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THE EFFECTS OF VISUAL DISTRACTORS ON THE PERFORMANCE OF HYPERACTIVE CHILDREN ON AN ARITHMETIC TASK

City University of New York PH.D. 1980

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THE EFFECTS OF VISUAL DISTRACTORS ON THE PERFORMANCE OF HYPERACTIVE CHILDREN ON AN ARITHMETIC TASK

by

ALICE RADOSH

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graduate faculty in psychology in partial
fulfillment of the requirements for the degree of
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Figure 1: Mean Number of Errors by Condition for Hyperactive and Non-Hyperactive Children. 51

The ability of hyperactive children to maintain attention to a task in the presence of distracting stimuli is a function of at least two factors: the nature of the task and the nature of the distracting stimuli. The present study is an investigation of the effect of varying the appeal level of visual distractors on the performance of hyperactive children on an arithmetic task. Previous studies of distractibility have, for the most part, found no difference between the task performance of hyperactive and non-hyperactive children. These studies did not distinguish between external stimuli that might be interesting to children and external stimuli that probably have very little interest for children. The present study determines empirically the appeal level of the external stimuli and hypothesizes a significant decrement in the task performance of hyperactive children in the presence of stimuli that are judged to be highly appealing.

History

Since the 1930's psychologists, educators, physicians and parents have been concerned with the definition and treatment of hyperactivity in children. The numerous diagnostic labels associated with this disorder reflect the debates among contemporary theorists regarding etiology and critical symptoms. Invariably, these debates conclude with the agreement

that although hyperactive children are discussed in terms of their "typical" symptoms, they represent a behaviorally and etiologically heterogeneous group (Wender, 1973).

Children considered to be hyperactive are described as overactive, restless, inattentive, distractible, impulsive, immature, easily frustrated or a combination of these or similar behaviors. Absent from the lists of difficulties are severely bizarre or psychotic symptoms. The problems exhibited by hyperactive children are typically chronic and have usually been present since infancy or early childhood. These behaviors frequently lead to conflicts with peers and authorities, particularly if the child is of school age.

In 1964 the United States Department of Health, Education and Welfare (HEW) called together a task force to focus on the issues of terminology concerning the hyperactivity syndrome. Two years later the task force published a monograph (Clements, 1966) which delineated the problems that existed in this area. Their review of the literature revealed a total of 38 terms used to describe children with similar behavioral problems. To aid identification, the HEW monograph compiled a list of behaviors most frequently cited by professionals working with hyperactive children. The behaviors are listed below in order of the frequency with which they are cited:

1. excessive activity
2. perceptual-motor impairment
3. emotional lability
4. general coordination deficits
5. disorders of attention (short attention span, distractibility, perseveration)

6. impulsivity
7. disorders of memory and thinking
8. specific learning disabilities
9. disorders of speech and hearing
10. equivocal neurological signs and electro-encephalogram irregularities.

Although the terms listed are not defined and, for some terms, such as "perceptual-motor impairment," the behavioral manifestations are not clear, the emphasis is clearly on motor activity. The symptom most frequently associated by professionals with hyperactive children in 1966 was excessive activity. Disorders of attention were listed fifth. Descriptors of hyperactive children have always included both excessive motor activity and attention disorders, but over the last decade the importance attributed to these two key symptoms relative to each other has shifted. Following the findings of empirical studies to be described later, there has been a transition from focusing on excessive motor activity as the primary symptom with attentional disorders relegated to a secondary position to an increasing emphasis on attentional disorders as the critical symptoms of hyperactivity, with excessive motor activity viewed as a consequence of distractibility.

This shift in focus is reflected in the change in the American Psychiatric Association's last two diagnostic and statistical manuals. The 1968 listing for "Hyperkinetic Reaction of Childhood" in <u>The Diagnostic and Statistical Manual II</u> (American Psychiatric Association, 1968) states that, "this disorder is characterized by overactivity, restlessness, distractibility and short attention span, especially in young

children" (p. 50). In the most recent preliminary version of Diagnostic and Statistical Manual III (American Psychiatric Association, 1978) hyperactivity is listed as part of a broader area of dysfunction entitled "Attention Deficit Disorders." Four operational criteria are listed under "Attention Deficit Disorder with Hyperactivity." First, children must exhibit general hyperactivity or motor restlessness which differs from the norm for their age. In the early years, crawling, climbing, or running is described as incessant, haphazard, and impulsive. In the later years, including middle childhood and adolescence, children with Attentional Deficit Disorders with Hyperactivity are described as showing "marked inability to sit still, up and down activity, and fidgeting" (p. 108). The second diagnostic criterion focuses on the difficulty these children have in sustaining attention. Inability to complete tasks, disorganization, and "forgetting" of tasks and demands are listed as three common manifestations of this attentional disorder. Unstructured conditions are claimed to exacerbate these problems, as well as unsupervised situations or situations that call for independent behavior. Additional operational criteria include impulsivity and the requirement that these behaviors have their onset in early childhood.

In summary, hyperactive children are multisymptomatic with attentional disorders and motor activity presenting themsleves as two of the key symptoms. The discussion below reviews the empirical data pertaining to the objective assessment of these two symptoms.

Excessive Motor Activity

As noted earlier, the professionals polled for the HEW report (Clements, 1966) listed excessive activity as the primary symptom that they thought characterized hyperactive children. The very labels "hyperactive children" or "hyperkinetic impulse disorder" emphasize the motor component of this disorder. These labels reflect the fact that, traditionally, excessive motor activity has been considered the defining characteristic of hyperactive children. Twenty years ago, for example, Laufer and Denhoff (1957) listed hyperactivity as the first essential symptom of the hyperkinetic impulse disorder and stated:

> The children show involuntary and constant overactivity which greatly surpasses the normal . . . . Parents often say such things as that he walked early and there was "no holding him" after that, or that he could not be kept in a playpen and was into everything, having to be tied to keep him in the yard (p. 463).

Perhaps the image of the hyperactive child tied in the yard overstates the case; but the sense of Laufer and Denhoff's picture is seconded by Hirt (1964), who described the hyperactive child as one who is always in motion and whose motion is always in double time. In equally colorful language, Wender (1971) described the hyperactive child who

> was active and restless in infancy, stood and walked at an early age and then, like an infant King Kong, burst the bars of his crib asunder and sallied forth to destroy his parents' house (p. 12).

Attempts to document the excessive movement about which parents and teachers complain have met with only varying success. There are three approaches that have been used to

document motor activity: mechanical devices, rating scales and objective ratings using observational codes.

Mechanical Devices

Mechanical devices have been used by a number of researchers who assumed that excessive gross motor activity as well as restlessness and fidgeting could be recorded by pedometers, actometers, and stabilimetric cushions. Pedometers measure the child's activity in terms of the number of leg movements which are necessary to make a unit change in the recording instrument. The actometer, a modified calendar watch, can be worn on the wrist or ankle. A pendulum attached directly to the hands of the watch records movements of the arms or legs. The pendulum rotates in a plane parallel to the watch face, and only those movements which have a component at right angles to this plane are recorded. Gentle leg swinging, commonly reported in hyperactive children, might not be recorded, therefore. Also, the inertia of the pendulum prevents the recording of minimal movements, so finger drumming and fidgeting with small objects might also go undetected (Johnson, 1971).

Bell, Waldrop, and Weller (1972) recorded activity level from pedometers attached to nursery school children who had been divided into two groups. The first group had been described by their teacher as being hyperactive. The second group consisted of their classmates described as non-hyperactive by the teacher. It was not possible to distinguish between

the two groups on the basis of pedometer recordings.

Millichap, Aymat, Sturgis, Larsen and Egan (1968) did not find significant activity level differences as measured by actometers worn by hyperactive children on and off methylphenidate, and other studies by Millichap and his co-workers were critical of the accuracy of the actometer because of the mechanical limitations described above. They suggested that minimal movements could be more accurately recorded if actometers were attached to all four extremities. They pointed out, however, that while this arrangement maximizes the recording of movement it might also be intrusive and interfere with the behavior being observed (Millichap & Boldrey, 1967; Kasper, Millichap, Backus, Child, & Schulman, 1971).

The third mechanical device used to measure activity level is a stabilimetric cushion, a recording platform which is mounted on the child's chair and which records both wiggling movements and up and down rump movements. Sprague, Barnes, and Werry (1970) measured activity level, defined as wiggling in a chair, using such a device. They obtained movement measures on twelve boys who had been placed in a special class for antisocial, distractible and hyperactive behavior. The boys had a mean age of 7 years 9 months and a mean IQ of 99 on the Wechsler Intelligence Scale for Children (WISC). The study employed repeated measures on the same group of children over three drug conditions (methylphenidate, thioridazine and placebo). Sprague et al. reported that motor activity, as measured by the stabilimetric cushion, was

significantly reduced when the children were on methylphenidate as compared to placebo or thioridazine.

In a review of mechanical measures of activity level, Ross and Ross (1976) argued that, although a stabilimetric cushion is a reliable measure of total activity obtained in a given time period, gross versus fine movements cannot be studied and that the weight of the child influences the amount of activity recorded, with lighter children likely to show less recorded activity than heavier ones.

In a recent study Barkley (1977a) used four objective measures to evaluate the activity level of 18 boys between the ages of 5 and 12 years who had been referred to pediatricians because of parental complaints of longstanding hyperactivity, distractibility, impulsivity, difficulty in disciplining and difficulties in school performance. All children had been placed on methylphenidate. Non-hyperactive children were used as a control group. Activity level scores were obtained with actometers, pedometers, stabilimetric cushions, and from the number of times a child moved from one space to another in a grid-marked playroom. Scores were obtained from the mechanical devices during free play periods, movie viewing periods and work periods. The hyperactive children were significantly more active than control children during all three experimental situations on all measures.

The conflicting findings and the fact that these recording devices are mechanically imperfect contributed to the difficulty researchers have had determining a level of

activity that can be labelled "normal" or "excessive." There is, to date, no objective, generally agreed upon definition of hyperactivity in terms of a mechanically measured quantity of movement or activity.

Rating Scales

Several comprehensive behavior rating scales designed to aid in the diagnosis of hyperactivity have been developed to be used by teachers and parents (Bell et al., 1972; Blunden, Spring & Greenberg, 1974; Conners, 1969, 1970; Davids, 1971; Dielman, Cattell & Lepper, 1971; Quay & Peterson, 1967; Stewart, Pitts, Craig & Dieruf, 1966; Werry, 1968). These scales can be used to rate children on such items as: sits fiddling with small objects, disturbs other children, impulsive and unable to delay gratification, irritable, nomadic play, unable to follow directions, leaves seat when he shouldn't, and many other related behaviors.

Although rating scales have the distinct advantage over mechanical devices of being inexpensive and easy to obtain, there are problems associated with the design of these scales and with their use. Ross and Ross (1976) pointed out that many of the items are not operationally defined and that raters rely on their personal definitions of such items as "easily frustrated." In addition, teachers and parents are left to interpret rating terms such as "frequently" and "pretty much," which results in considerable differences among raters (Simpson, 1944). Factor analytic studies of the most frequently

used school behavior rating scales have indicated that on many of the scales there is an overlap between hyperactivity and conduct disorders (Lahey, Stempniak, Robinson & Tyroler, 1978; Zukow, Zukow & Bentler, 1978). The Conners Scale (1969, 1970), for example, includes "Disturbs other children" and "Teases other children or interferes with their activities" as two items that are used to assess hyperactivity.

In addition to the problems intrinsic to the rating scales, the way in which the raters use the scales is problematic. Ratings may be subject to "halo effects" (Guilford, 1954). Teachers who rate a child as overly active may also rate that child as highly distractible without an independent assessment of the two behaviors.

The use of rating scales in situations in which children have been referred for treatment on the basis of difficulties in school presents a special problem. Vincent, Williams and Elrod (1977) suggest thatteachers may exaggerate ratings for hyperactive children in order to justify their referrals. A related problem was described by Neisworth, Kurtz, Jones and Madle (1974). They found that raters of young children were influenced by reading diagnostic reports describing "hyperkinesis" in the child they were observing. Raters who had read the report produced significantly higher ratings of hyperactivity on the Davids Rating Scale (1971) than did raters who had not been given the report prior to completing the Davids Rating Scale.

