THE UNIVERSITY OF MANITOBA

The Effect of Temperament and Arousal on Performance in a Cognitive-Perceptual Task in Children

by

John P. Cuff

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Abstract

A study was made to find relationships among temperament, arousal and performance on a cognitive-perceptual task in young children. Forty-six children, between four and six years of age, were rated by their mothers (or other primary care-giver) on the six scales of the Colorado Childhood Temperament Inventory (CCTI). Two cards, A and B, each with a distinct set of 10 different pictures from the Picture Completion test of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) were presented sequentially to the subjects. The first 23 subjects were given the cards in sequence A-B, while the second 23 subjects were given the cards in sequence B-A. For the first card, the children were required to pick out the missing object in each of the ten pictures on the card within a period of two minutes. They were not informed of the time limit nor was any pressure put on them to do well. For the second card, their task was the same but they were told of the time limit and certain socially based arousal factors were introduced that were designed to enhance arousal. During the presentation of both cards, the subject's GSR was recorded. The score on each card was the number of correct picture completions. The GSR score for each card was the highest GSR level attained during the two minute period of the card presentation. The results showed that performance variance was accounted for primarily by subject age and that GSR level was primarily a

function of the number of subjects tested: the more subjects tested, the lower GSR became. Only a slight relationship between GSR and performance was found. Of the six temperaments, only Attention Span-Persistence showed any influence on performance while none of them influenced GSR. Evidence suggested that habituation of GSR across and within subjects took place. Possible reasons were adduced to account for this and recommendations for a more controlled study were presented.

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Introduction

There has been, and continues to be, a great deal of controversy about just what personality is. Various theorists have emphasized different perspectives. It is perhaps safe to say that, generally, personality is viewed as an all, or nearly all, inclusive construct which attempts to encompass those major, stable behavior patterns, mood states, attitudes, etc., that most completely describe an individual over a long period of time. Temperament is an aspect of personality. While personality includes both inherited tendencies and learned or acquired attributes, temperament is mainly restricted to inherited tendencies (Buss and Plomin, 1975). Heredity is the single most important aspect of temperament for it separates it from other personality variables. Temperament deals less with the content of behavior than with its style; it is concerned with broad personality dispositions rather than highly specific traits.

Temperament as an innately determined variable has been around as a concept for millenia. During pre-scientific times the prevailing theories held that bodily fluids were responsible for different types of temperament. Examples of these include the belief that an excess of bile caused a person to be chronically angry and that black bile was the cause of a melancholic temperament (Buss and Plomin, 1975). In the twentieth century more scientific approaches were employed to study temperaments. Sheldon (1942) is famous for

his somatype theory which correlates each of three body types (ectomorph, endomorph and mesomorph) with a corresponding temperamental constellation. The theory, while possessing many intriguing aspects, does not rate highly as a theory of temperament because, among other deficiencies, it lacks a demonstration of inheritability of temperament type. Diamond (1957) advanced a theory that posited four temperaments that he felt could be derived from comparisons between man and his close animal relatives. They are Fearfulness, Aggressiveness, Affiliativeness and Impulsiveness. To the author's knowledge, no serious research has been conducted to adequately test this hypothesis.

Personality inventories have been the most frequently used method to attempt to narrow down, to a basic few, fundamental personality characateristics which would account for all other personality variables. Thurstone (1951), for example, did a factor analysis of the thirteen personality scores of the Guilford schedule and determined that there were seven factors represented: Active, Vigorous, Impulsive, Dominant, Stable, Sociable and Reflective. Several of these factors have reappeared through much subsequent research. However, the results of many of these types of studies often conflicted in that some traits or factors found to be central in some reports would not be so identified in others.

As can be deduced from the above, a consensus on what constituted the group of fundamental personality characteristics or temperaments was difficult to develop, let alone

support, with any convincing evidence. The method, commonly used in many of these studies, of inventorying and factor analyzing the behaviors and attitudes of individuals as reported on self-report questionnaires, simply did not produce the types of results on which any confident statements about temperament could be made.

Nevertheless, what is important to note at this point is that all of these attempts carried with them, either implicitly or explicitly, the construct of the inheritance of basic traits or temperaments as the foundation of all other personality variables. Another point to be made is that these types of studies, while making some contribution toward identifying several potential temperaments, failed to make a strong case for any one or group of temperaments. In many studies the crucial genetic factor was poorly manipulated -- if at all. This accounts for much of the confusion and contradiction that plagued research in this area for so long.

Fortunately, as research continued in the field, the role of heredity was examined more and more. In this context it is appropriate to introduce at this point a definition of temperament by Allport (1961) which is generally accepted by contemporary researchers in the field and is the definition for purposes of this thesis.

> "Temperament refers to the characteristic phenomenon of an individual's nature, including his susceptibility to emotional stimulation, his customary strength and speed of response, the quality of his prevailing mood and all the peculiarities of fluctuation and intensity of mood, these being

> phenomena regarded as dependent on constitutional make-up and therefore largely hereditary in origin." (p. 34)

It was through twin studies that various temperaments began to emerge as clearly genetically based. The twin study utilizes measurements of personality and behavior with two types of twins. Monozygotic twins (MZ) share 100% of their genes while dyzygotic twins (DZ) share 50% of their genes. Both types share the same uterine environment at the same time and arrive in the external environment at virtually the same time. Since they presumably share the same rearing environments at the same time, it is theorized that if MZs measure more closely (at a statistically significant level) on a personality or behavioral variable than do DZs, that difference must reflect a genetic or hereditary influence and that variable is a candidate for being designated a temperament.

The twin method has been used in many studies. Gottesman (1963) found significant differences between MZs and DZs on five scales of the Minnesota Multiphasic Personality Inventory (MMPI): Depression, Psychopathic Deviate, Psychasthenia, Schizophrenia and Social Introversion. Gottesman (1966) also found all 18 intraclass correlations for MZ twins on the California Psychological Inventory (CPI) were significant at the .01 level compared to 9 for the DZs. Some of the traits -- Sociability, Dominance, Self-Acceptance, Socialization, Social Presence, Good Impression and Psychological Mindedness -- were found to be significantly associated

with genetic factors. Scarr (1966b) found intraclass correlations were higher for MZs than DZs on measures of Activity Motivation which include, among others, reaction times, number of activities, anxiety and patience. She also found (Scarr, 1969) a strong genetic component for social Introversion-Extraversion. Eysenck (1956 and 1967) also found evidence for a genetic component for extraversion. Owen and Sines (1970) found evidence, using the Missouri Children's Picture Series with twins, that there is a genetic influence for inhibition, social introversion-extraversion, activity level and aggressiveness. Salzano and Rao (1976) found, using Greiger's Characterological Questionnaire with twins, that for 14 of 20 sets of data, the genotype contributed more than 50% of the variance. Horn, Plomin and Rosenman (1976) using the CPI found that some of the genetic factors were Conversational Poise, Compulsiveness and Social Ease. The genetic factors accounted for most of the variance. Dworkin, et al. (1977) found significant genetic variance in the organization of personality as reflected by the CPI and MMPI. Matthews and Krantz (1976) found evidence of a genetic contribution to Type A behavior in sets of same sexed twins based on questionnaire responses. Matheny and Dolan (1975) observed young twins in unstructured free play and relatively structured test taking and found that MZs remained significantly more similar in adaptability from one setting to another and across ages but only in the playroom. They concluded that situation variables contribute to the low stabilities frequently reported for

personality dimensions, but that the direction and degree of behavioral change are genetically conditioned.

As can be seen from the above, these studies have found genetic influences in many personality variables, but progress was slow in determining exactly which traits are temperaments as opposed to those personality variables that are merely closely related expressions of those temperaments. However, with the publication of two books in the mid-seventies, order began to appear in what seemed to be an incoherent, super-abundance of genetically based personality traits.

