Using Factor Patterns to Augment the Interpretation of Continuous Performance Tests in a Child Population

By

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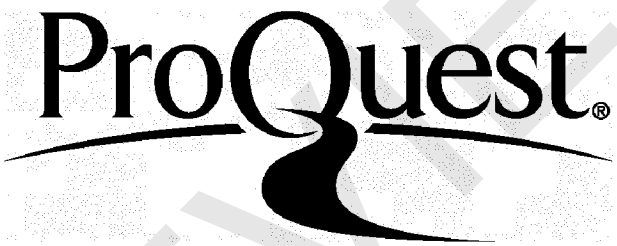

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CHAPTER I.

INTRODUCTION

This paper focuses on one neuropsychological test commonly used in the assessment of attention, the Continuous Performance Test (CPT). On the CPT task (Rosvold, et al., 1956) the subject is required to attend for a period of time and respond to target stimuli. Letters or numbers flash briefly on the screen and the subject is required to press a button every time the target stimulus appears. Since the introduction of the CPT in the 1950s the test has become an important measure used in both research and assessment. This study focuses on one version of the CPT, the Conners (CCPT), (Conners, 1992; 1995; 2004), which is a CPT paradigm that is commercially available and frequently used in neuropsychological assessment. The CCPT shows acceptable reliability (Conners, 2004; Hommack & Riccio, 2006). Validity studies however have been mixed; some have shown that ADHD groups do demonstrate poorer performance in comparison to controls (Conners, 1995, 2004), while other studies show little overlap between the CCPT and other measures of attention (Weis & Totten, 2004; McGee, Clark & Symons, 2000). However, it is suggested that parameters of the CCPT, which require a high number of responses, may be a better measure of sustained attention in comparison to other CPT tasks that require less total responses and may better measure vigilance (Egeland & Kovalik-Gran, 2010a). Recent research with adults suggests that a factor analytic model of attention based on the scores reported for the CPT can better aid in differential diagnosis (Egeland 2010b; Egeland 2007; Egeland 2003) , although this line of research has yet to be implemented with a child sample. Thus, this paper aims to investigate the factor structure of the CCPT in a clinical child population. Furthermore,

the present study aims to investigate the correlates of those factor analytically derived scores with parent and therapist ratings of attention, depression, and psychotic symptom and to see what combination of factor scores best discriminates those with high ratings on ADHD symptoms from those who do not show these ratings, but show signs of dysfunctional behavior in other areas.

CHAPTER II.

LITERATURE REVIEW

History of the CPT

Rosvold, Mirsky, Sarason, Bransome and Beck, at Yale University, developed the first test called a CPT in 1956 for use in assessing brain damage. They developed this test to capture an expected decline in sustained attention and vigilance by those suffering from brain damage. In developing the CPT they sought to devise a test that would capture a decline in vigilance and sustained attention over time (Rosvold, et al., 1956).

In the original CPT paradigm letters were presented one at a time and the subject was required to press a lever every time a target stimulus, in this case the letter X, appeared. Letters were presented with a fixed interstimulus interval (ISI) of 920 milliseconds. Simultaneously the subject was to inhibit responses to any stimulus other than the letter X leading this to be termed X-type CPT, or Target-Only. Rosvold and colleagues (1956) also designed an AX-type CPT in which the subject was to respond to the letter X only when it is immediately preceded by the letter A. This has also been called a Signal-target paradigm (Borgaro et al., 2003). Rosvold et al.'s results showed that the X-type CPT identified subjects with brain damage and showed differences between brain damaged subjects and controls; the differences increased with the difficulty level of the AX-type CPT (Rosvold, et al., 1956).