Despite the difficulties with rating scales, they continue

to be widely used, perhaps in part because of the willingness of teachers to cooperate and fill out the forms. Scores from these instruments are currently the most frequently used dependent variable for clinical studies examining the effects of behavioral treatments on hyperactive children (Lahey et al., 1978). It has been suggested that rating scales should serve as a guide in the identification and treatment of hyperkinetic children and that they should be used in conjunction with other diagnostic or evaluation tools (Abikoff, Gittelman-Klein & Klein, 1977; Frankenburg, 1974).

Observation Codes

Classroom observation codes have been developed which note the occurrence of specified behaviors during brief time periods (10-15 sec.). These instruments typically list behaviors such as: out of seat, non-compliance, vocalization, aggression, soliciting teacher attention, and other, similar behaviors which are associated with hyperactive children (Abikoff, Gittelman-Klein & Klein, 1977; Bovich, Malitz and Kugle, 1978; Shaffer, McNamara and Pincus, 1974).

In a recent study, Abikoff et al. (1977) describe an observation code designed to assess classroom behavior in hyperactive children. They observed 60 children who had been rated as hyperactive by their teachers on the Conners' Teacher Rating Scale (Conners, 1969) and who had been reported by their mothers to be hyperactive or to have other behavior difficulties at home. Sixty children reported as presenting

"average" behavior by their teachers were also observed. Fourteen behaviors were coded, and comparisons were made between the two groups on these behaviors. Twelve of the 14 categories discriminated significantly between hyperactive and non-hyperactive children. Of these 12, the authors reported that

> the five most reliable, clinically relevant and frequently occurring code behaviors were interference (disruptiveness), off task (attention to stimuli other than the assigned work), minor motor movement, gross motor movement and solicitation (seeks out teacher's attention) (p. 781).

They pointed out, however, that hyperactive and non-hyperactive children overlapped on all categories, yielding high percentages of false positives and false negatives, suggesting that confirmation of the diagnosis of hyperactivity should not be based on the presence or absence of a single sign.

Regardless of which method of activity measurement is used: mechanical devices, rating scales or observation codes, the extent of activity which can be verified rarely corresponds to the level of activity which parents and teachers complain about. This fact has led numerous researchers to comment that the behavior that hyperactive children display which parents and teachers interpret as excessive activity is, in fact, poorly focused or undirected behavior. Shaffer et al. (1974) stated that frequent changes in goal direction, meaningless activity, the dependency demands of the child, and the "social nuisance value" of the behavior contribute to a judgment of overactivity which is not borne out by objective observation.

The possibility that the appearance of overactivity is

due not simply to the _extent_ of activity but rather to the _pattern_ of activity displayed has also been suggested by Douglas (1974a). She felt that consideration should be given to whether or not the child's behavior is organized, goal directed and in conformity with demands made upon him. If the activity does not have these qualities, it is likely to be labelled "excessive" regardless of its quantity. Wender (1971) also emphasized that inappropriate activity, though not excessive in amount, can be confused with hyperactivity. Some children, Wender wrote

> are in fact not hyperactive but only appear so. Some give the impression of hyperactivity because of their constant shifting of activities and lack of goal direction. In other children the striking feature is not the total amount of activity but the children's inability to inhibit activity when inhibition is appropriate; these children are no more active than other children on the playground but cannot curtail their activity in the classroom (p. 13).

Rutter, Graham, and Yule (1970) also suggested that the impression of excessive movement in hyperactive children is probably due to the children's short attention span rather than to an absolute increase in tempo or amount of movement.

In their review of the literature on activity level, Cromwell, Baumeister, and Hawkins (1963) drew attention to the confusion between short attention span and excessive motor activity. They referred to the "so-called" hyperactive child and described as a "paramount problem" the fact that the subjects with a short attention span may appear to have a higher rate of activity than the child who is able to sustain attention but who, in fact, is engaging in an equal amount of

movement. The rapid shifts from one goal-directed activity to another may be responsible for the illusion of excessive motor activity in many hyperactive children. Empirical studies are needed which attempt to distinguish between unfocused or non-goal-oriented behavior from excessive motor activity.

Increasingly, the primacy of the role of motor activity in the diagnosis of hyperactivity has been challenged by the importance of problems of attention. Rutter et al. (1970), for example, suggested that over-activity _must_ be linked with such features as impulsiveness and distractibility before the hyperkinetic syndrome can be diagnosed. Similarly Douglas (1974b) stated that when she began her research on hyperactivity she selected excessive activity as a target symptom because it seemed less vague and easier to define operationally than many of the other symptoms thought to be common in hyperactive children. The lack of clear findings yielded by activity level studies of hyperactive children and the increasing emphasis on the quality rather than the quantity of activity led Douglas to be less satisfied with concentrating on excessive activity as the critical symptom. In addition, Douglas's thinking was influenced by follow-up studies which showed that impaired attention and impulsivity remained serious problems for adolescents who were no longer overly active. These findings led Douglas to suggest that children should be considered hyperactive on the basis of attentional problems and poor impulse control rather than on the basis of activity level alone.

Studies of hyperactive children by Douglas and her co-workers have stressed the importance of attentional problems (Cohen, Weiss, & Minde, 1972; Douglas, 1974a). Excessive activity is only one of several symptoms and the inability of hyperactive children to sustain and to keep impulsive responding under control may be even more crucial for the identification and treatment of hyperactive children (Douglas, 1972).

Attention and Distractibility

Although attentional problems have been included among the symptoms associated with the hyperactive syndrome for over twenty years (Clements & Peters, 1962; Strauss & Kephart, 1955; Wender, 1971), there has been relatively little adequate research on these disabilities. As a result, there are usually no effective, well-structured techniques used in the evaluation of attentional difficulties in hyperactive children. Too often, attentional problems are either ignored or dealt with in a peripheral or haphazard manner, not only in the diagnostic process, but also during treatment (Douglas, 1974b).

Descriptions of the distractible, hyperactive child abound in the literature. Wender (1971) described the child's "forced responsiveness" which derives from his inability to fix attention:

> With the hyperactive child, as with an infant, striking external stimuli will interrupt a mental set. When he is told to perform a task, he may start willingly enough and then forget to complete it; he abandons tasks in the middle. An irrelevent stimulus, a bright toy, an interesting noise, fixes his attention and "distracts" him from his task, holding his attention until another stimulus seizes it (p. 142).

Years earlier, Strauss and Lehtinen (1947) also claimed that hyperactive children are capable of being "caught" by something which non-hyperactive children would disregard. Rather than labelling these children as distractible, however, they described them as "hyper-vigilant." According to Strauss and Lehtinen, rather than failing to pay attention, hyperactive children pay too much attention, often to inessential stimuli such as page numbers on books or flaws and marks on papers. It was Freibergs and Douglas' (1969) impression also that their hyperactive subjects paid more attention to inessential stimuli than did non-hyperactive children. The non-hyperactive children were "remarkably quiet and businesslike" during testing, while the hyperactive children, ages 6-12 were often distracted by objects in the room, the experimenter, the testing apparatus, or even their own bodies. All of these seemed to compete with the task for their attention. Freibergs and Douglas suggested that both excessive motor activity and attentional problems derive from the same fundamental difficulty: "a chronically excessive level of arousal" (p. 394). This excessive arousal level causes the hyperactive children to have abnormally low response thresholds which translate into hyperactivity when the response is motoric or into distractibility when the response is cognitive.

The Role of the Task

Objective estimates of attention and distractibility are usually derived from performance on a task. Thus

distractibility is often referred to as "off-task" behavior, and the term distractibility denotes a deterioration in task performance in the presence of extraneous stimuli. With the exception of one study which measured eye movements (Bremer & Stern, 1976), all empirical studies of distractibility in hyperactive children have measured distractibility by comparing performance on tasks in the presence and absence of extraneous stimuli. There is often a positive association between degree of distractibility and task difficulty. As the level of task difficulty increases, susceptibility to extraneous stimuli increases (Keogh & Margolis, 1976; Keogh, Welles & Weiss, 1976). Broadbent (1958) expressed this idea in the suggestion that the human organism operates as a "limited capacity information channel" and that external stimuli affect performance mainly in situations where the "information channel" is fully occupied with relevant or task-related information. When additional, irrelevant information is introduced into the situation, the information channel becomes overloaded and a breakdown in performance results. However, when the task is undemanding, the information channel is working below capacity, and the introduction of additional irrelevant information does not lead to a deterioration in performance.

In contrast to Broadbent's (1958) information channel analogy, which describes the task in quantifiable terms, Klein and Gittelman-Klein (1975) discuss the interaction of task and distractor, concentrating on the qualitative nature of the task. Mental tasks, they suggest, are often experienced as effortful and fatiguing even by non-hyperactive children.

Quite possibly the process of concentrating for the hyperactive child is even more effortful and fatiguing and, therefore, aversive. If this were the case, then a task which is simply tiring to non-hyperactive children, would be unpleasant to hyperactive children. Distractibility, then, can be conceptualized as an attempt to gain relief from an aversive situation. In addition, Klein and Gittelman-Klein suggested that hyperactive children have a "dysregulation of pleasure-pain experience and anticipatory mechanism" (p. 50). This factor would lead hyperactive children to be even less likely to stay with an aversive task since they fail to appreciate the fact that performing the task now might lead to future rewards. Unable to withstand fatiguing tasks and unable to anticipate future rewards, the hyperactive child is quick to respond to peripheral signals "signifying the possibility of short-range, here and now rewards" (p. 51). The importance of the characteristics of the task is basic to the Klein and Gittelman-Klein model which views distractibility in hyperactive children as a two-stage process involving a "defocusing" on an aversive task and a seeking out of immediate rewards from extraneous stimuli.

Studies of the association between the properties of the task and distractibility must take into account more than the difficulty level of the task. The length of the task is another important factor. A series of studies by Sykes and his colleagues examined the effects of task difficulty and task length on the performance of hyperactive children (Sykes, Douglas & Morgenstern, 1973; Sykes, Douglas, Weiss & Minde,

1971).

Sykes et al. (1973) compared the performance of hyperactive children and non-hyperactive children on a brief reaction time task and two longer tasks. The longer tasks, which they defined as "prolonged" were a 9 minute Serial Reaction Task and a 15 minute Continuous Performance Task. There was no impairment in performance in either group on the reaction time task. Both groups deteriorated at a similar rate with time on the Serial Reaction Task. On the longer Continuous Performance Task the performance of the hyperactive children deteriorated significantly with time while that of the non-hyperactive children did not.

In an earlier reaction time study comparing the performance of hyperactive and non-hyperactive children, Cohen and Douglas (1971) found that the reaction times increased over time to a significantly greater extent in the hyperactive group. Based on these studies, and on her observations of hyperactive children at the Montreal Children's Hospital, Douglas (1975) stated that although hyperactive children are able to match the performance of non-hyperactive children on early stages of a wide variety of tasks, they tend to "fall apart" over long periods of time.

The Role of the Distractor

A distractor has commonly been defined as a stimulus which diverts a subject's attention from an ongoing focus. A distractor may create this diversion by virtue of its intensity, its novelty, or its meaningfulness due to associations attributed to it over time. An auditory distractor for example,

can be described either in terms of its decibel level (intensity) or in terms of certain other features with which the subject has formed prior associations (e.g., the ring of a telephone).

Typically, clinical descriptions of hyperactive children have indicated that they are less able than non-hyperactive children to sustain attention in the presence of any type of distractor. Most empirical studies of distractibility in hyperactive children have used distractors devoid of obvious meaningful association. Such distractors have included hooters, white noise, color cues, and flashing lights.