Ironically, one of the big breakthroughs in the study of temperament came about through a study that, for the most part, did not use twins. In what has come to be known as the New York Longitudinal Study (NYLS), Thomas,et al. (1970) and Thomas and Chess (1977) have been following, since 1956, a group of 141 children in New York City that is predominantly middle class. In addition, they began following a group of 95 working class Puerto Rican children, a group of 68 prematurely born children, a group of 52 mildly retarded children and, in 1964, a group of 243 children with congenital rubella. Beginning at the age of two to three months, the child's behavior was monitored by gathering detailed descriptions of it through structured interviews with their parents at regular intervals. There were independent checks by trained observers to confirm the reliability and significance of the parents' observations. Using an inductive content analysis of the parent interview protocols for the first 22 children studied,

they identified nine categories of temperament that could be scored on a low-medium-high scale. They are: 1) Activity - the level and extent of motor activity; 2) Rhythmicity - the degree of regularity of functions such as eating, elimination and the sleep-wakefulness cycle; 3) Approach-Withdrawal - the response of either approaching or withdrawing from a new object or person; 4) Adaptability of behavior to changes in the environment; 5) Threshold of Responsiveness - the intensity level of stimulation that is necessary to evoke an observable response; 6) Intensity or energy level of responses; 7) Quality of Mood - the amount of joyful, pleasant, friendly behavior versus unpleasant, crying and unfriendly behavior; 8) Distractability - the degree of the child's distractability from what he is doing; 9) Attention Span-Persistence - the length of time a child pursues an activity and the continuation of an activity in the face of obstacles.

They found three temperamental constellations through qualitative analysis. The first is the Easy Child, characterized by regularity; positive approach to new stimuli; high adaptability to change and mild or moderately intense, positive mood. These children have regular sleep and feeding schedules; take to new foods easily; smile at strangers; adapt easily to school; accept frustration with little fuss and accept the rules of new games with no trouble. This group made up 40% of the sample.

The Difficult Child which comprised 10% of the sample

displayed irregularity in biological functions; negative withdrawal response to new stimuli; slow or no adaptability to change; intense, negative mood expressions. These children have irregular sleeping and feeding schedules; are slow to accept new foods; have prolonged adjustment periods to new routines, people or situations; frequent and loud crying and a tantrum response to frustration.

A third constellation which comprises 15% of the sample is called the Slow-To-Warm-Up Child and is characterized by a combination of positive and negative responses. These children have a low activity level; tend to withdraw on their first exposure to new stimuli; are slow to adapt; negative in mood and have a low intensity of reaction to situations. The remaining 35% of the sample did not have traits that could be categorized into any constellation.

Carey (1973) developed a questionnaire for rating infant temperament based on the nine categories that came out of the NYLS study. Thomas and Chess (1977) also present a questionnaire to be used with teachers and parents of children 3-7 years of age. It too is based on the nine categories of the study.

Support for the genetic component of the nine categories comes from a study by Torgersen (1974) as cited by Thomas and Chess (1977). She conducted a twin study that found three of the categories -- Regularity, Threshold and Intensity -- had a statistically significant, genetic component at two months of age while at nine months, all nine categories were significant.

Torgersen believes that the difference can be accounted for by viewing the behavior of the infant at two months as reflecting gestation and birth experience effects, while at nine months the infant was displaying his temperament in a much clearer fashion.

Buss and Plomin (1975) have posited four temperaments. They are: 1) Activity which is the total energy output. A high activity individual is busy, seems tireless and vigorous. 2) Emotionality which is equivalent to intensity of reaction. A highly emotional person is easily aroused and tends to have an excess of affect such as temper, fearfulness and violent mood swings. 3) Sociability which is primarily a strong desire to be with others. 4) Impulsivity which is the tendency to respond quickly as opposed to inhibiting a response. There are subcomponents to this which are: a) resisting versus giving in to urges, impulses or motivational states and b) responding immediately and impetuously to a stimulus versus holding back and planning before making a move.

The adaptive aspects of activity can be seen by viewing it as motive power to do things and work toward goals. In man's early evolution, and even now, the activity level often meant the difference between full or empty stomachs. And yet there are environmental situations in which low activity is also adaptive such as in extremely cold conditions where long periods of inactivity are conducive to survival; or in very hot climates where high levels of activity are a danger to health. These factors can be seen with great clarity in the

animal world where species vary greatly in the activity level of their members. In addition, Buss and Plomin (1975) cite several studies that provide support for a genetic factor in Activity (Willerman, 1973; Buss, Plomin and Willerman, 1973; Plomin, 1974; Scarr, 1966b; Owen and Sines, 1970; Schoenfeldt, 1968). They acknowledge that research is needed to establish the course of Activity temperament through development.

Sociability, as a temperament, is concerned with seeking others; with a preference for the company of others as opposed to being alone. It is concerned more with public relationships than private, intimate ones. While having a strong need for others, the sociable person also is warm and responsive in relation to others. Thus sociability includes the directional component of movement toward others and the warmth component of responsiveness to others. Sociability, especially for humans, is an adaptive trait. It facilitates the organization and maintenance of groups for defense, child rearing, and division of labor. Observation of many animal species, especially primates which are closest to man, indicates that sociability is an important factor in group, and therefore individual, survival. The genetic influence for the temperament has been demonstrated in several studies, e.g., Freedman (1965); Wilson, Brown and Matheny (1971) and Scarr (1966a). There is also evidence for its presence in childhood (Schaefer and Bayley, 1963) and adulthood as measured in longitudinal studies (Kelly, 1955; Tuddenham, 1959).

Impulsivity is reported by Buss and Plomin (1975) to be

questionable as a temperament, although they tend to believe that it is one. They find the evidence about half and half, for and against, a genetic influence for it, e.g., Vandenberg (1967) and Vandenberg (1962). There is no strong evidence for this temperament being stable throughout development. However, there is evidence for its presence in adulthood as demonstrated in personality inventories (Barratt, 1965; Zuckerman, 1971). From an adaptive standpoint, different environments would favor different levels of impulsivity: in impoverished environments, impulsivity would enhance survival chances by maximizing opportunities for food, mates, etc.; while low levels of impulsivity would also enhance survival chances in highly dangerous environments.

The final temperament, Emotionality, will be given special and extensive consideration below.

From their research and theorizing, Buss and Plomin (1975) developed a temperament inventory (EASI). This went through a couple of item revisions so that the final product, the EASI Temperament Survey (EASI III) had 54 items tapping various elements of the four temperaments.

Plomin (1976) studied the EASI on 137 pairs of young twins, 2 to 6 years of age, and their parents for a total of 548 individuals. Parents rated themselves and their spouses on an adult version of the EASI and their children on a child version of the EASI. The results showed that, for all 11 EASI scales, MZs were significantly more similar than DZs. This confirmed an earlier study (Buss, Plomin and Willerman,

1973).

What obtained at this point were two major constructs of temperament competing with each other. Although they agreed on many points, there were also disagreements. In a major study, Rowe and Plomin (1977) tested the NYLS and the EASI temperaments together with the idea of merging the two into a comprehensive new instrument. Six items were written to tap the nine temperaments of the NYLS and were added to the twenty items of the short form of the EASI to create a 74 item questionnaire. The items were arranged in random order and were rated on a scale of 1 ("Not at all like the child") to 5 ("a lot like the child"). Ninety-one mothers of twins rated their 182 twins. Retest reliabilities were obtained by mailing another questionnaire to randomly selected mothers who were asked to rate one of their randomly selected twins a second time.

A factor analysis was done on the completed questionnaires. The results of this analysis for the NYLS items showed seven factors: Reaction to Food; Attention Span-Persistence; Sociability; Stubbornness; Sleep Rhythmicity; Reactivity and Soothability. They accounted for 63% of the common variance and 40% of the total variance. The results for the EASI items showed factors of Activity, Sociability, Emotionality and Impulsivity. These accounted for 93% of the common variance and 53% of the total variance.

The NYLS and EASI items were factor analyzed together to determine their joint factor structure. The results showed

six factors: Sociability; Emotionality; Activity; Attention Span-Persistence; Reaction to Food and Soothability. The six factors accounted for 56% of the common variance and 36% of the total variance. These were the six scales of the new instrument, the Colorado Childhood Temperament Inventory (CCTI). (See Appendix A.) It is a 30 item questionnaire, with five items for each factor, that is a parental rating instrument for children 3-6 years of age. There seem to be no real gender differences in the responses to the instrument. Plomin and Rowe (1977) found a genetic influence for each of the temperaments with the exception of reaction to food. Thus, for at least five of the temperaments in the CCTI, there is a good foundation in theory, factorial integrity and genetic influence.