Types of CPTs

Since its introduction the CPT has been used in the study of attention and the original paradigm has been modified significantly. Many different versions of the task

now exist, and some speculate that there are now over 100 variations of the test in use (Greenberg & Waldman, 1993). A review of the literature yields significant variability in what is termed a Continuous Performance Test. These differences encompass many aspects of the paradigm, including stimulus, use of auditory/visual modality, time-related factors, and scores reported. Research has shown that utilizing different versions of the CPT will have an effect on the performance as measured by CPT scores (Schachar, Logan, Wachsmuth & Chajczuk, 1988a; 1988b). Research looking at the inter-correlations between different types of CPT found correlations between the different types;however the levels of correlation was not significant or near what would be expected of test-retest reliability, indicating that they are measuring similar constructs, but they are in fact different tests (Borgaro et al., 2003).

Stimuli

Versions of the CPT vary in stimulus presentation. For a stimulus some paradigms use the original X, and some vary the stimulus and utilize, for example, a picture (Garretson et al., 1990), a number (Friedman, Vaughan & Erlenmeyer-Kimling, 1978), a word or non-word (Earle-Boyer, Serper, Davidson & Harvey, 1991), and color (Garfinkel & Klee, 1983). Utilizing different targets, such as these outlines, was shown to impact performance (Earle-Boyer et al., 1991; Harper & Ottinger, 1992).

The type of task can also vary. Types of CPTs include Rosvold et al.'s (1956) original X-type, or AX-type CPT. In addition, there are also paradigms, such as the Conners' CPT (CCPT), termed the non-X type, which ask the subject to respond to all stimuli expect the target, i.e. the X (Conners, 1992, 1995). In some version of the test

researchers use an XX-type (Fitzpatrick, Klorman, Brumaghim & Borgstedt, 1992), also termed Identical Pairs, or IP-type, where the target stimulus is two stimulus sets that appear after the other (e.g., Cornblatt, Lenzenweger, & Erlenmeyer-Kimiling, 1989). This paradigm developed in working with first degree relatives of schizophrenia patients, as it was determined that the X and AX-types were often too simple (Cornblatt & Erlenmeyer-Kimling, 1985; Erlenmeyer-Kimling & Cornblatt, 1992). Due to the increase in demands on working memory, it is expected that of the three paradigm types, XX, or Identical Pairs would be more challenging than the Signal-Target or AX type, which would be more complex than the Target Only, X-type. Studies have compared performance on the X-type to performance on the AX-type CPT and found the AX-type to be more difficult (Rosvold et al, 1956; Goldstein, Rosenbaum & Taylor, 1997). Similarly, the X-CPT is easier than the XX-type as measured by responses time (Friedman et al., 1978, 1981). Further research controlled for practice effects and varied the order of tasks presented while the findings remained consistent; performance on AX and XX-types decreased over time in contrast to X-type CPTs (Schachar et al 1988a).

Auditory/Visual Modality

Another variable in the CPT paradigm revolves around the use of visual and auditory modalities to present the target stimulus. Rosvold et al.'s (1956) original paradigm was only a visual task, however later versions included auditory variations, (e.g. Riccio, Cohen, Hynd & Keith, 1996), while some versions incorporate auditory and visual demands in the same CPT (e.g., Sandford & Turner, 1995). Studies have shown that subjects exhibit poorer performance on auditory modalities than visual types (Baker,

Taylor & Levya, 1995) and studies with children have shown that subjects make more commission errors when the task is auditory (Sandford & Turner, 1995).

A further variation in paradigm is the quality of the stimulus presented. In working with relatives of schizophrenics who were not clinically impaired there was a need to increase difficulty the difficulty of the task, leading to the Degraded Stimulus CPT, developed by Nuechterlein (1983), in which the stimulus can be blurred or degraded and is thus more difficult to see. Evans (1988) compared performance on the following CPT types: X-type, X-type degraded, X-CPT with feedback after each response and not-X-type and found the degraded condition to be the most difficult. In this study, the X-type was again the easiest (Evans, 1988).