Auditory Distractors

Sykes, Douglas, Weiss and Minde (1971) studied the effect of auditory distractors on 40 hyperactive and 19 control subjects. The hyperactive sample consisted of 34 males and 6 females, who ranged in age from 5 to 12 years (mean = 8 years). All IQs for the hyperactive sample were above 80 as measured by the Wechsler Intelligence Scale for Children (WISC). The control group was matched for age, sex, and IQ. Selection of children for the hyperactive group was hampered by the fact that "no exact definition of 'hyperactive child' in terms of a measured quantity of movement or activity has yet been made" (p. 130). In their study, in order for a child to be considered hyperactive, both the child's parents and teacher had to report "overactivity" as a major complaint. Furthermore, this difficulty had to be reported as having been chronic and sustained throughout the day. Children diagnosed as psychotic, brain-damaged, or whose major presenting symptomatology was "behavior disturbance of an emotional nature" were excluded from this study.

The children were tested on a Continuous Performance Task (CPT), a vigilance task which presents stimuli on a small screen in a machine on the child's desk. The children were instructed to monitor the screen and

press a button whenever a criterion stimulus appeared. Stimuli were presented at intervals of 1.0 to 1.5 seconds. A failure to attend to the CPT screen could result in missing the appearance of the criterion stimulus. The failure to respond to the criterion stimulus represented an error of omission. Responding in the absence of the criterion stimulus represented an error of commission. The stimuli were presented under two conditions of distraction; a minimal condition and an intermittent noise condition. In the minimal condition, the room was kept as free as possible of extraneous distracting noise. In the intermittent condition, white noise (80db) was piped into the room at frequent, random intervals. Sykes et al. found that the presence of a "distractor" did not produce a significant decrement in the performance of hyperactive or non-hyperactive children on the CPT. They suggested that the absence of significant differences might have been due to the nature of the task; the intermittent noise might have disrupted the hyperactive children's performance if the task had been more demanding.

In another study using auditory distractors devoid of meaningful associations, Dykman, Walls, Suzuki, Ackerman and Peters (1970) tested 20 hyperactive boys whose ages ranged from 8 to 12 years with a mean age of 9 years 3 months. All children had WISC IQ scores of at least 90. Control subjects were obtained by asking teachers at local elementary schools to identify boys, ages 8 to 11, with no serious behavior problems. The boys were considered to be hyperactive based on ratings obtained on a teachers' rating scale,[1] parents' reports, and clinic observations which stated that the hyperactive children were "distractible, impulsive, easily exhaustible, lacking in ability to concentrate . . . and their movements were poorly focused or devoid of purpose" (p. 768)

Response latencies for telegraph key pressing and

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[1]Described in Dykman, Ackerman, Clements, and Peters, 1971, p. 67.

telegraph key releasing in the presence of discriminative stimulus lights were recorded for the hyperactive group and the control group. The auditory distractor was described by Dykman et al. as a "very loud" hooter (90db) which lasted one second and occasionally sounded before or during the discriminative stimulus light. Differences in response latencies between the hooter and non-hooter conditions were analyzed. Both the hyperactive and control groups showed a deterioration in performance during the trials in which the hooter was present as indicated by a significant increase in latencies for key pressing. The extent of deterioration in performance, however, was not significantly greater for the hyperactive group than for the control group.

Both the Dykman et al. (1970) study and the Sykes et al. (1971) study examined the effect of an auditory stimulus devoid of meaningful associations and within an 80-90 decibel range on the performance of hyperactive children. Neither study found the hyperactive children to be more affected by the external stimuli than the control group, and the Sykes et al. study found neither group to be affected by the stimuli. It is possible that the decibel level of the auditory stimuli in the Sykes et al. study was set too low to distract the children significantly. It is also possible that the stimuli may have failed to affect hyperactive children differently from non-hyperactive children, not because of inadequate decibel intensity, but because of the lack of content or meaning associated with the white noise which they used in their attempt to distract the children.

Visual Distractors

Studies of distraction, using visual distractors, like those using auditory distractors, found no differences in performance between hyperactive and non-hyperactive children. One method used to measure distractibility in hyperactive children is a visual distraction test designed by Santostefano and his colleagues (Santostefano, 1964; Santostefano & Paley, 1964; Santostefano, Rutledge, & Randall, 1965). Santostefano's test, entitled the Color Distraction Test, measures the extent to which a child is affected by a stimulus field containing background information which is intrusive or contradictory to the central task.

The Santostefano Color Distraction Test involves the sequential presentation of three cards: (1) On the first card there are 50 colored pictures of fruit and the children are instructed to name the color of each fruit. A baseline speed is obtained from this card. (2) Following this, a second card is presented on which are printed the same fruit pictures, but the card is bordered with black and white pictures of familiar objects such as chairs, cups, etc. The children are instructed to name the color of the fruit and ignore the black and white pictures. (3) Finally, the children are shown the third card on which the 50 fruit pictures are printed in contradictory colors. Bananas, for example, are not yellow but blue, red or green. The children are instructed to name the correct color of the fruit and ignore the color in which the fruit appears on the card.

The speed of color naming for each card is recorded. In

addition, three types of errors are scored: (1) errors of omission, (2) partial errors of commission (starting to name a color incorrectly but stopping before the entire word is said), and (3) complete errors of commission (making an incorrect response).

Campbell, Douglas and Morgenstern (1971) used the Santostefano test and hypothesized that non-hyperactive children would be able to withhold attention selectively from the intrusive information. They further suggested that hyperactive children would have difficulty withholding attention from the intrusive stimuli and that their performance on the central task would be disrupted when compared to that of the non-hyperactive children.

Campbell et al. tested 19 hyperactive children in their study. They ranged in age from 5 years 9 months to 11 years 4 months with a mean of 7 years 9 months. IQ's on the WISC rangéd from 85 to 128 with a mean of 102.7. The diagnostic criteria were the same as for the Sykes et al. study (1971). Nineteen non-hyperactive control children were selected from the local schools. The hyperactive and non-hyperactive groups were matched for age, sex, socioeconomic level and IQ.

On all three conditions--baseline, black and white peripheral pictures, and contradictory colors--the hyperactive group took significantly longer to name the colors than did the control group. However, the extent of deterioration, as measured by the difference in color-naming speed between the baseline condition and the other two conditions did not differentiate between hyperactive children and non-hyperactive

children. Hyperactive children were not significantly more distracted than non-hyperactive children on this task. In addition there was no difference between the two groups in the number of errors of omission. Finally, the total number of errors of commission did not differentiate the groups, but there was a significant interaction between subject group and type of error of commission. Hyperactive children made more complete errors of commission and non-hyperactive children made more partial errors of commission. The results do not support the hypothesis that hyperactive children are more distractible than non-hyperactive children under the conditions of the study.

Another study using visual distractors was conducted by Cohen, Weiss, and Minde (1972). They tested 20 boys who ranged in age from 13 years 5 months to 16 years 5 months (mean 15 years). All of the boys had originally been referred to the Montreal Children's Hospital because of complaints of chronic, sustained hyperactivity at home and at school. At the time of their inclusion in the study, the children were taking part in a follow-up evaluation. A control group of non-hyperactive children matched for age, sex and socioeconomic status was selected.

Three tasks were used. The first two tasks were measures of "automatization," the ability to respond rapidly to simple repetitive material. The first task measured the speed with which the children were able to read 100 words printed on a single card. The words were the names of four colors printed in black ink and repeated in random order. The second task

measured the speed with which children were able to name the color of 100 color patches printed on a card. The same four colors were used as were printed on the first card, and again the patches were randomly presented. These tasks were chosen since earlier studies (Broverman, 1960; Broverman, Broverman & Klaiber, 1966) had found that children who were strong automatizers were able to resist distractions. Cohen et al. hypothesized that since hyperactive children were reported in the clinical literature to be poor in concentration, low in persistence, and easily distracted by extraneous input, they would maintain a less efficient response rate to repetitive tasks than non-hyperactive children.

The third task of Cohen et al. was modelled after the Santostefano Color Distraction Task described above, which is aimed at measuring the extent to which children are affected by a stimulus field containing background information which is intrusive or contradictory to the central task. On this task, which was presented on a single card, the names of colors were printed in an ink of a contradictory color. For example, the word "blue" would appear in green ink. The children were instructed to name the color in which the color word was printed.

The speed with which the children read each of the three cards was recorded. Color naming errors were also noted. No differences were found between the two groups on any of the task cards. Hyperactive and non-hyperactive children showed no difference on automatization skills, as measured by

performance on the first two cards, or on the ability to ignore distractors, as measured by the performance on the third card.

The third study using discrepant color as a distractor was performed by Sykes, Douglas, and Morgenstern (1973). They selected 20 hyperactive children, 17 males and 3 females between the ages of 6 and 12 years (mean = 8 years). The children had IQ's above 80 on the WISC (mean = 102). Children were included in the hyperactive group if they were reported to be overactive by both their parent and their teacher. Furthermore, the hyperactivity had to have been reported as being chronic. Children with signs of emotional disturbance or gross brain damage were excluded. Twenty non-hyperactive children matched for age, sex, and IQ were also tested.

The task required the children to press one of four buttons that showed a shape that corresponded to a shape that appeared on the screen. During the non-distraction condition, both the stimuli on the buttons and on the screen were white and were displayed on a black background. During the distraction condition, each of the shapes on the screen had a different colored background and the push buttons had colored backgrounds. The background color on the screen and background color of the correct pushbutton were discrepant. The background color was designed to act as a distractor. Reaction times for both conditions were measured and compared. No significant difference was found between the hyperactive and the non-hyperactive group. Although both groups showed significantly longer reaction times during the distraction condition,

the hyperactive group's performance was indistinguishable from that of the non-hyperactive group.

None of the three empirical studies using visual distractors found that hyperactive children were more distractible than non-hyperactive children. In all three studies, the task placed very little demand upon the children, requiring simply color-naming or symbol recognition. Although some of the tasks were designed to confuse the child, none of them could be considered taxing or aversive. Similarly, the external stimuli intended as distractors in all three studies share a single characteristic. All three, like their counterparts in the auditory studies discussed earlier (white noise, hooters), are relatively devoid of meaningful associations.

Auditory and Visual Distractors

Two recent studies combined auditory and visual stimuli in an attempt to study the effect of distractors on the performance of hyperactive children. In the first study, Bremer and Stern (1976) measured eye movements on a reading task to determine whether or not hyperactive children exhibit more head and eye movements in the presence of a distractor compared to non-hyperactive children. Bremer and Stern studied 15 hyperactive boys who range in age from 9 to 12 years (mean = 10 years 7 months), with IQ's above 80 on the Peabody Picture Vocabulary Test (mean 97.5) and with at least a third grade reading level as measured by the Wide Range Achievement Test (Jastak & Jastak, 1965). The children were diagnosed as hyperactive on the basis of two criteria: (1) an impression of

overactivity as a prominent symptom, derived from clinical records and/or referral statements and (2) parental ratings on a scale developed by Stewart, Pitts, Craig, and Dieruf (1966). Non-hyperactive boys matched for age, IQ, reading level, and socioeconomic status were used for the control group.

The children were instructed to sit in a room and read brief stories to themselves. The stories were selected from materials published by Science Research Associates (1960) and were on the second, fourth, and sixth grade levels. The stories were first presented to each child to read silently under quiet background conditions. After the stories were completed in the quiet condition, an alternate set of stories was given to each child, and a "distraction tape" was activated. Distracting stimuli consisted of either a telephone ringing (65db) with lights flashing on the phone and a sinusoidal oscilloscope display accompanied by the sound of a Monroe calculator performing multiplication operations (75db). Auditory stimuli were taped in random order with a 5-second stimulus duration and with variable intertrial intervals from 10 to 20 seconds.

Reading speed for the two groups was measured. In addition, measures of duration of fixation pauses, incidence of exceptionally long or short fixations, variability in reading speed, eye-blink frequency, head movement artifacts and horizontal eye movements away from the printed page were obtained from electro-oculograms. Reading speeds in the two groups were not significantly different. Furthermore, hyperactive children could not be discriminated from non-hyperactive

children on any of the eye movement measures under the no distraction condition. However, when distractors were introduced, the hyperactive group was found to be significantly more reactive to the distracting stimuli than the non-hyperactive group. Bremer and Stern did not report on the specific eye movements and head movements that differentiated their two groups. They concluded, however, that the hyperactive group responded to more of the distracting intervals and for longer periods of time. The median time distracted during the distracting intervals was 18 seconds for the hyperactive group and 5 seconds for the non-hyperactive group.