Since Emotionality plays such a prominent role in this study, it will be, as stated above, treated in more detail than the other temperaments.

Emotionality is vital for survival in that preparation for either "fight or flight" is necessary for dealing with the environment. This can be seen especially clearly in animals. The temperament of Emotionality will be considered under the more basic and comprehensive variable of arousal, the behavioral manifestations of which the CCTI seeks to measure with its Emotionality subscale. Arousal is here understood to be any measurable psychophysiological change such as in heart rate, respiration, blood pressure, electroencephalographic recordings (EEG), galvanic skin response (GSR), etc. which

accompany any psychophysical change in an organism due to internal or external stimuli.

Arousal is involved in almost all behavior; at the basic level of attention and orientation to stimuli, arousal plays the chief role (Lynn, 1966). Its neurophysiologic mechanism lies in the reticulo-thalamo-cortical system. Lynn (1966) has summarized the research in this area the results of which point to the following sequence.

Non-specific stimulation from the sensory tracts via the collateral afferents activates the reticular formation and reaches the cortex via thalamic connections. If the stimulus is new, the cortex sends down excitatory impulses to the reticular formation. The activation of the reticular formation from both these sources initiates the orientation reaction. If the stimulus is a familiar one, it matches a model in the cortex which does not send excitatory impulses to the reticular formation but does block the excitatory non-specific effects via the collateral afferents. Thus the orientation response does not take place. In either case the cortex must analyze the incoming stimulus.

Aside from the simple turning towards the source of the novel stimulus which is the most apparent aspect of the orientation response, there are several physiological changes that indicate generalized arousal. The pupil dilates; there is an increase in electromyographic muscular electrical activity; the EEG changes towards increased arousal with faster and lower amplitude activity; vasoconstriction occurs in the limbs

and vasodilation in the head; the galvanic skin response occurs; respiration changes -- first a delay, then an increase in amplitude and a decrease in frequency; and changes in heart rate occur.

There is a generalized orientation reaction in which there is EEG desynchronization over the whole of the cortex with the increase in arousal lasting for a long period (an hour or so) and habituating quickly, usually between 10-15 trials. This is called the tonic arousal reaction. With further repetitions of the stimulus, the generalized orientation reaction becomes habituated and there remains the localized orientation reaction. In this, the EEG desynchronization is confined to the cortical area of the particular sensory modality and there are no EEG effects in the rest of the cortex; the reaction lasts for about one minute and is more resistant to habituation, lasting for about 30 trials. Stimulation of the reticular formation by implanted electrodes reproduces both the autonomic and EEG components of the orientation reaction while lesioning of this area results in apathy, somnolence, hypokinesis and often a comatose state.

Twin studies (Eysenck, 1967; Vandenberg, 1965; Block, 1967) have provided genetic support for Emotionality as a temperament. Studies have indicated that there are differences in infants in Emotionality responses (Birns, 1965; Bridger and Birns, 1968; Korner, 1971). Walker (1967) found one year stability for third and fourth grade children on measures of fearfulness and emotional stability. Guilford

(1959) extracted a "nervousness" factor from several personality inventories as well as a general emotionality and "hypersensitivity" factor.

There is also evidence for individual differences in arousal which is the physiological substrate of the behaviors measured in the CCTI for the Emotionality temperament. Lipton et al. (1961) found individual differences in neonate cardiac reactivity to a stimulus. Richmond et al. (1962) also found individual differences in neonates in their ability to restore their cardiac rates to prestimulus levels, i.e., their homeostatic capacity. Bridger et al. (1965) studied neonate cardiac rate and behavioral responses to the application of a cold disc and a loud sound. All the behavioral ratings were correlated with heart rate but the rating of overall excitation was found to be a better indicator of heart rate than other separate components. For both heart rate and overall behavioral excitation there were significant individual differences among the neonates tested with regard to the level of excitation produced by the stimuli. Vandenberg (1965) found differences in heart rate and respiration between MZ and DZ twins in response to stress producing stimuli. Failure to find any GSR differences were attributed to technical factors in the experiment. Voronin and Sokolov (1960) found wide individual differences in several EEG and other physiologic measurements of the orientation reaction.

Arousal is also related to performance. Hebb (1955) and Malmo (1959) have described the inverted U effect in

which an organism's performance on a task is a function of its arousal level. As arousal increases so too does performance until an optimal level is achieved. If arousal increases much beyond this point, performance declines and continues to decline as a function of the increasing arousal.

The purpose of this study was to find some of the relationships among temperament, arousal and performance on a cognitive-perceptual task in children 4-6 years of age. In order to do this, appropriate measurements of these three variables were required. The Colorado Childhood Temperament Inventory was considered, on the basis of the data presented above, to be a good instrument for measuring temperament. The GSR was chosen to measure physiologic arousal. Brodsky and Brodsky (1978) have made a convincing case for the use of an interval scale with the GSR using a base level of zero. This is possible since it has been found that GSR does not conform to the Law of Initial Value.

The Picture Completion Test of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) was chosen as an appropriate cognitive-perceptual task. The format of clustering two groups of ten pictures each on separate cards will be described more fully in the Methodology section. Sattler (1974) writes that the test:

> "...involves recognizing the picture, appreciating its incompleteness, and determining the missing part. It is a test of the ability to differentiate essential from non-essential details, and requires concentration, reasoning (or visual alertness), and visual organization and visual memory. Thus, many psychological processes enter into the child's performance, including perception, cognition,

> judgment, and delay of impulse (Taylor, 1961)...The time limit on the subtest is important, since it places additional demands on the examinee." (p.182)

He describes the test's Structure of Intellect Classification as

> "...CFU (Cognition of Figural Units--the ability to perceive or recognize figural entities) and EFS (Evaluation of Figural Systems--the ability to evaluate a system of figural units that have been grouped in some manner). Every item receives both classifications." (p. 182)

The definitions of these structures are given as follows:

> "C Cognition. Immediate discovery, awareness, rediscovery, or recognition of information in various forms; comprehension or understanding.
>
> E Evaluation. Reaching decisions or making judgments concerning criterion satisfaction (correctness, suitability, adequacy, desirability, etc.) of information.
>
> F Figural. Information in concrete form, as perceived or as recalled, possibly in the form of images. The term "figural" minimally implies figure-ground perceptual organization. Visual spatial information is figural. Different sense modalities may be involved; e.g., visual kinesthetic.
>
> U Units. Relatively segregated or circumscribed items of information having "thing" character. May be close to Gestalt psychology's "figure on a ground."
>
> S Systems. Organized or structured aggregates of items of information; complexes of interrelated or interacting parts." (p.457)

The functions of the Picture Completion Test of the WISC-R which is for an older age group but which has overlay with the WPPSI are described as "Ability to differentiate

essential from non-essential details; concentration; reasoning; visual organization." (p. 443) For the WPPSI itself, the functions of the test are described as "Alertness to details; visual memory; reasoning; concentration." (p.453) In general, "...the Picture Completion...load[s] on the Perceptual Organization factor (Cohen, 1959)." (p. 197)

The test cards provide a complex stimulus whole which challenges perceptual discrimination and cognitive organization and operations. The experimental task can be objectively scored and was thought to have a sufficient degree of difficulty to produce a probable increase in arousal. Walsh and Cummins (1975) reviewed literature which indicates that arousal is crucially involved in environmentally induced brain changes that accompany such behaviors as exploration and social interaction. Berlyne (1960) reports that novelty, complexity, uncertainty and incongruity are among the characteristics that elicit the orientation response. Berlyne et al. (1963) found that there was an increase in GSR when subjects were highly attentive to more complex and incongruous visual patterns. The test cards, for young children, possess all of these characteristics and it was felt that they would elicit the orientation reaction and its accompanying arousal.