Time Variables

Furthermore, today's CPTs often measure changes in responding over time. The first historical study to suggest that this might be a useful variable to be studied appeared in 1969 (Anderson, Siegal, Fisch & Wirt, 1969). In a sample of children errors greatly increased toward the end of the six and a half minute task, which led the researchers to recommend that future CPT studies be lengthened in order to see this effect, which they termed sustained attention (Anderson, Siegal, Fisch & Wirt, 1969). This parameter varies greatly among CPTs: the MINI-CPT (Bremer, 1989) lasts three minutes and is the shortest version of the task available. At the other extreme is a common paradigm, the Test of Variables of Attention (TOVA), which is 22 minutes long. Sustained attention is likely to vary as well as a function of the duration of the task itself, which differs greatly among test labeled as CPTs (Riccio, Reynolds & Lowe, 2001).

Building upon this, today, many CPTs score reports are divided into time blocks to measure sustained attention in each block and capture the variability in the subject's ability to consistently respond to the stimuli presented (e.g. Conners, 1992, 1995). There are researchers who argue that a measure of the standard error of reaction time is the best indicator of consistence that is yielded from the CPT (Riccio, Reynolds & Lowe, 2001). Other ways of analyzing sustained attention include looking at the change in reaction time as measured by slope throughout the task as well as comparing changes in blocks over time (Gordon Systems, Inc., 1991). These aspects of attention and executive control are not unitary and the test may assess different aspect of attention within the CPT task (Egeland & Kovalik-Gran, 2010a).

Another difference in paradigms is the time lapse between stimuli, or the interstimulus interval (ISI), which can be short, long or variable in length. For example, the Conners CPT varies the ISI for different blocks of the task (Conners, 1992, 1995). Furthermore, paradigms differ in how long each stimulus is presented (Riccio, Reynolds & Lowe, 2001).

The effects of both ISI and duration of stimulus presentation were examined by Chee and colleagues (1989). They discuss another variable, stimulus onset asynchrony (SOA), which is the interval between the onset of one stimulus and the next. This is essentially the sum of the ISI and the duration of stimulus presentation. Trials with the longest and shortest ISIs that had decreased duration of stimulus display resulted in a decrease in correct hits and increased commission errors in the trials with the longest ISIs. Trials with shorter display times had more commission errors as opposed to those with longer display durations (Chee et al., 1989).

Target/Noise Variables

Another useful way of differentiating CPT paradigms that is discussed in the literature is to understand whether they have a low or high signal, or target, to noise ratio (Egeland & Kovalik-Gran, 2010a). This ratio is the percent of presented stimuli that require a response, and are the target, versus those stimuli presented that are not the target stimulus, and are thus considered just noise. Some CPTs have a high signal to noise ratio, due to the high number of required responses over time by the subject these types of tasks may be influenced by fatigue, as opposed to those tasks that do not require a high number of responses and have a low signal to noise ratio (Egeland & Kovalik-Gran, 2010a). Furthermore, CPT tasks with a low signal to noise ratio may not be true CPT tasks and may be measuring vigilance, while those with a high signal to noise ratio may be true CPT tasks (Egeland & Kovalik-Gran, 2010a). The high number of responses required in high signal to noise CPTs may also decrease chance error (Conners, 2004).

Egeland & Kovalik-Gran's (2010a) definition of signal to noise ratio is different than noise as incorporated into the parameters of the CPT task itself. For example, some tasks include a distractor condition where competing stimuli appear on screen along with the target stimuli (e.g. Gordon Systems Inc., 1991). Crosby (1972) investigated CPTs that incorporated distractors in a child population, both auditory and visual in separate conditions in X and AX paradigms. His results showed decreased performance in both distractor conditions. Sykes, Douglas, Weiss & Minde (1971) examined the effect of noise, both intermittent and white, on both X and AX CPTs with varied ISIs in a child population. Results showed that children demonstrated improved performance in the conditions with the longer ISIs, irrespective of noise condition.