A second study using both auditory and visual distractors was conducted by Zentall and Zentall (1976). Although the purpose of their study was to test the hypothesis that hyperactive children are understimulated and will show an _improvement_ in performance in the presence of external stimuli, their findings are relevant to the present study. They selected 16 children from 88 students who were enrolled in a private school for children with learning disabilities and emotional disorders. The children were chosen on the basis of their scores on Davids' Rating Scale for Hyperactivity (Davids, 1971), which consists of 6 items, scored 1-6, yielding a range of scores between 6 and 36. According to Davids, children are considered hyperactive if they obtain a score of 24 or above. The children chosen by Zentall and Zentall (1976) had scores ranging from 26 to 36. The Davids scale was the only diagnostic instrument used. As noted earlier, restricting the criterion to behavior in a single setting

(school) may result in an inaccurate assessment of the child's behavior. No normal control group was used in the study.

The children ranged in age from 7 to 11 years. Mean age was not reported. Each child was exposed to two levels of external stimulation (high and low) while performing two successive tasks. During the low stimulation condition, children were tested in a bare room with moderate illumination and white masking noise (45-55db) piped into the room. During the high-stimulation condition the walls were decorated with brightly colored pictures, posters, and large lettered signs. A "Habit Trail" cage containing mice was hung from a wall in front of the testing desk. Papier mache scenes, a brightly colored carpet, stings of colored Christmas lights, and rock music (Led Zeppelin) piped into the room at 70-80db completed the high stimulation distraction condition.

Each child was exposed to both conditions in counterbalanced order. Each session lasted 20 minutes, divided in two equal segments. For the first ten minutes the child was instructed to remain at a desk until the experimenter returned. Mechanical measures of motor activity were recorded from wrist and ankle actometers. During the second 10 minute period, the child was instructed to perform what Zentall and Zentall described as an "academically related performance task." The task involved locating and circling the letters of the alphabet in sequential order from a large array of letters. When the child reached the end of the alphabet, he repeated the procedure with a new array of letters.

Activity level and task performance scores during the

the low stimulation condition were compared with scores during the high stimulation condition. Hyperactive children performed as accurately and rapidly in the presence of stimuli meant to serve as distractors as they had when external stimuli were kept at a minimum. Zentall and Zentall found, however, that on three out of the four activity measures the level of activity was significantly reduced in the presence of high stimulation.

Summary and Critique of Empirical Studies

Documentation of excessive distractibility in hyperactive children has eluded researchers despite the unanimous agreement that attentional problems are an important clinical characteristic of this population. With the exception of Bremer and Stern (1976), the investigators cited above found either that hyperactive children were unaffected by the extraneous stimuli or that non-hyperactive and hyperactive children were affected to the same degree by the distracting stimuli. A plausible explanation for why most empirical studies have found hyperactive children to be no more distractible than non-hyperactive children is the possibility that the external stimuli used as distractors were not appealing to young children. Klein and Gittelman-Klein (1975) suggest that the implication that _any_ stimulus suffices to divert the attention of hyperactive children, while consistent with "unrefined clinical observation," is probably not the most accurate description of the problem. They state that

> it is probably incorrect to view a failure in stimulus inhibition as central to the lack of sustained attention in hyperactive children . . . . An alternative explanation for the attention defect is that much so-called distractibility may be an interaction between a spontaneous "defocusing" combined with exploratory behavior in the service of appetitive interests (p. 50).

If this alternative explanation is correct, then hyperactive children would be no more or less distracted than non-hyperactive children in the presence of white noise (Sykes et al., 1971), hooters (Dykman et al., 1970), black and white pictures of common objects (Campbell et al, 1971) or contradictory color cues (Campbell et al., 1971; Cohen et al., 1972; Sykes et al., 1973). There is little about these external stimuli that offer the possibility of reward or even of interesting relief from a fatiquing or aversive task.

The Bremer and Stern study (1976), published after work on the present study had begun, was the first study of distractibility that used external stimuli which had a differential effect on hyperactive and non-hyperactive children. Their stimuli consisted of an oscilloscope with a TV-like screen and a flashing, ringing telephone. These stimuli, which may have been qualitatively different from the relatively content-free stimuli used by earlier researchers, were more distracting to hyperactive children than they were to non-hyperactive children.

The distractors used by Zentall and Zentall (1976) would seem to be potentially interesting to young children. The brightly colored pictures and figures, live mice, rock music, and Christmas lights seem capable of eliciting exploratory behavior and, therefore of serving as distractors. The fact

that their study did not obtain a decrement in performance in the presence of these external stimuli seems to conflict with the position that hyperactive children are distracted by highly appealing stimuli. However, there are a number of methodological problems with the Zentalls' study which should be considered when reviewing their findings. The Zentalls established a single criterion for determining hyperactivity: teacher rating scores. With this criterion it has been ascertained only that the children in the Zentall study were considered hyperactive by a single source (the teacher) and in a single setting (the classroom).

In addition, the study design required every child to wait alone in the high stimulation environment for 10 minutes before beginning the task. It is possible, therefore, that the children had habituated to the external stimuli before the task began.

The view that distractibility in hyperactive children involves turning away from a task as well as turning toward external distractors for anticipated reward means that careful attention should be paid to the tasks used in the empirical studies of distraction as well as to the distractors. For the most part, the studies cited above used tasks which were brief and non-taxing. The children were instructed to press a button in the presence of criterion stimuli (Sykes et al., 1971; Dykman et al., 1970), to name the color of fruits and color words (Cohen et al., 1972; Campbell et al., 1971), to match simple shapes (Sykes et al., 1973), or to circle letters of the alphabet in sequential order (Zentall & Zentall, 1976).

It is unlikely that these tasks are representative of those usually presented in the classroom. In contrast, Bremer and Stern (1976), who obtained significant between-group differences, duplicated a classroom task in their study of distractibility since the children were required to read grade-level passages to themselves.

In addition to using brief, non-taxing tasks, the empirical studies reviewed above did not assess the appeal level of the external stimuli used as distractors. It is possible, therefore, that one of the reasons they found no significant differences between the performance of hyperactive and non-hyperactive children is that the external stimuli had too low an appeal level to distract the children effectively.

The effect on performance of varying the level of external stimulus appeal and task difficulty are two issues that need to be explored more fully in studies of distractibility in hyperactive children. The present study compares the effectiveness of external stimuli, varying in level of appeal, to serve as the distractors. The task for the present study was selected because it is representative of elementary school classroom work. The difficulty level of the task is not manipulated.

Hypotheses

The general hypothesis of the present study is that appealing stimuli have a negative effect on the task performance of hyperactive children as compared to the effect of these stimuli on the performance of non-hyperactive children on a school-related task.

The specific hypotheses tested are: (1) High appeal distractors (to be described later) will disrupt the performance of hyperactive children significantly more than the performance of non-hyperactive children on an arithmetic task. (2) Compared to the performance of non-hyperactive children, hyperactive children will not perform as well in the presence of High Appeal stimuli as in the presence of Low Appeal stimuli (to be described later).

METHOD

Subjects

The sample of hyperactive children consisted of 20 boys who had been referred by their teachers for treatment at the Child Development Clinic of the Long Island Jewish Hillside Medical Center. They were chosen from a group of over 100 children on the basis of age and grade.

The boys ranged in age from 7 years 3 months to 10 years 7 months (mean = 9 years 1 month, SD = 10 months). Intelligence quotients were obtained on the revised Wechsler Intelligence Scale for Children (WISC-R; Wechsler, 1974). Verbal IQ scores ranged from 87 to 128 (mean = 105, SD = 13.10). Performance IQ scores ranged from 87 to 122 (mean = 106, SD = 11.55); and Full Scale IQ scores ranged from 91 to 121 (mean = 106, SD = 9.33). Age and IQ scores for each child are presented in Appendix A.

All the children were in either the second, third or fourth grades of elementary schools in Queens or Nassau counties. Four boys were in the second grade; 6 were in the third grade; and 10 were in the fourth grade. Because of the nature of the task (to be described later) only children whose arithmetic scores were within 1 year of grade level on the Wide Range Achievement Test (WRAT; Jastak, 1965) were included in the study. WRAT scores for each child are presented in Appendix A. On the average, WRAT scores were 2 months below grade level (SD = .67). Three of the children were Black, two were Hispanic, and the remaining 15 were White.

The socioeconomic status of the hyperactive children was determined on the basis of father's occupation and level of education (Hollingshead, 1958). The socioeconomic status of each child is presented in Appendix A. Demograhpic data for the hyperactive group is presented in Table 1.

Assessment of Hyperactivity

Assessment of hyperactivity was based on teacher ratings and parent reports. All the children in the hyperactive group had to be referred by their teachers for treatment for hyperactivity. The Conners' Teacher Rating Scale (Conners, 1969) was used to obtain teachers' evaluations. (See Appendix B for Rating Scale. The seven criterion items are indicated on the scale.) In order to be considered hyperactive, a child had to have a minimum mean score of 1.8 out of a possible maximum of 3.0 on the Hyperactivity factor of the Conners scale. This criterion score was based on norms obtained by Sprague, Christiansen, and Werry (1974) who reported a mean factor score of .40 (SD = .55) for normal children and a mean of 2.17 (SD = .78) for hyperactive children. In the present study the children's scores on the Conners' Teacher Rating Scale ranged from 1.9 to 3.0 (mean= 2.4, SD = .40); their scores are presented in Appendix A. Three items on the Conners scale most directly reflect gross motor activity (Fidgeting, Restless/Overactive, Excitable/Impulsive). A minimum score of 3 and a maximum score of 9 could be obtained on these three items. Scores ranged from 6 to 9 (mean = 7.8, SD = 1.0).

In addition to the teachers' ratings, parents had to report that the child was hyperactive or had troublesome behavior problems at home. Parents frequently reported that their child had

TABLE 1

DEMOGRAPHIC DATA FOR HYPERACTIVE AND NON-HYPERACTIVE GROUPS

	Age		Race			SES		Grade		WISC[b] VIQ		PIQ		FISQ		WRAT Arithmetic	
Group[a]	M	SD	Black	White	Hispanic	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Hyperactive	9 yr- 1 mo	10 mo	3	15	2	3.11	.90	3.9	.80	105	13.10	105	11.55	106	9.33	3.70	.7
Non-Hyperactive	8 yr- 6 mo	9 mo	3	13	4	2.94	1.21	3.4	.70	107	14.70	--	--	--	--	3.30	.40

[a]n = 20 in each group

[b]only Verbal IQ scores are available for the Non-Hyperactive Group

been extremely active since infancy, including one report of a child who broke through the bottom of his crib. Current behavior at home was described in one case as "horrendous." Another mother stated that her son runs through the house like a fire engine, and there are frequent reports of disorganized and destructive play. A sample of parents' comments are presented in Appendix C.

Medication

Fifteen of the 20 hyperactive boys had been receiving methylphenidate prior to testing. They were taken off medication at least 72 hours prior to the testing session. A "washout period" of this duration appears to be sufficient to eliminate any residual effects of methylphenidate (Berkley, 1977a). The remaining five children were in the process of being evaluated by the Child Development Clinic and no treatment had been initiated.

The control group was comprised of 20 boys from the second, third, and fourth grades of a Brooklyn, New York, public school (P.S. 321). Eight boys were in the second grade, seven in the third grade, and five in the fourth grade. Teachers in each grade were asked to submit the names of boys who showed no signs of hyperactivity or behavioral problems. Children in the control group had never been referred for treatment for hyperactivity. Ages ranged from 7 years 3 months to 10 years 1 month (mean = 8 years 6 months, SD = 9 months). The Non-Hyperactive Group was 7 months younger than the hyperactive group. The difference was significant, t (38) = 2.34, p = .03 and there was no significant difference in grade level, t (38) = 1.99, p = .06. Verbal IQ scores were obtained on the WISC-R for each child. The scores ranged from 86 to 131 (mean = 107, SD = 14.7). There was no significant difference in Verbal IQ scores between the Hyperactive and Non-Hyperactive Group, t (38) = .45, p = .65. All control group children had to meet the criterion of having arithmetic scores within 1 year of grade

level on the Wide Range Achievement Test. On the average, WRAT scores were 1 month below grade level (SD = .45). The mean WRAT score for the Non-Hyperactive Group was 4 months lower than that of the Hyperactive Group, t (38) = 2.21, p = .03.