Furthermore, there are relationships between perceptual-cognitive operations and arousal. Lynn (1966) reports that, in the orientation reaction, not only does the pupil dilate but that there are photochemical changes in the retina

lowering the threshold for intensity of light. He also reviewed evidence showing that the orientation reaction, which is accompanied by arousal, produces increased discriminatory power of the cortex and the sensory system. Sensory receptors have also been shown to be made more sensitive by neural impulses from the reticular formation and the cortex. Schonpflug (1966) found that enhancement of arousal accentuated perceived stimulus properties. Lindsley (1970) summarized findings showing that impulses

> "...originating in various cortical regions which are directed into the central core of the reticular formation represent the corticifugal pathways by means of which it is possible to stimulate the cortex and record evoked potentials in the reticular formation (French, et al., 1955). Such pathways are presumed to mediate the effects of cortical activity such as might be engendered by thinking, worry, apprehension, and the like, activities which tend to reexcite the reticular activating system and in turn tend to make wakefulness and arousal persist..." (p. 158)

Beatty and Wagoner (1978) using pupillometry found that higher brain processes require greater amounts of central nervous system vigilence or activation for their execution. Thus there was a strong basis for expecting that the stimulus properties of the cards and the cognitive demands of the task would induce arousal.

In addition to the effect on performance that the increase in arousal caused by the above described factors would produce, it was also anticipated that the social motivating factors built into the experimental design, via the instructions given to the child as described below in the Methodology section, would also increase arousal and have an

effect on performance. In this design, the child would be in a state of conflict trying to perceive as many missing objects as possible from complex stimuli while trying to do it in as short a time as possible. In addition, the child would be trying to achieve a standard that is presented as the norm below which the child is expected not to fall. Fenz (1964) studied physiological arousal in a stress and conflict situation with social variables involved. He found increases in GSR in response to cues associated with the performance task (parachute jumping). He also found a deficit in performance as arousal increased; this followed the inverted U model. There was also a high positive correlation between GSR and reaction time which is of relevance to this study. Thus it was thought that, in this study, increasing levels of GSR should be correlated with performance scores which will be described in the Methodology section below.

Amsel et al. (1977) found increases in rat arousal as a result of non-reinforcement. It was thought possible that the child's difficulties with the task, given the time period allowed for solution, would be experienced as non-reinforcement and therefore increase arousal or act as a motivator which would increase arousal.

Thus it was expected that all of these factors would tend to increase arousal which would increase performance and that the performance scores and GSR levels would, in part, be a function of the level of temperamental Emotionality as measured by the CCTI.

It was felt that temperamentally based Emotionality would have to account for at least 15%-16% of the variance in the performance scores to be considered an important variable. This study, then, had as its purpose the testing of the following specific hypotheses: that there is a statistically significant, positive correlation of at least .38-.40 (a) between scores on the Emotionality subscale of the CCTI and performance scores on the experimental task; (b) between scores on the Emotionality subscale of the CCTI and GSR measurement; (c) between performance scores on the experimental task and GSR measurement. In addition, the study sought out empirical relationships, as measured by correlation coefficients, among the temperament scores of the CCTI, levels of GSR measured arousal and performance scores on the experimental task. For these, no specific hypotheses were advanced.

Methodology

Subjects

A total of 46 children was used as subjects for this study. They were recruited from various daycare centers, nursery schools and kindergartens in Winnipeg. There were 23 males and 23 females in the sample. They ranged in age from 47.09 months to 73.78 months. The median age was 58.59 months; the mean was 58.585 months with a standard deviation of 6.229 months. The mean age of the males was 61.0209 months (standard deviation = 6.029) while the mean age of the females was 56.1491 months (standard deviation = 5.533). The difference in age between the sexes was statistically significant, t (43.68) = 2.86; p = .007.

Procedure

The CCTI questionnaires were distributed by the institutions to the mothers or primary caregivers of the children along with a description of the study. Those wishing to participate were instructed to complete the questionnaire on their child and return it; those not wishing to participate were told to return it unanswered.

Each participating child was asked by the experimenter, in the presence of the daycare worker or teacher, if the child would like to come and play a game for a few minutes. If the child agreed, he and the experimenter went together into a private room where the child met the experimenter's

assistant. The child was told that they were going to look at some pictures but first the experimenter's assistant would show the child the machine that was used while the game was played. For all subjects the same Lafayette Psychogalvanometer model 7609A was used. The assistant then showed the child the machine and the clamp and explained in very simple terms how, when the sensor clamp was on the hand along with some "blue jelly" (electrode gel), the sweat from the hand made "squiggly lines" on the paper. The child was then shown some samples of GSR recordings and told by the assistant that the child could make his own "squiggly lines" since everyone's lines were different from everyone else's. A "rule of the game," the child was told, is that he can't look at the lines until after he had looked at all of the pictures. There was to be no "peeking."

The child was then asked if he wanted "to play." If he said no, he was asked why and if there was no specific response, the assistant would ask the child to help put the clamp on her (the assistant) thus showing the child that it didn't hurt. If the child persisted in his refusal, he was thanked and the session was terminated.

If the child agreed "to play," the experimenter had the child sit down at the table, turned away from the psychogalvanometer so that he could not see the recording. The experimenter then ascertained which was the child's dominant hand by asking him to pick up a pen and "hold it like you do when you are coloring or drawing." This was done so that the

sensor clamp would be placed on the non-dominant hand thereby reducing sensor movement: if the child were to point to the pictures that were to be shown, he would probably be inclined to point with his dominant hand. Electrode gel was then placed on the palm and dorsum of the non-dominant hand and on the two electrodes of the clamp. The clamp was then attached to the hand. While this was taking place, the experimenter kept up a running conversation with the child about what was being done and asked the child questions about such things as how he liked school or daycare or how many brothers and sisters he had. This was done to reduce the child's potential anxiety about the clamp that was being attached and the task that was about to be presented. When the clamp had been fastened, the experimenter continued with the above described conversation while the assistant ascertained the GSR baseline of the child.

When this was done the experimenter said to the child: "I am going to show you a card with three pictures on it. Each one of the pictures has something missing and I want you to tell me what's missing." The practice card was then presented by the experimenter who held it in an upright position on the table in front of the child. This card had on it the first three pictures of the Picture Completion Test of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). (See Appendix B.) The experimenter said: "Here are the three pictures; tell me what's missing in each one." As the child pointed out each missing thing, the experimenter said:

"That's right, do the others (or next one)." The child was not required to do them in any order. If the child made an error or errors or generally indicated that he did not understand the task, the experimenter patiently explained and demonstrated what was to be done and helped the child to correct his errors. It was rare for a child to need any additional explanation or assistance. In any event, the procedure went no further unless the experimenter had satisfied himself that the child fully understood what the task was.

Once this was ascertained, the two measurement trials were initiated. In these measurements trials, which are described below, two cards were used for each subject. Card A had clustered on it pictures 4, 6, 8, 10, 12, 14, 16, 18, 20 and 22 of the Picture Completion Test of the WPPSI; Card B had clustered on it pictures 5, 7, 9, 11, 13, 15, 17, 19, 21 and 23. (See Appendices C and D.) The first 23 subjects were given the cards in an A-B sequence and the next 23 subjects were given the cards in a B-A sequence. This was done to insure that any differential level of difficulty between the cards would be controlled for. The pictures themselves, as can be seen from the lists given above, were assigned to the cards on an alternating basis in order to create as much balance in difficulty as possible.

The experimenter presented the first task card by saying: "Now I am going to show you a card with ten pictures on it. Just like the first card , each of the pictures has something missing and I want you to tell me what's missing

in each of them. Okay?" When the child indicated he understood, the card was presented to him and the experimenter unobtrusively activated a stopwatch while the assistant marked the GSR record to indicate the presentation of the first card. As the card was presented (in the same position as the practice card) the experimenter said: "What's missing in these pictures?" If the child made no response or otherwise indicated that he didn't know what to do, the experimenter would say: "Each one of these pictures has something missing; look closely and tell me what it is." In most cases such prompting wasn't necessary but was effective when it was used. The children responded sometimes by naming the object and at other times by pointing to it. Whenever a response was ambiguous, the experimenter required the child to clearly point to the missing part. Each correct response was marked on a score sheet by the assistant out of the child's sight. If the child made an incorrect response, the experimenter said in a matter-of-fact tone that there was something else missing and that the child could either look for it or go on to another picture. When two minutes elapsed, the experimenter said: "That was very good," and removed the card from the child's view. The assistant marked the GSR record to indicate the end of the first card presentation.

