with Wernicke-Korsakoff Syndrome did commit perseverative errors, they were almost exclusively of the stuck-in-set type, unlike the thematic and phonemic perseverations found in the protocol of the patient with dementia of the Alzheimer type. It should be noted that frontal cortex impairment is a feature involved in all types of perseveration, but stuck-in-set perseverations are particularly characteristic of frontal lobe pathology, while thematic perseverations are common in patients with Alzheimer's (Sandson & Albert, 1984).

In a sample of patients with diagnosed schizophrenia, Perry and Braff (1998) provided further empirical support for the Perry et al. (1996) linguistic and perseveration scale. Operating from a framework that assumes that schizophrenia is a syndrome characterized by frontal cortical dysfunction, the researchers hypothesized that patients with schizophrenia should commit a higher number of perseverative errors as assessed by the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) and the Rorschach Inkblot Test. Results revealed that Wisconsin Card Sorting perseverations and stuck-in-set perseverations on the Rorschach were significantly correlated. Further, a logistic regression equation created by entering the Wisconsin Card Sorting Test variables and Rorschach perseveration variables resulted in a 4-item prediction equation that correctly identified 89.4% of cases as belonging to the schizophrenia or control condition. Of these variables, Wisconsin Card Sorting perseverations and Rorschach stuck-in-set perseverations had the highest coefficients (Perry & Braff, 1998).

Consistent with the Wisconsin Card Sorting Test findings of Perry and Braff (1998), Ilonen et al. (2000) found significantly more perseverative responses in a sample of schizophrenic patients. In this study, 27 patients with first-episode schizophrenia were administered the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981), the Wisconsin Card Sorting Test, and the Rorschach. A 27 participant sample of “normal participants” administered the same test battery served as the reference sample. Results revealed significantly poorer performance on the WAIS-R, significantly fewer WCST categories completed, and significantly more WCST perseverative responses. Patients with schizophrenia also achieved significantly higher Rorschach Lambda scores (a Comprehensive System measure of response simplicity in which higher scores are indicative of less sophisticated responding that is based on form features alone) and Experience Actual scores (a Comprehensive System variable indicative of cognitive and emotional resources based on envisioning enlivened human objects and incorporating the inkblot colors into perceptions). Both Rorschach variables were significantly correlated with WAIS-R IQ scores and WCST perseverative responses.

The Rorschach results for patients having sustained closed head injuries have also been investigated. Ellis and Zahn (1985) compared the protocols of 35 subjects with severe closed head injury with 36 nonpatient protocols. Results indicated several key differences. The sample of patients with closed head injury, or traumatic brain injury using current nomenclature, had fewer responses, higher Lambda scores, more vague and impressionistic responses (i.e., higher DQv), more reactive responding to color features (more percepts based solely on the color features of the inkblot [C], rather than integrating the stimulating color information within the perceptual parameters established

by the inkblot structures [FC]), and fewer Texture response (perception of a tactile quality due to shading features). Several of these results, were supported in a separate study of Rorschach responding with closed head injury patients. Protocols for 60 closed head injury patients were obtained 3 to 7 weeks post injury. Although a reference group was not obtained in this study and statistical comparisons were not conducted, obtained results were qualitatively compared to non-clinical norms, leading the authors to conclude that closed head injury patients likely provide fewer responses, achieve elevated Lambda score, and ineffectively organize features of the stimulus field (Exner, Colligan, Boll, Stischer, & Hillman, 1996).

In addition to analyzing Rorschach performance in cases of neurocognitive impairment and dysfunction, the correspondence between Rorschach performance and intact intellectual functioning has been examined. Wood, Krishnamurthy, and Archer (2003) factor analyzed 19 Comprehensive System variables from the protocols of 152 adolescent inpatients. Results revealed a 3-factor solution: a Synthesized Complexity factor, a Productivity factory, and Form Quality factor. These factors were correlated with Full Scale Intelligence (FSIQ), Verbal Intelligence (VIQ), and Performance Intelligence (PIQ; all assessed via the Wechsler Scales), with results indicating the Synthesized Complexity and Form Quality factors were significantly correlated with measures of FSIQ, VIQ, and PIQ, suggesting the role of mental complexity and intelligence in each factor.

Acklin and Fechner-Bates (1989) sought to examine the relationship between Developmental Quality (a measure of differentiation and integration reflective of cognitive complexity and sophistication) as defined by Exner in the Comprehensive

System and intellectual functioning as assessed by the Wechsler Adult Intelligence Scale-Revised (WAIS-R). To do so, they examined Developmental Quality on its own and in combination with perceptions making use of different location areas. The Rorschach protocols of 125 undergraduate psychology students were analyzed using multiple regression. Of all the variables examined, only Whole responses accompanied by cognitive synthesis (W+) accounted for unique variance across multiple domains of WAIS-R assessed intellectual functioning, including overall functioning (FSIQ), verbal intelligence (VIQ), performance intelligence (PIQ), perceptual organizational (Perceptual Organization factor), and attention (Freedom From Distractibility factor). Common Detail locations without cognitive synthesis (Do) were negatively predictive of the perceptual organizational factor of the WAIS-R. Correlations of the variables with WAIS-R intelligence factors revealed similar results; W+ was positively correlated across all domains of intelligence (excluding Verbal Comprehension), while Do was inversely correlated with factors of perceptual organization, VIQ, PIQ, and FSIQ. These results suggest perceptual problem-solving complexity is represented by W+ responses and simplicity is captured by Do responses.