Three of the control children were Black, four were Hispanic and the remaining 13 were White. SES scores were obtained using the same procedure described for the Hyperactive Group. There was no significant difference between the mean SES Scores of the two groups, t (34) = .45, p = .66. Age, Verbal IQ scores, SES scores, and WRAT scores for each child are presented in Appendix D. Demographic data for the Non-Hyperactive Group is presented in Table 1 (page 39).

Stimuli

The task stimuli, three sets of arithmetic problems, were chosen to simulate a demanding classroom task. Each set contained eight problems and included addition, subtraction and, for the higher grade, multiplication problems (See Appendix E). The problems were chosen by second, third and fourth grade teachers from P.S. 321 in Brooklyn. Each child was administered a single set of problems corresponding to his grade level.

Surrounding the task stimuli, which were presented in the center of a testing machine window, was a two-inch border. The appearance of this border area determined which of three external stimulus conditions was being presented: "High Appeal," "Low Appeal" or "No Appeal." The border during the High Appeal condition contained magazine pictures of toys, comical animals and people, food, television characters, space-craft, etc. During the Low Appeal condition, the border contained five fragments of abstract art paintings (Jackson Pollock) and op-art posters. For the No Appeal condition, the white border contained no pictures. Selection of the stimuli used in the High Appeal and Low Appeal conditions was guided by attempts to

control for potency of visual impact. All pictures and abstract fragments were brightly colored and of approximately the same size. See Appendix F for examples of each type of stimulus condition.

In order to test empirically whether the different external stimulus conditions in fact varied in level of appeal, two pilot studies were conducted. In the first pilot study, four hyperactive and four non-hyperactive boys between the ages of 7 and 9 were asked to rate 15 stimulus cards. Five cards had pictures selected from the stimuli to be used in the High Appeal condition; five cards had abstract art fragments chosen from stimuli to be used in the Low Appeal condition; and five cards were blank, as in the No Appeal condition. The children were told to choose whether each card was (a) "interesting and fun to look at," (b) "a little bit interesting to look at," or (c) "not interesting or fun to look at at all." The results of the categorization of the stimulus cards are presented in Table 2. Eighty-five percent of the magazine pictures were described as "interesting and fun to look at"; 75 percent of the abstract art fragments were categorized as "a little bit interesting to look at"; and 95 percent of the blank cards were considered to be of no interest. (See Appendix G for additional description of the first pilot study.)

A second pilot study, using an expanded, representative sample of the stimulus cards was conducted.[1] In this pilot

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[1]Because of the importance of empirically determining the appeal level of the external stimuli, a second pilot study, with a larger sample of stimulus cards, was run to confirm the results of the first pilot study.

TABLE 2

PILOT STUDY I: PERCENT OF STIMULUS CARDS PLACED IN EACH APPEAL CATEGORY

Stimulus Cards[a]	Appeal Category		
	High	Low	No
Magazine Pictures	85%	12%	2%
Abstract Art	18%	75%	8%
Blank Cards	2%	2%	95%

[a]Five cards in each group

study, seven hyperactive and seven non-hyperactive boys between the ages of 7 and 9 viewed 100 stimulus cards to be used in the main experiment. These cards were randomly selected from the three appeal conditions. Each card was rated on the same three-choice scale used in the first pilot study.

The results of the second pilot study are presented in Table 3. The hyperactive children rated 78% of the magazine pictures as highly appealing; non-hyperactive children rated 79% of the magazine pictures as highly appealing. The abstract art fragments were rated as having little appeal in 75% and 78% of the cases by hyperactive and non-hyperactive children respectively. The plain white cards were judged to be of no interest in 94% and 96% of the cases in hyperactive and non-hyperactive children, respectively.

TABLE 3

PILOT STUDY II: DESCRIPTION OF APPEAL LEVEL OF STIMULUS CARDS

Group	High Appeal[a]	Low Appeal[b]	No Appeal [c]
Hyperactive	78%	75%	94%
Non-Hyperactive	79%	78%	96%

[a]Percent of magazine picture cards rated, "High Appeal."

[b]Percent of abstract design cards rated, "Low Appeal."

[c]Percent of blank cards rated, "No Appeal."

See Appendix I for a complete description of the second pilot study.

Procedure

Each child was tested individually and told that he was to play a math game. The child was brought into an unoccupied office either at the Child Development Clinic at the Long Island Jewish-Hillside Medical Center or at P.S. 321 in Brooklyn. The child was seated at a small desk on which was placed the BCI teaching machine and the four-button response box. (The apparatus will be described later.) In order to familiarize the child with the apparatus and the task, an eight-trial pretest training session was administered to each child. The child was told that arithmetic problems were going to be shown in the window of the teaching machine. He was instructed

to press the button that showed the correct solution to the problem visible in the window. The four specific response choices shown on the solution buttons are presented for each grade in Appendix F. Each child was informed that the problems would only be shown for a short time and that they should press the correct button as soon as possible. No stimuli surrounded the arithmetic problems during the pretest session.

Following the pretest, the experimental packs of stimuli were placed in the BCI teaching machine. A total of 300 trials were administered to each child, 100 for each stimulus level. The three stimulus conditions were not presented in blocks but rather the 300 stimuli (100 stimuli for each appeal condition) were presented in random order over the 300 trials. Eight different arithmetic problems were randomized over all 300 trials, with each problem appearing in the display window approximately 38 times. Each problem was shown for a maximum of 3 seconds. The 3-second duration was chosen as a result of the findings of a pilot study conducted to determine the rate of stimulus presentation which precluded the possibility of responding correctly on every trial and which therefore allowed for the detection of differences among conditions. See Appendix J for a description of this pilot study. It took 1.2 seconds for the machine to advance from one stimulus presentation to the next.

If the child pressed a response button during the 3-second period the stimulus paper automatically advanced to the next problem. The length of each trial varied, therefore, according to each child's response latency, up to a limit of 3 seconds. Allowing two 60-second periods to change the stimulus rolls, and a 1.2 second interval between stimulus presentation, each testing session lasted a maximum of 23 minutes. However, if a child responded at an average of 1.5 seconds per trial,

his testing session lasted a total of 14.5 minutes. A counter recorded whether or not the button displaying the correct answer had been pushed. The experimenter recorded the response to each trial.

Apparatus

A Behavioral Control Incorporated (BCI) teaching machine was used to present the stimuli. The BCI machine is desk-size and has a 5 x 7-inch window in the center. The machine is constructed to permit a pack of paper to be rolled through the mechanism and displayed under the display window. The machine was programmed so that stimuli attached to the paper could be stopped for display under the window for an amount of time specified by the experimenter or until the subject made a response.

For the present study, a four-button response box was connected electronically to the teaching machine. Each button displayed a number. On each trial, one of the four numbers corresponded to the answer to an arithmetic problem visible in the display window. The teaching machine was programmed to tally all correct and incorrect button pushes. The data were grouped by stimulus appeal level, and total error scores were obtained for each stimulus condition for each child.

In addition, to permit examination of the change in performance across trials, the total number of errors for the second 50 trials (51-100) and the total number of errors for the last 50 trials (251-300) were recorded for the hyperactive and the non-hyperactive children.

Statistical Design

The data, consisting of the number of incorrect responses for each child, were analyzed using a two-way factorial design. The two factors were groups (Hyperactive and Non-Hyperactive) and conditions (High, Low and No Appeal), with conditions a repeated measure. Following the analysis of variance, an analysis of the simple effects was conducted using the Newman (1939) and Keuls (1952) procedure based on the studentized range statistic (NKQ). The Newman-Keuls test, a stepwise, multiple-comparison procedure (MCP) for comparisons among means, is a powerful MCP which gives adequate control of the Type I error rate in studies where the number of levels of the treatment conditions is equal to or less than three (Ramsey, 1978). In the present study, there were three levels of the treatment condition: High Appeal, Low Appeal and No Appeal. Comparisons of difference scores were made using an independent sample t test of difference scores (Edwards, 1968). Two-tailed tests were applied to all data analyses.

A total of 14 statistical analyses were performed on the data. The limited number of analyses permitted the alpha level to be fixed at .05 for all significance tests and statistical comparisons.

RESULTS

Analyses were performed on the errors obtained by the hyperactive and non-hyperactive children on an arithmetic task in the presence of No Appeal, Low Appeal and High Appeal stimuli. The total number of errors in each stimulus condition for each child is presented in Appendix K.

The mean number of errors made by the Hyperactive Group and the Non-Hyperactive Group within each stimulus condition are presented in Table 4.

TABLE 4

MEAN NUMBER OF ERRORS MADE ON ARITHMETIC TASK

	Stimulus Condition[a]					
	No Appeal		Low Appeal		High Appeal	
Group[b]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hyperactive	39.20	19.12	43.60	20.00	47.30	21.40
Non-Hyperactive	32.25	17.09	31.80	16.26	35.80	18.03

Note: [a]100 trials in each condition (maximum error score = 100).

[b]n = 20 in each group.

A two-way analysis of variance (group x stimulus conditions) was performed. The results of the analysis of variance are presented in Table 5.

TABLE 5

ANALYSIS OF VARIANCE OF ERRORS OF HYPERACTIVE AND NON-HYPERACTIVE CHILDREN ON AN ARITHMETIC TASK

	Sum of Squares	d.f.	Mean Square	F
Main Effect				
Groups[a]	3050.21	1	3050.21	2.98*
Error Term	38892.78	38	1023.49	
Conditions	702.05	2	351.02	23.66**
Error Term	1127.57	76	14.84	
Interaction				
Groups x Conditions	147.72	2	73.86	4.98**

[a] $n = 40$

* $p \doteq .09$

** $p < .01$

The significant difference across conditions, $F\ (2,76) = 23.66$ $p < .001$, indicates that when both groups (Hyperactive and Non-Hyperactive) are combined, there is a significant increase in the number of errors as the stimulus appeal level increases from No Appeal to Low Appeal to High Appeal. The non-significant difference between groups $F\ (1,38) =$

2.98, p =.09, indicates that when the three levels of the stimulus condition were grouped together the number of errors made by the Hyperactive Group was not greater than that made by the Non-Hyperactive Group. The significant groups by condition interaction, $F\ (2, 76) = 4.98$, $p < .01$, indicates that the pattern of change in errors from No Appeal to Low Appeal to High Appeal differed for the two groups. Figure 1 depicts the groups by condition interaction graphically.

In order to determine whether pair-wise differences between treatment conditions were significant for either the Hyperactive or the Non-Hyperactive group, the Newman-Keuls multiple comparison procedure was performed. The difference between pair-wise means, Wr, which had to be met or exceeded in order for differences between a pair of treatment means to be considered significant at the .05 level was 2.96. The difference between pairs of means among the levels of the stimulus condition are presented in Table 6.

There was a significant increase in the number of errors made in the High Appeal condition compared with the Low Appeal condition for the Hyperactive Group , as well as a significant increase in errors in the Low Appeal condition compared with the No Appeal condition.

The Non-Hyperactive Group also made significantly more errors in the High Appeal condition than in the Low Appeal condition. There was no significant difference in the number of errors between the Low Appeal and No Appeal conditions for this group. The difference in the number of errors made between the High and No Appeal conditions was significant for the Non-Hyperactive Group.