The experimenter then told the child that he would show him one more card with ten pictures on it "just like the other card." The experimenter repeated the instructions given for the first card. He added that this time the child

would have two minutes to find all the missing parts and showed a stopwatch to the child telling him that this would keep the time. The child was also told that the experimenter had shown these pictures to many other children "just like you" before and that all of them found the missing parts before the time was up. The experimenter said that he was sure that the child would do just as well as the others. This was done to increase the child's performance motivation. The child was asked if he understood what he was to do. When it as ascertained that he did, the second card was presented to him, he was told "start" and the stopwatch was activated. Immediately prior to the presentation of the second trial card, the GSR record was marked to indicate the commencement of this measurement trial.

The pictures, for all three cards, while distinct, were positioned close together thus presenting a complex perceptual whole which required discrimination at two levels. First it was necessary to isolate each picture from the others in the complex and identify it; and secondly, to detect its missing part. For each correct response that the child pointed out and declared, he received one point and the picture was checked off on the score sheet. The child received no credit for repeating a correct response but did receive credit for giving the correct response to a picture to which he had previously given an incorrect response. In no case was the child informed that he had repeated a picture. He was told if he was right or wrong, however. If he gave a

correct response, the experimenter said "Go on! Go on!" in an urgent voice. If the child made an error, the experimenter said "That's wrong. You can try again or go on to another: it's up to you." Every thirty seconds or so, the experimenter said in an urgent voice, "Hurry! hurry! time is running out." All this was done to increase the child's drive to complete as many pictures as possible and thus fulfill the experimenter's "expectations." If the child did not make any responses or seemed to have difficulty, the experimenter reminded him that he was to find the missing parts in each picture and that he should look closely to find them.

At the end of the two minute period, the experimenter said "Time's up," and the scoring of responses was stopped. The GSR recording paper was marked to show the onset and offset of the second trial period. Regardless of the child's actual performance, he was told, at the end of the experiment, that he did very well and that he would have gotten the pictures he missed if he had a few more seconds. This was done to prevent the development of feelings of failure by the child and to reduce his arousal level. The child was then shown his personal set of "squiggly lines" on his GSR record as promised. The experimenter thanked the child for participating and again said that he had done well. The experimenter and assistant remained unaware of the child's CCTI scores until after the card presentations.

The child had a performance score for each card (0-10);

a net score -- the difference between Card 1 and Card 2; and a total score -- the sum of Card 1 and Card 2. The child also had a GSR score for each of the two experimental cards. This was the number of equal intervals the GSR maximally changed from the base level during the two minute presentation of the card; a Net GSR score -- the difference in GSR between the First and Second cards; the Total GSR -- the sum of the First and Second GSR scores; and the Maximum GSR which was the highest GSR level achieved on either card during the presentation of the two experimental cards. Each child was assigned a Subject Number as he was tested; the first child, number 1, the second child number 2, ..., the forty-sixth child, number 46.

As described above, two stimulus cards were used in the experiment proper. It was felt that by setting a measurement of both performance and GSR under conditions of low arousal it would be easier to attribute increases in performance and GSR to the cumulative effects of the arousal condition and the Emotionality temperament. This methodology, it was thought, would control for the influence of either high or low general intelligence that could bias the scores. Thus it was thought possible to detect an intelligence or other variable that would otherwise confound the results.

Finally, the teacher or daycare worker of each child rated the child on the Emotionality and Sociability subscales of the CCTI. This was done to get an additional rating of two important temperaments. The experimenter and the assis-

tant were also unaware of these ratings until after the card presentations.

All data were computer analyzed using the SPSS program (Nie et al., 1975).

Results

Each subject was rated by the mother or other primary caregiver on the six temperaments of the CCTI. The subjects were also rated on the Emotionality and Sociability scales of the CCTI by their teacher or daycare worker. The scores for each of the temperaments could range from a potential low of 5 to a potential high of 25. Table 1 gives the range, median, mean and standard deviation of these CCTI scores for the subjects. As can be seen in this table, there was wide variation in the temperament ratings of the children both among and within temperaments.

The performance scores on the First and Second cards were the number of correct, missing objects that the child picked out. Thus for each card, the performance score could range from 0-10. There was also a Net Performance score which was obtained by subtracting the First Card score from the Second Card score and keeping the sign. The Total Performance score was the sum of the First and Second Card scores. Table 2 gives the range, median, mean and standard deviation of the performance scores. The scores were relatively low and had a wide variation.

A GSR score was obtained at each of the two experimental card presentations. This score was the number of equal intervals the GSR maximally changed from the base level during the two minutes of the card presentation. As stated above, this method of scoring was based on the model described by Brodsky and Brodsky (1978). The Maximum GSR score was also

Table 1

Range, Median, Mean and Standard Deviation

of the CCTI Subscales

Subscales	Range	Median	Mean	SD
Sociability	8-25	18.900	18.500	4.406
Emotionality	6-24	13.000	13.348	3.854
Activity	10-21	16.875	16.826	2.719
Attention Span-Persistence	5-25	18.000	16.870	4.287
Reaction to Food	5-24	11.833	13.435	5.468
Soothability	10-20	14.192	14.239	2.243
Sociability Rating by Daycare Worker or Teacher	5-25	17.500	17.174	4.730
Emotionality Rating by Daycare Worker or Teacher	5-25	12.833	12.891	5.182

Table 2

Range, Median, Mean and Standard Deviation

of the Performance Scores

	Range	Median	Mean	SD
First Card	0 to 9	3.500	3.826	2.080
Second Card	0 to 9	4.625	4.500	2.519
Net	-4 to +6	+0.864	+0.674	1.956
Total	2 to 18	8.000	8.326	4.185

recorded. This was the highest GSR attained on either of the two experimental cards. It was thus identical with the GSR score for one of the two cards. The Net GSR score was obtained by subtracting the First Card GSR score from the Second Card GSR score and keeping the sign. Total GSR was the sum of the First Card GSR and the Second Card GSR. Table 3 gives the range, median, mean and standard deviation of these GSR scores. The GSR scores were low and, like the temperament and performance scores, varied widely. GSR scores for the First Card were found to be higher than for the Second Card which implicitly contradicted the hypothesis.

It was hypothesized that the Emotionality scale of the CCTI would be correlated at .40 with both performance scores and GSR scores and thereby account for about 16% of these scores. Table 4 gives the Pearson correlations of Emotionality with these scores. None came close to the hypothesized level.

It was hypothesized that performance scores and GSR scores would also be correlated at .40, again accounting for 16% of performance score variance. Table 5 gives the Pearson correlations of performance scores with GSR scores. It shows a correlation of .2988 between Second Card Performance and Net GSR (p = .044). Thus 8.928% of the Second Card Performance variance was accounted for by Net GSR. The table also shows a correlation of Net Performance with Net GSR of .2585 thereby accounting for 6.682% of Net Performance variance but at a significance level of only .083.