The relationship between total Rorschach Responses (*R*), Determinant Blends (multiple features of the inkblot are integrated in formulating and articulating the percept), and WAIS FSIQ was examined in a study of 70 outpatient records (Wagner, Young, & Wagner, 1992). Pearson correlations were computed between *R*, Determinant Blends, and IQ, with significant correlations obtained for relationships between Blends with FSIQ and *R* with FSIQ. When *R* was partialled out, the correlation between Blends and IQ remained significant, although it decreased from .35 to .26.

In a systematic review of the Rorschach validity literature, Mihura, et al. (2013) meta-analyzed existing research on the 65 variables comprising the core of the Comprehensive System. Several variable-criterion relationships relevant to the present discussion should be noted. A validity coefficient of  $r = .33$  for the Human Movement variable was obtained when evaluated by externally assessed criterion measures of mental abilities such as planning, imagination, and empathy. Synthesized responding as a marker of concept integration abilities achieved a validity coefficient of  $r = .37$ . A validity coefficient of  $r = .22$  was obtained for Vague responses as an index of unsophisticated thinking. Perseveration responses were found to have a validity coefficient of  $.29$  against the criterion difficulty shifting cognitive sets. Finally, a validity coefficient of  $.28$  was obtained for the variable-criterion relationship between Organizational Frequency and the ability to sustain cognitive effort. All reported validity coefficients achieved statistical significance.

Because psychiatric patients frequently experience simultaneous emotional and neuropsychological disturbance, Zillmer and Perry (1996) examined the relationship between neurocognitive abilities assessed by traditional neuropsychological measures and psychological disturbance assessed by selected variables from the Rorschach Comprehensive System and the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1967). The neuropsychological battery included the Wechsler Adult Intelligence Scale-Revised and selected tests from the Halstead-Reitan Neuropsychological Test Battery (i.e., Finger Tapping Test, Grip Strength, Trail Making Test; Reitan & Wolfson, 1993), the Short Category Test (Wetzel & Boll, 1986), Peabody Individual Achievement Test-Reading Comprehension (Dunn & Markwardt, 1970),

Grooved Pegboard Test (Matthews & Klove, 1964), and the Russell-Modification of the Wechsler Memory Scale-Revised (Russell, 1975). After removing conceptually redundant variables and those violating statistical assumption, 11 neuropsychological variables, 8 clinical scales from the MMPI, and 8 Rorschach indices were analyzed by exploratory factor analysis in a sample of 190 psychiatric inpatients. Results revealed a 6-factor solution accounting for 65% of the total variance (the variables defining each factor are listed in order of factor loading); Factor 1, MMPI Somatic/Neurotic, composed of MMPI scales 3, 1, 2, and 4; Factor 2; Rorschach Response Process, consisting of Organizational Activity, Whole responses, response total ( $R$ ), and Human Movement; Factor 3, MMPI Severe Disturbance, defined by MMPI scales 8, 6, 7, and 9; Factor 4, Motor/Visuospatial-Learning, comprised of Trail Making B, Object Assembly, and Block Design; Factor 5, Verbal-Comprehension, composed of Vocabulary, Information, Peabody Individual Achievement Test-Reading Comprehension, and WMS-R Verbal Memory; Factor 6, Rorschach Perceptual Accuracy, defined by Conventional Form, Popular responses, Distorted Form, and Conventional Pure Form. The 6 factors were correlated with each other, revealing that Factor 2, Rorschach Response Process, was associated with the neuropsychological factors Motor/Visuospatial Learning ( $r = .39$ ) and Verbal Comprehension ( $r = .36$ ). No other substantial personality-neuropsychology factor relationship was demonstrated. The two neuropsychological factors had a correlation of  $r = .44$ .

Zillmer and Perry's (1996) analysis evidences that a factor defined by Rorschach measures of organizational complexity and abstraction represents a unique dimensional cluster independent of the visuospatial measures encompassed by Factor 4 (i.e., Block

Design and Object Assembly). This factor is moderately correlated with neuropsychological measures of cognitive functioning; the magnitude of correlation between Rorschach Response Process and Motor/Visuospatial Learning (.39) was nearly as large as the correlation between the two neuropsychologically defined factors (.44). Together, these findings indicate that despite being somewhat related, neurocognitive performance as measured by highly structured, clearly defined tasks with minimal response options (features characteristic of traditional neuropsychological tests) meaningfully differs from performance on a task that is somewhat ambiguous, open ended, and self-directed. This is a significant distinction; everyday life is defined by varying degrees of structure and self-directive requirements and certain assessment procedures better approximate these varied contextual demands. Key differences in assessment procedures critically influence the nature of obtained data and the conditions under which results are likely to generalize.

Meyer (2016) utilized an archival data set to correlate Rorschach scores with measures of neuropsychological functioning in a youth sample. Rorschach variables were correlated with indices from the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1981), the Developmental Test of Visual-Motor Integration (VMI; Beery & Buktenica, 1982), the Trail Making Test (Reitan & Wolfson, 1985), the JOLO, the Bender Visual Motor Gestalt Test (Bender, 1938), and the ROCF. Results revealed an expected pattern of association between Rorschach variables of synthesized responding, organizational activity, perceptual accuracy, and perceptual complexity, supporting the validity of analyzed Rorschach variables as indexes of visuo-perceptual sophistication.