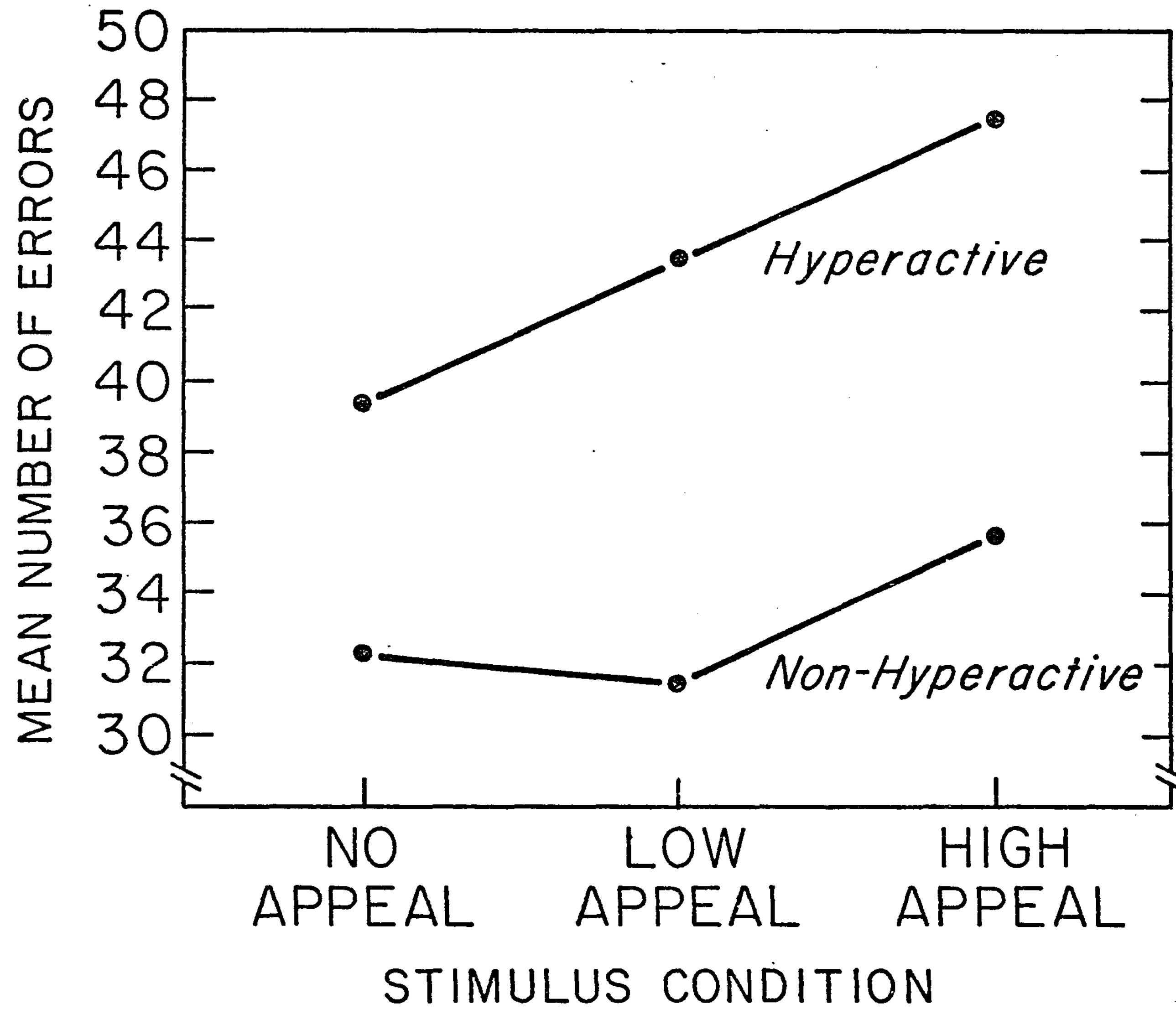
50
48
46
44
42
40
38
36
34
32
30
MEAN NUMBER OF ERRORS
Hyperactive
Non-Hyperactive
NO APPEAL
LOW APPEAL
HIGH APPEAL
STIMULUS CONDITION

TABLE 6

DIFFERENCES IN MEAN NUMBER OF ERRORS:
COMPARISONS BETWEEN CONDITIONS

	Stimulus Condition Comparison		
Group[a]	Low Appeal vs. No Appeal	High Appeal vs. Low Appeal	High Appeal vs. No Appeal
Hyperactive	4.40*	3.70*	8.10*
Non-Hyperactive	-.45	4.00*	3.55*

Note: $\underline{W}_r$ (Newman-Keuls) = 2.90

[a]n = 20 in each group
*$p < .05$

The significant difference between groups, as indicated by the ANOVA with all conditions combined, was analyzed to permit pair-wise comparisons between the two groups in each treatment condition. The Newman-Keuls procedure yielded a $\underline{W}_r$ of 20.46. The pair-wise differences between the Hyperactive and Non-Hyperactive Groups are presented in Table 7. Since no pair-wise differences between group means met or exceeded 20.46, no significant differences between groups within conditions were obtained. The failure to find significant pair-wise differences between groups by the Newman-Keuls procedure is consistent with the non-significant between groups $\underline{F}$ obtained from the analysis of variance.

TABLE 7

DIFFERENCE IN MEAN NUMBER OF ERRORS:

COMPARISON BETWEEN GROUPS

Group Comparison	Stimulus Condition		
	No Appeal	Low Appeal	High Appeal
Hyperactive vs. Non-Hyperactive	9.95	12.30	11.50

<u>Note</u>: $\underline{W}_r$ (Newman-Keuls) = 20.46

No significant differences were obtained.

<u>Hypothesis I</u>

Both hyperactive and non-hyperative children showed a significant deterioration in performance in the High Appeal condition compared to the No Appeal condition. The extent of deterioration for the two groups was compared to determine whether High Appeal stimuli disrupted the performance of hyper-active children significantly more than they disrupted the

performance of non-hyperactive children on an arithmetic task. The mean difference in number of errors was 8.10 for the Hyperactive Group and 3.55 for the Non-Hyperactive Group. In order to determine whether the extent of deterioration differed significantly, an independent *t* test of difference scores was performed. The hyperactive children showed a significantly greater deterioration between the High Appeal stimulus condition and the No Appeal stimulus condition than did the non-hyperactive children (*M* 47.30 - *M* 39.20 vs. *M* 35.80 - *M* 32.25), t (38) = 2.29, $p < .03$. The first hypothesis, therefore was confirmed.

Hypothesis 2

Error scores were analyzed to determine whether the performance of hyperactive children deteriorated more in the presence of High Appeal stimuli than in the presence of Low Appeal stimuli compared to the performance of non-hyperactive children in the same two conditions. The mean difference in errors between the High and Low Appeal conditions was 3.70 for the hyperactive children and 4. 0 for the non-hyperactive children. The analysis was performed using an independent sample *t* test of difference scores. Although both groups made significantly more errors in the presence of High Appeal than Low Appeal stimuli, the extent of this deterioration was not greater for the Hyperactive Group than for the Non-Hyperactive Group (*M* 47.30 - *M* 43.60 vs. *M* 35.80 - *M* 31. 0, t (38) = .21, $p = .84$). The second hypothesis was not supported.

The Newman-Keuls test of simple effects indicated a

significant increase in errors between the No and Low Appeal conditions for the Hyperactive Group and a non-significant decrease in errors between the No and Low Appeal conditions for the Non-Hyperactive Group. Since, for the Hyperactive Group, the number of errors between the two conditions was significantly greater than zero and since the Non-Hyperactive Group showed no increase in errors between the two conditions no further statistical test of differences was performed.

Deterioration Across Trials

In order to determine whether hyperactive and non-hyperactive children make more errors across trials, a comparison was made of the mean number of errors made by both groups during the second block of 50 trials (51-100) and the last block of 50 trials (251-300). The total number of errors in each block for each child is presented in Appendix L. The mean numbers of errors for both groups in both blocks of trials are presented in Table 8. A two-way analysis of variance indicated a significant difference between the second and the last block of 50 trials, but it did not reveal a significant difference between the Hyperactive and Non-Hyperactive groups nor was there a significant interaction effect. The results of the analysis of variance are presented in Table 9.

The data indicate that, rather than the number of errors increasing across trials, both the Hyperactive and Non-Hyperactive Groups improved significantly between the second block of 50 trials and the last block of 50 trials, F (1,38) = 18.73, $p < .01$. The difference between the performance of the

TABLE 8

MEAN NUMBER OF ERRORS ON TWO BLOCKS OF TRIALS:

CHANGES ACROSS TRIALS

	Trials			
	Second Block (51 - 100)		Last Block (251 - 300)	
Groups[a]	*M*	*SD*	*M*	*SD*
Hyperactive	23.75	10.91	19.36	11.27
Non-Hyperactive	19.75	10.12	15.55	8.90

[a]n = 20 in each group.

TABLE 9

ANALYSIS OF VARIANCE OF ERRORS ON SECOND AND LAST

BLOCK OF TRIALS (51 - 100 AND 251 - 300)

	Sum of Squares	d.f.	Mean Square	*F*
Main Effect				
Groups[a]	300.31	1	300.31	1.52
Error Term	7483.58	38	196.94	
Blocks of Trials	374.11	1	374.11	18.73*
Error Term	759.08	38	19.98	
Interaction				
Groups x Blocks of Trials	312.00	1	312.00	.02

[a]n = 40

Hyperactive Group and the Non-Hyperactive Group was not significant. F (1,38) = 1.52, p = .27.

In order to assess whether the change in performance across trials differed according to stimulus condition, the number of errors for each condition was computed for the first and last 90 trials (trials 1-90 and 211-300). These data are presented in Table 10. The differences in mean number of errors within each condition for the hyperactive and non-hyperactive groups are presented in Table 11. The difference between the Low Appeal condition (4.95 errors) and the High Appeal condition (2.85 errors) for the non-hyperactive group was analyzed by means of a t test. The difference was not significant: t (38) = 1.37 p = ns.

In summary, the performance of hyperactive and non-hyperactive children on an experimental arithmetic task deteriorated in the presence of High Appeal distractors compared to No Appeal distractors, with hyperactive children showing significantly greater deterioration. Both the hyperactive and non-hyperactive children made more errors in the presence of High Appeal distractors compared to Low Appeal distractors, and the extent of deterioration of performance was not significantly different for either group. Both groups showed improvement in performance across trials.

TABLE 10

CHANGES ACROSS TRIALS: MEAN NUMBER OF ERRORS WITHIN EACH CONDITION ON TWO BLOCKS OF TRIALS

	First Block (1-90)						Last Block (211-300)					
	No Appeal		Low Appeal		High Appeal		No Appeal		Low Appeal		High Appeal	
Group[a]	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Hyperactive	14.30	6.10	15.70	5.73	16.40	6.62	10.05	6.05	11.70	7.59	13.05	7.41
Non-Hyperactive	12.05	6.80	11.95	5.76	12.0	6.64	7.65	4.73	7.00	6.00	9.15	6.52

[a]n = 20 in each group

TABLE 11

CHANGES ACROSS TRIALS: DIFFERENCES IN MEAN NUMBERS OF ERRORS WITHIN EACH CONDITION

	Number of Errors*					
	No Appeal		Low Appeal		High Appeal	
Group[a]	M	SD	M	SD	M	SD
Hyperactive	4.25	.05	4.00	1.86	3.35	.79
Non-Hyperactive	4.40	2.07	4.95	.24	2.85	.12

[a]n - 20 in each group

*Number of errors on first block of trials (1-90) - number of errors on last block of trials (211-300).

DISCUSSION

Empirical studies of distractibility in hyperactive children, with a single exception (Bremer & Stern, 1976) have not reported significant differences in performance between hyperactive and non-hyperactive children. These studies did not attempt to ascertain whether the external stimuli were appealing to young children before labelling them "distractors." Therefore, it is possible that the absence of positive findings might have resulted, in part, because of lack of interest in the external stimuli.

The present study was designed to determine whether stimuli that had been rated as having High Appeal would significantly disrupt the performance of hyperactive children on a grade-level arithmetic task. In addition, an attempt was made to distinguish between the effectiveness of High Appeal and Low Appeal stimuli in their ability to disrupt the performance of hyperactive children. In both cases the extent of deterioration in the performance of the hyperactive children was compared to the extent of deterioration in the performance of non-hyperactive children.