Table 3

Range, Median, Mean and Standard Deviation of GSR Scores

	Range	Median	Mean	SD
First Card GSR	1.00 to 8.50	2.750	3.120	1.427
Second Card GSR	1.25 to 5.50	2.625	2.772	1.031
Maximum	1.25 to 8.50	3.125	3.375	1.433
Net	-4.75 to +2.25	-0.313	-0.348	1.188
Total	2.50 to 12.25	5.375	5.891	2.187

Table 4

Pearson Correlations of the Emotionality Subscale with GSR and Performance Scores

Emotionality with	r	p
First Card GSR	.1762	.242
Second Card GSR	.0791	.601
Maximum GSR	.1449	.337
Net GSR	-.1428	.344
Total GSR	.1522	.313
First Card Performance	.1297	.390
Second Card Performance	-.0824	.586
Net Performance	-.2441	.102
Total Performance	.0149	.922

Table 5

Pearson Correlations of Performance Scores with GSR Scores

First Card Performance with	r	p
First Card GSR	-.0453	.765
Second Card GSR	.0743	.625
Maximum GSR	.0037	.980
Net GSR	.1188	.431
Total GSR	.0055	.971
Second Card Performance with		
First Card GSR	-.1732	.250
Second Card GSR	.1048	.488
Maximum GSR	-.0855	.572
Net GSR	.2988	.044
Total GSR	-.0635	.675

Continued...

Table 5 (Continued)

Net Performance with	r	p
First Card GSR	-.1749	.245
Second Card GSR	.0559	.712
Maximum GSR	-.1140	.451
Net GSR	.2585	.083
Total GSR	-.0877	.562
Total Performance with		
First Card GSR	-.1267	.401
Second Card GSR	.1000	.508
Maximum GSR	-.0496	.744
Net GSR	.2389	.110
Total GSR	-.0355	.815

Data analysis produced some results not anticipated in the hypotheses but which were relevant to the study and, as will be discussed below, to the hypotheses-related results that were obtained. Table 6 gives Pearson correlations among some variables at a level of significance $\leq .05$. There are strong correlations of Sex with Age, First, Second and Total Card Performance. Age is even more strongly correlated with these performance scores, reaching a peak with Total Card Performance ($r = .5824$, $p = <.001$). The effect of sex on the performance scores was further examined with t-tests, the results of which are shown in Table 7. There were significant differences between males and females on all performance scores, except Net Performance, with males having higher mean scores than females in each instance. Since Age and Sex were so strongly correlated themselves, a multiple regression analysis was used to determine which of the two accounted for more of the performance scores' variance. The hierarchial method was used (Cohen and Cohen, 1975). Table 8 shows the results of this analysis. For each of the three performance scores, Age was tested, controlling for Sex, and then Sex was tested, controlling for Age. In each instance Age accounted for more of the variance than did Sex.

Strong, negative correlations were found among Subject Number and GSR scores as well as Card Order and GSR scores. These are shown in Table 9. Because the first 23 subjects had Card Order A-B and the last 23 subjects had Card Order B-A, and because the subjects were assigned consecutive sub-

Table 6

Pearson Correlations Among Some Variables

with Level of Significance $\leq .05$

	r	p
Sex With		
Age	.3953	.007
First Card Performance	.3805	.009
Second Card Performance	.3578	.015
Total Performance	.4044	.005
Age With		
First Card Performance	.5354	<.001
Second Card Performance	.5255	<.001
Total Performance	.5824	<.001
Activity With		
Sociability	.3154	.033
Emotionality	.3113	.035
Attention Span-Persistence	-.2994	.043

Continued...

Table 6 (Continued)

	r	p
Emotionality With		
Attention Span-Persistence	-.4759	.001
Card Order	-.3308	.025
Attention Span-Persistence* With		
Soothability	.3985	.006

*Also correlated with First Card Performance (r = .2790, p = .06).

Table 7

Mean and t-Test of Performance Scores

of Males and Females

	Mean				
	M	F	t	df	p
First Card Performance	4.6087	3.0435	2.73	43.88	.009
Second Card Performance	5.3913	3.6087	2.54	43.86	.015
Total Performance	10.0000	6.6522	2.93	43.28	.005
Net Performance	+0.7826	+0.5652	0.37	41.76	.711

Table 8

Summary of Hierarchial Analysis of Sex and Age

With First, Second and Total Card Performance

	R	R^2	R^2 Change	F	df	p
First Card Performance						
Sex	.38049	.14477	.14477	9.160	1, 43	<.01
Age	.56609	.32045	.17568	11.116	1, 43	<.01
Age	.53542	.28668	.28668	18.140	1, 43	<.01
Sex	.56609	.32045	.03378	2.137	1, 43	>.05
Second Card Performance						
Sex	.35777	.12800	.12800	7.894	1, 43	<.01
Age	.55030	.30283	.17483	10.783	1, 43	<.01
Age	.52551	.27616	.27616	17.033	1, 43	<.01
Sex	.55030	.30283	.02667	1.644	1, 43	>.05
Total Card Performance						
Sex	.40441	.16355	.16355	11.253	1, 43	<.01
Age	.61245	.37509	.21155	14.556	1, 43	<.01
Age	.58236	.33914	.33914	23.336	1, 43	<.01
Sex	.61245	.37509	.03596	2.474	1, 43	>.05

Table 9

Pearson Correlations of Subject Number and Card Order With GSR Scores at Level of Significance $\leq .05$

Subject Number With	r	p
First Card GSR	-.3928	.007
Second Card GSR	-.4656	.001
Maximum GSR	-.4486	.002
Total GSR	-.4757	.001
Card Order* With		
Second GSR	-.4689	.001
Maximum GSR	-.3874	.008
Total GSR	-.3969	.006

*Also correlated with First GSR ($r = -.2696$, $p = .07$).

ject numbers in the order that they were tested, there was a strong correlation between Subject Number and Card Order (r = .8662, p = <.001). Table 10 gives the mean of the GSR scores for the two Card Order groups and the results of the t-tests done on them. As can be seen, group A-B had higher GSR levels in all categories, four of them at or near the .05 level of significance.

In addition, Card A was more arousal-inducing when presented as the first card than was Card B when presented as the first. Card B, however, was more arousal-inducing when presented as the second card than Card A when presented as the second. Whatever the Card Order, the second card presentation resulted in lower GSR than the first card presentation. The highest mean GSR level of the experiment was achieved on Card A when it was presented as the first card. The lowest mean GSR level of the experiment was also achieved on Card A -- when it was presented as the second card.

Since there was such a high correlation between Card Order and Subject Number (to be expected under the circumstances) a hierarchial analysis was done to determine which of the two had the greater bearing on GSR levels. Table 11 gives the results of this analysis. It is the same method used in Table 8. For First Card GSR, Subject Number accounted for more of the variance than did Card Order. For Second Card GSR, there was little difference accounted for. For both Total GSR and Maximum GSR, Subject Number seems to have accounted for more of the variance than Card Order.

Table 10

Mean and t-Test of GSR Scores

of Card Order Groups

	Mean				
	A-B	B-A	t	df	p
First Card GSR	3.50	2.74	1.86	35.50	.072
Second Card GSR	3.25	2.29	3.52	36.50	.001
Total GSR	6.75	5.03	2.87	37.34	.007
Net GSR	-0.25	-0.45	0.55	31.22	.584
Maximum GSR	3.92	2.83	2.79	35.33	.009

Table 11

Summary of Hierarchial Analysis of Subject Number and Card Order with First, Second, Total and Maximum GSR Scores

	R	R^2	R^2 Change	F	df	p
First Card GSR						
Subject Number	.39281	.15430	.15430	8.019	1, 43	<.01
Card Order	.41749	.17430	.02000	1.041	1, 43	>.05
Card Order	.26961	.07269	.07269	3.785	1, 43	>.05
Subject Number	.41749	.17430	.10161	5.291	1, 43	<.05
Second Card GSR						
Subject Number	.46558	.21677	.21677	12.168	1, 43	<.01
Card Order	.48375	.23401	.01724	.967	1, 43	>.05
Card Order	.46891	.21988	.21988	12.343	1, 43	<.01
Subject Number	.48375	.23401	.01413	.793	1, 43	>.05

Continued...

Table 11 (Continued)

	R	R^2	R^2 Change	F	df	p
Total GSR						
Subject Number	.47567	.22626	.22626	12.589	1, 43	<.01
Card Order	.47664	.22718	.00092	.051	1, 43	>.05
Card Order	.39688	.15752	.15752	8.764	1, 43	<.01
Subject Number	.47664	.22718	.06967	3.876	1, 43	>.05
Maximum GSR						
Subject Number	.44856	.20121	.20121	10.831	1, 43	<.01
Card Order	.44857	.20121	.00001	.001	1, 43	>.05
Card Order	.38742	.15009	.15009	8.079	1, 43	<.01
Subject Number	.44857	.20121	.05112	2.751	1, 43	>.05

It should also be noted that Emotionality was significantly correlated (negatively) with Card Order (see Table 6). Card Order group A-B had a significantly higher mean Emotionality rating than did group B-A: 14.6087 versus 12.0870; t (38.73) = 2.32, p = .025.