The results of the present study support the hypothesis that, compared to No Appeal stimuli, High Appeal stimuli are significantly more distracting to hyperactive children than to non-hyperactive children as measured by errors on a task.

Earlier empirical studies have reported a significant deterioration in performance in the presence of extraneous stimuli in both hyperactive and non-hyperactive children. The extent of deterioration of performance in the presence of extraneous stimuli had not been found to be greater for hyperactive children than for non-hyperactive children in previous studies (Cohen et al., 1972; Campbell et al., 1971; Dykman et al., 1970; Sykes et al., 1973). In the present study, however, the extent of deterioration for the hyperactive children in the presence of the High Appeal stimuli compared to the No Appeal stimuli was significantly greater than the extent of deterioration for the non-hyperactive children. These findings are consistent with Douglas's (1972) view that hyperactive children are

> less disrupted by outside distractors than many of the reports in the literature would suggest; nevertheless, they can be led astray by stimuli that are highly attractive to them (p. 275).

It is possible that white noise, hooters and contradictory color cues are not "highly attractive" stimuli and that hyperactive children, therefore, are not "led astray."

The High Appeal stimuli in the present study, however, were rated "interesting" and "fun to look at," by both hyperactive and non-hyperactive children (See Appendices H & I). In addition, spontaneous comments made by both groups of children during the testing indicated that the High Appeal stimuli were a source of interest and pleasure. The following remarks are a sample of those recorded during the testing session.

Hyperactive children:

Ooh look, King Kong.

I like the gambling machine picture.

I got that Evel Knevel bike.

Why are there no green bikes like mine?

I'm not looking at these funny pictures.

They have a big selection of toys, but it makes problems for me.

Non-Hyperactive children:

Chocolate cake, yummy.

What are the pictures for, to get you wrong?

There's Casper the ghost.

When confronted with stimuli that appealed to them, hyperactive children were relatively unable to maintain attention on the arithmetic task, as indicated by their error scores. Non-hyperactive children were significantly less distracted by these stimuli than were hyperactive children.

Two previous empirical studies of distractibility in hyperactive children used external stimuli likely to interest young children (Bremer & Stern, 1976; Zentall & Zentall, 1976). Bremer and Stern used telephones with flashing lights and an oscilloscope display with tapes of calculator noises. Their findings support the view that appealing external distractors distract hyperactive children to a greater extent than they distract non-hyperactive children. The hyperactive children looked toward the distractors more often and for longer periods of time than did the non-hyperactive children.

The only other empirical study which used highly appealing

stimuli, Zentall and Zentall (1976), used an abundance of highly appealing external distractors, but the hyperactive children in their study were not significantly distracted by them, as measured by a deterioration in task performance. These results are inconsistent with the findings of the present study and with those of Bremer and Stern (1976). An examination of the Zentall and Zentall study provides a possible explanation for this inconsistency.

Zentall and Zentall maximized the possibility of habituation to the external distractors by having all of their subjects sit alone in the testing room for 10 minutes prior to starting the task. This 10 minute period, during which time mechanical devices measured motor activity, provided each child time to attend fully to the stimuli in the testing room. By the time the task was presented the external stimuli might have lost their novelty.

There is some evidence that supports the possibility that habituation affected the Zentalls' results. A study of the orienting response in hyperactive children, as measured by skin conductance, by Cohen and Douglas (1972) reported a trend ($p = .08$) for hyperactive subjects to habituate to an auditory signal more rapidly than control subjects. Since many of the external stimuli used by Zentall and Zentall duplicate the type of stimulation often found in elementary school classrooms (posters, signs, live animals), the results of a distractibility study, which uses these stimuli and which is designed to avoid habituation, would be of considerable interest to educators.

The present study was designed with the intention of being able to distinguish between the effects of High Appeal and Low Appeal distractors. The second hypothesis, which addressed this issue, was not confirmed; that is, although hyperactive children made significantly more arithmetic errors in the presence of High Appeal stimuli than in the presence of Low Appeal stimuli, this was also the case for the non-hyperactive children, thus there was no difference in the magnitude of the deterioration between the two groups.

This failure to obtain a significant difference in the extent to which the performance of the two groups deteriorated over High Appeal and Low Appeal stimulus conditions appears to be due to the capacity of the Low Appeal stimulus condition to distract the Hyperactive Group. There was a significant deterioration of performance in the hyperactive children between the No Appeal and the Low Appeal stimulus conditions.

In addition to the obvious possibility that the second hypothesis is incorrect, there are two other possible explanations for the findings that the Low Appeal stimuli distracted the hyperactive children. In both cases it may not be the properties of the Low Appeal stimuli used in the present study that caused them to serve as distractors, but rather factors attributable to the design of the present study. Indeed, the Low Appeal stimuli were rated, in the pilot studies, as having little interest either to the hyperactive or to the non-hyperactive children. Moreover, in the main experiment, in contrast to the comments made in the presence of the High Appeal stimuli, there were no comments indicating interest in

the Low Appeal stimuli.

The first explanation assumes a contamination of the Low Appeal stimuli by the High Appeal stimuli and requires a review of the method in which the three stimulus conditions were presented. In order to minimize habituation, the three conditions were randomly distributed over all 300 trials. On any give trial, therefore, the task might have shown up in the teaching machine window bordered by either amusing magazine pictures, abstract art fragments or blank paper. Only the blank white border could instantly be perceived as not containing High Appeal magazine pictures. The art fragments, simply because of their color and their position, might well require that the children spend a very brief period of time determining that these stimuli were not highly interesting magazine pictures and offered no markedly interesting alternatives to the task. Although the time needed to determine that the colorful border was devoid of attractive pictures might be brief, it could presumably interfere with performance on the timed arithmetic task. Stimuli were presented for only 3 seconds and the button press response had to be completed within that period of time. If hyperactive children are more likely than non-hyperactive children to turn to external stimuli in an attempt to find an interesting alternative to to task, then it is possible that they would scan the colorful Low Appeal stimuli more often and for longer periods of time than the non-hyperactive children.

This possibly contaminating factor could be eliminated by redesigning the present study so that all the Low Appeal

stimuli were grouped together in a block of 100. With that alteration it is possible that the hyperactive children would not be distracted by the Low Appeal stimuli which had been judged earlier to be of little interest. This change in design, however, would increase the possibility of habituation to the magazine pictures used as High Appeal stimuli. Perhaps the issue could be clarified if the present study were modified with the High Appeal stimulus condition eliminated from the study. Without the possibility of any contamination of Low Appeal stimuli by High Appeal stimuli, hyperactive children might not perform significantly worse than non-hyperactive children in the presence of the Low Appeal stimuli.

A second possible explanation of the effectiveness of the Low Appeal stimuli as distractors for hyperactive children in the present study is the possibility that there is a distractor-task interaction and that as the task becomes more difficult the level of stimulus appeal necessary to produce distractibility declines. This explanation requires comparison of the types of tasks used in earlier studies with that used in the present study.

With the exception of Bremer and Stern (1976), who used a reading task, investigators have used undemanding tasks which might possibly be less aversive than academic tasks that face hyperactive children in the classroom where distractibility is mainly reported. It is possible that the uniformly negative results of the earlier studies are the result of the use of low appeal stimuli in conjunction with undemanding, non-aversive tasks. For example, the children in the Cohen et al.

(1972) and the Campbell et al. (1971) studies had to name colors. Sykes et al. (1971, Sykes et al. (1973), and Dykman et al. (1970) had their subjects press buttons in the presence of a criterion stimulus. And finally, Zentall and Zentall (1976) instructed children to pick out letters in alphabetical order from an array of letters.

In contrast to the tasks used by these investigators, the present study used grade level arithmetic problems. These problems, presented rapidly (3-second exposures), provided an appropriately challenging task for young children and a task which many of the children seemed to find aversive particularly over 300 trials. Although all the children completed the task, many of them complained about the work and were frustrated by the speed with which the problems were presented. A number of the hyperactive children exhibited their frustration by yelling at the machine to stop, kicking the desk, and, in one case, threatening to break the equipment. Although most reactions to the test were less dramatic, children from both groups expressed uncertainty and some anxiety. If, as has been suggested earlier (Klein & Gittelman-Klein, 1975), distractibility in hyperactive children is in part in response to mental effort, then there would be reason to expect that the hyperactive children required to perform the task in the present study might show distractibility even in the presence of low appeal stimuli.

The possiblity that distractibility in hyperactive children is closely related to task difficulty is supported by the work of Keogh and Margolis (1976) and Keogh, Welles, and

Weiss (1976). According to Keogh and Margolis, hyperactive children can be differentiated from non-hyperactive children by their "ineffectiveness of attention" when faced with a task that results in a feeling of uncertainty. They found that when hyperactive children were asked to solve tasks that were described as ambiguous or difficult there was a significant increase in glancing away from the task. Keogh et al. (1976) interpreted this inattentive, glancing away behavior as an effort on the part of the children to gain information that might help them improve their task performance. The glancing away behavior, which appears to educators as increased distractibility, might in fact be a strategy used to increase information in order to reduce ambiguity and uncertainty. Although they did not use the term, Keogh and her co-workers are suggesting a type of exploratory behavior on the part of hyperactive children. This notion of distractibility as exploratory behavior has been discussed earlier by Klein and Gittelman-Klein (1975), who perceived exploratory behavior as servicing "appetitive interests." In the Keogh et al. (1976) interpretation, the gratification of needs takes the form of reducing anxiety aroused by a difficult task.

In the present study, the extent to which the distractibility observed in the hyperactive group in the presence of low appeal stimuli is the result of turning away from a difficult task cannot be assessed since only one level of task was used. An extension of the present study, varying the level of task difficulty for each stimulus condition would clarify the issue of task difficulty-appeal level interaction. It is

conceivable that a study using a sufficiently undemanding, non-aversive task might fail to find hyperactive children distractible, not only in the presence of Low Appeal distractors, but even in the presence of High Appeal distractors. Conversely, increasing the difficulty level of the tasks might result in an increase in distractibility in hyperactive children.

The issues of the role of task difficulty and of the effect of the level of stimulus appeal on distractibility are of major importance to educators. The belief among educators that hyperactive children have an attentional disorder manifested by an impaired ability to ignore irrelevant, external stimuli has been common since the work of Strauss and his colleagues (Strauss, 1939; Strauss & Lehtinen, 1947; Strauss & Werner, 1943). This assumption, although previously unsupported by empirical studies, is currenly generally accepted.

In a recent study, Johnson and Prinz (1976) found that, of 42 teachers who reported having hyperactive children in their class, 93% cited distractibility as the main factor interfering with learning. The importance of reducing distraction within the classroom has been stressed by numerous authors, many of whom have conducted classroom studies aimed at determining the optimal conditions for the teaching of hyperactive children (Bateman, 1973; Cruickshank, Bentzen, Ratzburg, & Tannhauser, 1961; Cruickshank, Junkala & Paul, 1968; Johnson & Prinz, 1976; Patterson, 1965; Rost and Charles, 1967).

The description of the classroom proposed by Cruickshank et al. (1961) serves as an example of the learning environment suggested for hyperactive children. They recommend that the color of the walls, woodwork, furniture and floor should all match. Windows should be opaque and all bulletin boards and pictures should be removed. In fact, all furniture and other items not absolutely essential to the teaching program, including pencil sharpeners, should be removed. In a later report, Cruickshank et al. (1968) suggested that isolation booths would be even more successful in minimizing distraction and facilitating learning in hyperactive children, although they cautioned teachers to be aware of the possible distracting properties of the shiny metal hinges visible on the isolation booth and of the stimulation provided by the grain of the wood.

If hyperactive children have difficulty screening out environmental distractors and maintaining attention to the academic task, then isolating the children in booths or removing all potential distractors should result in improved classroom performance. In fact, classroom studies which have minimized external stimulation have failed to obtain the expected improvement. For example, Rost and Charles (1967), who measured changes in arithmetic, reading and spelling scores of hyperactive children who were placed in isolation booths, concluded that

> contrary to numerous suggestions in the literature, there was no evidence to suggest that having a . . . hyperactive child spend his study time in a separate booth has any effect on his academic achievement (p. 125).