Several hierarchial analyses were done on the data using various combinations of variables in an attempt to find which ones accounted for the performance and GSR scores at a level of significance $\leq$.05. This was largely unsuccessful except to confirm the findings presented above. One additional, significant finding was that, while controlling for Sex, Age, Card Order, Sociability, Emotionality and Activity, Attention Span-Persistence accounted for 6.866% of First Card performance score: $F(1, 35) = 4.6825$, $p = <.05$.

The significant correlations of the CCTI subscales with each other are given in Table 6. The temperaments of Activity and Attention Span-Persistence had the most correlations with other temperaments. There were no significant differences between parental and teacher/daycare worker ratings of the children on Emotionality and Sociability.

Discussion

The results did not support the hypotheses that there would be a .40 correlation of Emotionality with both GSR and Performance and a .40 correlation of GSR with Performance. A few reasons for this lack of support suggest themselves. For example, the sample may have been, by chance, unrepresentative or the CCTI may have been defective as an instrument. In the case of the former, however, there is no reason to think that the sample was other than a broad representation of children in this age group. In the case of the latter, neither the data from the study nor the literature indicates any such difficulty with the CCTI.

Although there was a significant correlation between Second Card Performance and Net GSR, it is hard to interpret this result in terms of the hypotheses. Nevertheless, it does provide some evidence that, as GSR increases, so too does performance. This is more directly evident in the correlation between Net Performance and Net GSR since these scores represent the differences in arousal and performance between the two conditions of the experiment. Unfortunately, it is compromised by its .083 level of significance. This level is close enough to .05, however, to indicate that the basic relationship between GSR and performance, as posited in the hypotheses, may obtain to at least some degree.

It should be noted that this relationship would be a function of an arousal system that has a very wide range.

Thus it would require a very intense stimulus to raise the arousal level of a representative sample sufficiently to affect performance. It may well be that the stimulus complex used in this study did not possess the necessary intensity. It is therefore possible that the Net Performance-Net GSR relationship found in this study is more meaningful than the numbers themselves indicate. The wide range of the arousal response, combined with an insufficiently intense stimulus complex, may account for the relationship between Net Performance and Net GSR not quite reaching significance. What does come through, however, is that there does appear to be a functional relationship between arousal and performance in this experiment.

The males in the sample had higher performance scores, but not higher GSR scores, than the females. The males were also significantly older. The results show that Age accounted for more of the difference in performance than Sex did. Thus it may well be that developmental maturation and/or age-related intelligence were important factors in the task performance.

One of the more interesitng features of the results was the negative correlation of GSR with both Subject Number and Card Order. Subject Number was the number assigned consecutively to the subjects as they were tested. The first subject was assigned Subject Number 1 and the last subject was assigned Subject Number 46. As the results showed, Subject Number predominated over Card Order in accounting for

GSR levels. Thus, as the experiment progressed, arousal levels decreased as more subjects were tested. And this relationship with subject order of testing held for all measurements of GSR. This decline in arousal level is also suggested by the significantly lower mean GSR scores of the B-A group as compared to the A-B group at all but one level of GSR measurement. The B-A group, of course, was comprised of the last 23 subjects tested.

One possible explanation is that the experimenter's behavior changed over the course of testing the sample in such a way that he and/or the way he conducted the experiment became decreasingly arousing for the subjects and was reflected in decreasing GSR scores. What exactly this behavior change could have been is unknown. Perhaps the experimenter became more relaxed as the number of children tested increased. In this hypothesis, the tension experienced by the experimenter at the early stages of testing was conveyed to the subjects but as the experimenter became more relaxed with increased experience, less of this tension was conveyed to them. This resulted in their arousal not being increased as much as that of earlier subjects. If this interpretation is correct, the trend seems to have held across the sample. The experimenter was not, and need not, have been aware of these changes for them to have had their effect.

Although an experimenter factor may have influenced the results, the standardized administration of the experiment across all subjects requires further explanation in order to

account for the results obtained. One clue as to what occurred can be found in the fact that the Second Card presentation resulted in a lower GSR than that of the First Card presentation regardless of the card used. When Card A was the second card presented, GSR decreased and when Card B was the second card presented, GSR also decreased from that of the First Card presentation. This rules out the cards themselves as the critical determining factor but rather points to the conditions under which the second card was presented -- which, of course, were the same regardless of the card used. It appears, therefore, that habituation took place between the first and second card presentation, thereby causing a decrease in GSR.

It is as if the children had an orientation response to the first card but, because of its lack of interest, quickly habituated. The second card, because of its similarity to the first card, may have elicited a lower level of orientation response which habituated even more quickly. The GSR would then have declined as habituation took place. The peak of arousal and GSR level would be at the peak of the orientation response which would have been the first card presentation. This is consistent with the finding of the contribution of Attention Span-Persistence to the variance of the First Card Performance score.

The habituation took place despite the fact that the second card presentation was attended by all of the intentional, arousal-inducing elements thought to increase arousal

beyond that provided by the stimulus properties of the card itself while the first card, which had the higher arousal scores, had no arousal-enhancing elements attached to its presentation.

Several reasons for this habituation suggest themselves. The cards themselves may not have had the arousal-inducing capacity that was originally thought. Despite this, the novelty of the pictures and the detection task associated with them may still have been the chief arousal-inducing element for the children. The two minute time span for the task may have been too long for children of this age range so that, by the time the second card was presented, the novelty had diminished and continued to do so over another "long" two minutes. If novelty, through the elicitation of the orientation response, was the chief factor in the First Card GSR scores, then its sharp diminution would account for the corresponding decline in GSR scores on the second card, even to the point of suppressing the effects of the other arousal-inducing elements attached to that card. Whatever arousal value the pictures had was also dissipated by dividing them into two groups. This reduced the overall complexity of the stimulus that twenty pictures would have presented and thereby, along with the lengthy time span, enhanced habituation.

The cumulative effects of both habituation of GSR across the cards and the decline in GSR as more subjects were tested

can be clearly seen in GSR levels of Card A. When Card A was presented as the first card to the first 23 subjects it elicited the highest mean GSR score of the whole experiment. But when it was the second card presented to the last 23 subjects it elicited the lowest mean GSR score of the whole experiment.

In addition, too much emphasis was probably placed on the arousal-inducing qualities of the competition and achievement-expectation elements attached to the second card presentation. The children may not have placed too much value on doing better than their peers nor may they have cared about attaining the achievement level "expected" by the experimenter. This lack of arousal could be attributed to both their age, in that they may not yet have had much experience with overt peer competition, and to the institutional settings which they attended where competition is played down and achievement expectation is not emphasized. Thus the arousal value of these features may not have been operating very effectively.

The observations of the experimenter support these explanations. He noticed that some of the children lost interest in the task while still working on the first card after about a minute had passed. Eyes would begin to wander off of the cards and less effort seemed to be invested in performing the task. This was also true for the second card except that there was a lower level of observable, initial

interest in the pictures than there seemed to have been for the first card.

There seems to be, therefore, a good basis for thinking that the conditions thought to induce and enhance high levels of arousal were not doing so in this experiment for the reasons given above.

The datum that Emotionality was not directly related to either GSR or performance can best be explained by reference to the finding that performance was accounted for primarily by age related factors -- maturity and intelligence -- and that, since GSR was not sufficiently elevated by the stimuli and task, Emotionality did not have an opportunity to display an influence. There is a possibility, however, that Emotionality did indirectly influence GSR to some small degree. There was a strong, negative correlation between Emotionality and Card Order. Since subjects were not assigned a Card Order according to an Emotionality rating (as stated above, the CCTI ratings were unknown to the experimenter or assistant until after the testing of the subject) the association of lower Emotionality ratings with Card Order group 2 (B-A), and, the obverse, the association of higher Emotionality ratings with Card Order group 1 (A-B) could have occurred only by chance. If subjects with higher Emotionality ratings had higher GSR scores than subjects with lower Emotionality ratings, as was the case, then it is possible that Emotionality ratings contributed to the level of GSR across the sample. The relation-

ship would be, of course, in the expected direction.

Some of the significant correlations of the CCTI temperaments with each other obtained in the results would logically be expected on the basis of theory and previous research. The positive correlation of Activity with Emotionality would be expected because higher levels of arousal would tend to produce higher levels of activity either to reduce the arousal or achieve a goal associated with it. The negative correlation of Activity with Attention Span-Persistence would also be expected. High levels of activity are inconsistent with high levels of attention and persistence in that the latter requires at least some suppression of the former. For the same reason, the negative correlation of Emotionality with Attention Span-Persistence would be expected: high levels of attention and persistence require a low to moderate level of arousal. This would also be reflected in the positive correlation of Attention Span-Persistence with Soothability, both require either low levels of arousal or levels of arousal that can be quickly and easily reduced. The positive correlation of Activity with Sociability does not lend itself to as clear an interpretation as the others. One plausible explanation is that highly sociable individuals are more active because activity may maintain and enhance social interactions: the more one does in a social environment, the more social contact there is likely to be.

Finally, in view of some of the unexpected data and indications found in the experiment it is appropriate, at

this point, to offer some recommendations for improvements in experimental design which might obviate these difficulties should this study be replicated.

1) Although the hypotheses to be tested should remain the same, no specific correlation coefficients should be stated for them. This will allow for greater flexibility in assessing the importance of the relationship among the variables.

2) Since there would be no specific correlation coefficients hypothesized, prudence dictates that the sample size be made rather large, perhaps as much as N = 100.

3) The age factor should be more rigorously controlled. An age range of 5 years $\pm$ 1 month seems to provide the necessary balance between youth (to maximize the CCTI's reliability) and maturity (so that there could be an adequate test of cognitive-perceptual functioning under arousal conditions).

4) In order to control for the possible effects of intelligence on performance and arousal, a standardized intelligence test should be administered before the experiment proper. The Stanford-Binet would seem to be appropriate. An IQ range of 100 $\pm$ 5 should be used in order to keep intelligence fairly homogeneous. No test should be used whose materials resemble to any appreciable degree the stimulus materials used in the experiment, e.g., the Peabody.

5) The task and/or stimulus materials should be altered. If the Picture Completion task is retained, all

twenty pictures should be combined on one card to be presented in one trial with all arousal enhancing elements included and with a time limit of approximately 45 seconds. This would maximize the complexity of the stimulus materials while the single card and the shorter time span would minimize the effects of habituation.

The better course, however, would be to find another task and stimulus material that would be more likely to elicit arousal and resist habituation. This may mean a completely different type of cognitive-perceptual task, one that is more suitable to the aims of the study than the Picture Completion test has turned out to be. Clearly, different arousal enhancing features will also have to be found.

6) During the experiment various difficulties with the psychogalvonometer were encountered which were believed to be associated with the young age of the children, e.g., moving the clamped hand during the testing; and flexing of the hand, thereby reducing contact with the electrodes. It is not known how these difficulties affected GSR scores. It is, therefore, recommended that another, or at least additional, measure of arousal be used which would not be subject to such technical vulnerabilities. Although this would have to be studied further, it is suggested that heart rate change might be a more reliable measure of arousal.

In conclusion, while the results offered only very

slight or indirect support of the hypotheses, it is felt that, for the reasons presented above, they cannot yet be rejected. Therefore, the hypotheses remain to be either supported or rejected through further, more rigorous testing.

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APPENDIX A: COLORADO CHILDHOOD TEMPERAMENT INVENTORY

Appendix A

Colorado Childhood Temperament Inventory

Instructions: Please circle the response that best represents your child's behavior. For instance,

	Not at all like my child 1	A little like my child 2	On the average like my child 3	Most often like my child 4	A lot or always like my child 5
Child shows fear of stranger.	1	2	(3)	4	5

You may change an answer by crossing out the incorrect response and circling another response. For instance,

Child shows fear of stranger.	1	2	~~3~~	(4)	5

For each of the following items, circle one response to describe your child's behavior.

	Not at all like my child 1	A little like my child 2	On the average like my child 3	Most often like my child 4	A lot or always like my child 5
1. Child makes friends easily.	1	2	3	4	5
2. Child gets upset easily.	1	2	3	4	5
3. Child is very energetic.	1	2	3	4	5
4. Plays with a single toy for long periods of time.	1	2	3	4	5
5. Rarely took a new food without fussing.	1	2	3	4	5
6. Whenever child starts crying, he can be easily distracted.	1	2	3	4	5

		Not at all like my child 1	A little like my child 2	On the average like my child 3	Most often like my child 4	A lot or always like my child 5
7.	Child is very friendly with strangers.	1	2	3	4	5
8.	Child tends to be somewhat emotional.	1	2	3	4	5
9.	Child is always on the go.	1	2	3	4	5
10.	Child persists at a task until successful.	1	2	3	4	5
11.	Child consistently dislikes many kinds of food.	1	2	3	4	5
12.	When upset by an unexpected situation, child quickly calms down.	1	2	3	4	5
13.	Child is very sociable.	1	2	3	4	5
14.	Child reacts intensely when upset.	1	2	3	4	5
15.	Child prefers quiet, inactive games to more active ones.	1	2	3	4	5
16.	Child goes from toy to toy quickly.	1	2	3	4	5
17.	Child makes faces at new foods.	1	2	3	4	5
18.	Child stopped fussing whenever someone talked to him or picked him up.	1	2	3	4	5
19.	Child takes a long time to warm up to strangers.	1	2	3	4	5

		Not at all like my child	A little like my child	On the average like my child	Most often like my child	A lot or always like my child
		1	2	3	4	5
20.	Child cries easily.	1	2	3	4	5
21.	Child is off and running as soon as he wakes up in the morning.	1	2	3	4	5
22.	Child gives up easily when difficulties are encountered.	1	2	3	4	5
23.	Once the child decides he doesn't like something, there is no getting him to like it.	1	2	3	4	5
24.	If talked to, child stops crying.	1	2	3	4	5
25.	Child tends to be shy.	.	2	3	4	5
26.	Child often fusses and cries.	1	2	3	4	5
27.	When child moves about, he usually moves slowly.	1	2	3	4	5
28.	With a difficult toy child gives up quite easily.	1	2	3	4	5
29.	Child has strong likes and dislikes in food.	1	2	3	4	5
30.	Child tolerates frustration well.	1	2	3	4	5

Table A

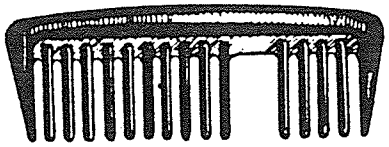
Colorado Childhood Temperament Inventory Scales and Their Items

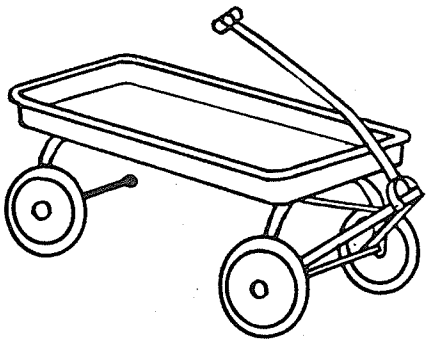
Scale	Items
Sociability	1, 7, 13, 19, 25
Emotionality	2, 8, 14, 20, 26
Activity	3, 9, 15, 21, 27
Attention Span-Persistence	4, 10, 16, 22, 28
Reaction to Food	5, 11, 17, 23, 29
Soothability	6, 12, 18, 24, 30

APPENDIX B: PRACTICE CARD

Appendix B

Practice Card





APPENDIX C: CARD A

Appendix C

Card A

APPENDIX D: CARD B

Appendix D

Card B