In 1973 Somerville, Warnberg and Rost reviewed the literature on the use of isolation booths and concluded that there was no study which clearly indicated that minimizing external stimulation had a beneficial effect on task performance.

The failure of classroom studies to show that the absence of external stimulation improved performance and the failure of most laboratory studies to show that the presence of external stimulation disrupts performance has led some authors to question the premise of the "stimulation-as-distractor" model presented by Struass and his co-workers (Carter & Diaz, 1971; Hallahan & Kaufman, 1972; Zentall, Zentall & Barach, 1977).

An alternative to the "stimulation-as-distractor" model is the "stimulation as facilitator" model which suggests that increased stimulation may help maintain alertness and thereby actually improve attention. The assumption underlying this model is that hyperactive children are underaroused and are using external stimulation to bring their arousal level into balance. For this reason the model is referred to as a homeostasis model. Proponents of this model feel that reducing external stimulation causes hyperactive children to create their own internal stimulation in the form of hyperactivity (Cromwell et al., 1963; Satterfield & Dawson, 1971; Zentall & Zentall, 1976).

The work of Zentall (1975; Zentall & Zentall, 1976; Zentall et al., 1977) is predicated on the homeostasis model. They draw an analogy between sensory deprivation studies with

adults to symptoms of the hyperactive syndrome. Subjects deprived of sensory input display restlessness, disorganization of thought and the self-reported inability to concentrate. Zentall and Zentall (1976) suggest that

> Active behavior . . . in hyperactive children may be the visible manifestation of a homeostatic mechanism that attempts to maintain an optimal level of sensory input by supplementing inadequate environmental input with response produced input. When environmental input is adequate, the hyperactive behavior is not needed to maintain optimal input. It is thus suggested that hyperactive children suffer not from oversensitivity to sensory input but from a kind of sensory blocking or overfiltering, which necessitates a higher level of stimulation to produce the same effect as in normal children (p. 696).

The present study, rather than rejecting the "stimulation-as distractor" model, has critically examined the earlier studies and found them to be an inadequate test of the model. The results of the present study support the hypothesis that distracting stimuli have an adverse effect on the performance of hyperactive children. Distractibility, as measured by the number of errors made on an arithmetic task, increased significantly for hyperactive children as the appeal level of stimuli increased from No Appeal to Low Appeal to High Appeal.

The impression that the performance of hyperactive children tends to deteriorate over testing time has been repeatedly noted by educators and clinicians. Douglas (1975) summed up her experience and the experience of her co-workers at the Montreal Children's Hospital:

> Our observations of these children performing a wide variety of tasks have repeatedly pointed up their difficulty in sticking with a task over long periods of time. Sometimes they have been able to match the performance of control subjects in the early stages of a testing session; but their performance drops

> off much more precipitously and, in the long run, they can look very bad indeed (p. 202).

Cohen et al. (1972) suggested that the reason empirical studies of distractibility in hyperactive children have failed to find these children more distractible than non-hyperactive children is that the restricted time period involved in an experimental situation can be managed by hyperactive children. However, they suggested that by the end of a long classroom day these children would be exhibiting hyperactive behavior.

In order to measure changes across trials in the present study, performance on the last 50 trials (251 - 300) was compared to performance on the second 50 trials (51 - 100). The second 50 trials were chosen to make certain that the children were completely familiar with the task. No deterioration in performance was found. In fact, both groups showed an improvement in performance on all stimulus conditions.

Deterioration in performance over time can be a function of fatigue brought on by the passage of time or boredom produced by carrying out a long, repetitive task. In the present study, the length of time spent on the task could not be standardized for all subjects due to the fact that, within the limit of a maximum duration for each trial, the task was self-paced. The variation in duration of sessions makes it impossible to interpret the effect of testing time on test performance. It is possible that changing the border surrounding each arithmetic problem minimized the likelihood of the testing session becoming boring or repetitive and of the performance deteriorating for this reason.

Another explanation for the absence of deterioration over time in task performance is the possibility of over-learning. Since each problem was presented approximately 38 times during the testing session, by the last 50 trials most of the children were probably familiar with all eight problems and their solutions. The likelihood of making a correct response within the limited time period therefore would increase.

Empirical studies of distraction, such as the present one, which report significantly more disruptions of the performance of hyperactive children than of non-hyperactive children can be useful in the assessment of treatments proposed for these children. A leading method of treatment has been the use of stimulant drugs.

Barkley (1977b) reviewed the literature on the effects of methylphenidate and other stimulant drugs on the behavior of hyperactive children. He suggests that the major effect of these drugs is on the modification of attentional disorders and that changes in levels of activity may be the results of improved attentional processes.

A preliminary off- and on-drug (methylphenidate) comparison of performance on the arithmetic test used in the present study was made using the same experimental procedure. Five of the hyperactive boys tested in the present main experiment were retested when on medication two months after the original testing. No attempt was made to equate dosage level and no control group was run to determine the effect of using the same test after a two month lapse. The mean scores of the

hyperactive children on and off medication are presented in Table 10. The reduction in the number of errors was striking. The hyperactive children, on medication, made markedly fewer errors than non-hyperactive children had made during the main experiment. These results suggest that the present design could be used to test the effect of methylphenidate on distractibility in hyperactive children.

TABLE 12

COMPARISON OF MEAN NUMBER OF ERROR SCORES ON AND OFF MEDICATION[a]

	Stimulus Conditions[c]		
Groups[b]	No Appeal	Low Appeal	High Appeal
Hyperactive			
off medication	40.8	48.6	50.2
on medication	13.4	16.2	16.6
Non-hyperactive			
off medication	32.8	31.2	37.8

[a]methylphenidate

[b]n = 5 in each group

[c]One hundred trials in each appeal condition; maximum error scores = 100

The procedures described in the present study could be employed to evaluate other treatments. For example, it could

be used to assess cognitive training methods which attempt to strengthen attending behavior (Meichenbaum & Goodman, 1971) or to assess the value of special diets suggested for hyperactive children (Feingold, 1976).

Understanding the conditions that result in distractibility is relevant to the concerns of parents, educators and clinicians who work with hyperactive children. Determining the nature of stimuli which act as distractors contributes to that understanding and warrants further research.

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APPENDIX A

HYPERACTIVE CHILDREN

Code #	Race & SES[a]	Age	Grade	VIQ	WISC-R PIQ	FSIQ	WRAT YR-MO	T'chr Rat'g	Inter-ference	OBSERVATIONS[b] Off Task	Minor Motor	Gross Motor	Solici-tation
1	B/3	9-3	3.7	101	114	107	3.2	2.8	20.3	2.3	17.7	1.0	4.0
2	w/4	7-5	2.5	106	111	109	2.6	2.1	15.8	4.4	26.8	1.4	0.0
3	B/4	9-5	4.5	102	95	99	3.5	2.0	28.6	18.6	35.1	2.4	1.4
4	W/4	9-5	3.5	105	106	105	3.3	2.0	----	----	----	---	---
5	W/3	9-4	4.7	103	120	112	5.7	2.0	11.2	1.8	17.4	.6	1.7
6	W/--	9-4	4.5	120	101	112	5.0	2.5	5.4	16.6	18.8	1.0	.8
7	W/3	9-1	3.5	113	122	119	3.8	2.3	8.4	21.9	22.8	2.9	.5
8	W/3	8-8	3.5	105	102	103	4.5	2.1	23.4	22.5	21.9	7.9	7.0
9	W/3	7-3	2.5	94	104	98	3.2	2.1	3.5	18.0	19.8	.7	.5
10	W/3	7-7	2.5	88	95	91	2.1	2.2	20.0	7.5	12.3	0.0	.8
11	W/1	9-7	4.5	120	98	111	4.2	2.6	6.0	1.2	25.1	.4	2.4
12	W/--	9-0	3.5	103	107	106	3.9	2.2	----	----	----	---	---
13	W/3	9-7	4.5	104	87	96	3.6	3.0	4.5	8.3	30.5	2.8	.5
14	W/3	9-6	4.5	109	130	121	4.7	1.9	8.8	6.2	18.7	1.0	3.0
15	H/3	8-8	3.6	107	118	113	2.8	1.9	15.3	4.4	23.3	6.0	7.3
16	H/4	9-7	4.6	87	100	92	3.6	2.1	16.2	2.3	17.7	1.7	13.0
17	B/4	8-1	2.6	97	96	96	1.9	2.8	9.0	4.5	21.3	2.3	1.0
18	W/3	10-6	4.6	106	103	105	4.5	3.0	27.4	25.8	9.9	4.9	10.4
19	W/4	10-7	4.6	107	104	106	3.6	2.7	----	----	----	---	---
20	W/1	10-0	4.6	128	100	116	3.9	3.0	30.3	32.5	21.5	13.3	4.3
M	/3.11	9-1	3.9	105	105	106	3.7	2.4	15.53	11.70	21.21	3.0	3.48
SD		-10	.8	13.10	11.55	9.33	.7	.4	4.06	3.52	4.75	1.77	1.89

[a]Socioeconomic Status derived from the Hollingshead Index of Social Position (SES).

[b]Observation scores unavailable from Child Development Clinic for three children.

Appendix B

TEACHER RATING SCALE

HILLSIDE DIVISION

CHILD DEVELOPMENT CLINIC

SCHOOL REPORT

Name of Child ____________________ Date ____________

I. In your own words, briefly describe the child's main problem.

____

____

____

Name of Teacher Filling out Form ____________________

Grade of Child ____________________

How long have you known this child? ____________

Telephone No. of School ____________________

II. ACHIEVEMENT IN SCHOOL SUBJECTS (list Subjects)

Subject	Very Good	Average	Barely Passing	Failing

What special placement or help has he had? (Underline)
Ungraded, sight-saving, special class, remedial reading, speech correction. Tutoring in ____________________

____

Other (Specify) ____________________

F. 40 12/73

474A
(revised)

-2-

PLEASE CHECK EVERY ITEM IN EVERY GROUP OF THE FOLLOWING. PUT YOUR CHECK IN THE ONE BOX THAT IS TRUE OF THIS CHILD.

Classroom Behavior	Not at All	Just A Little	Pretty Much	Very Much
(1.) Fidgeting	☐	☐	☐	☐
(2.) Hums and makes other odd noises	☐	☐	☐	☐
3. Demands must be met immediately, gets frustrated	☐	☐	☐	☐
(4.) Coordination poor	☐	☐	☐	☐
(5.) Restless (overactive)	☐	☐	☐	☐
(6.) Excitable, impulsive	☐	☐	☐	☐
(7.) Inattentive, distractible	☐	☐	☐	☐
8. Fails to finish things he starts (short attention span)	☐	☐	☐	☐
9. Sensitive to criticism	☐	☐	☐	☐
10. Serious or sad	☐	☐	☐	☐
(11.) Daydreams	☐	☐	☐	☐
12. Sullen or sulky	☐	☐	☐	☐
13. Cries	☐	☐	☐	☐
(14.) Disturbs other children	☐	☐	☐	☐
15. Quarrelsome	☐	☐	☐	☐
16. Mood changes quickly	☐	☐	☐	☐
17. Acts "smart"	☐	☐	☐	☐
18. Destructive	☐	☐	☐	☐
19. Steals	☐	☐	☐	☐
20. Lies	☐	☐	☐	☐

	Not at All	Just a little	Pretty Much	Very Much
22. Up and down, leaves seat during class	☐	☐	☐	☐
GROUP PARTICIPATION				
23. Isolates himself from other children	☐	☐	☐	☐
24. Appears to be unaccepted by group	☐	☐	☐	☐
25. Appears to be easily led	☐	☐	☐	☐
26. No sense of fair play	☐	☐	☐	☐
27. Appears to lack leadership	☐	☐	☐	☐
28. Does not get along with opposite sex	☐	☐	☐	☐
29. Does not get along with same sex	☐	☐	☐	☐
30. Teases other children or interferes with their activities	☐	☐	☐	☐
ATTITUDE TOWARD AUTHORITY				
31. Submissive	☐	☐	☐	☐
32. Defiant	☐	☐	☐	☐
33. Impudent	☐	☐	☐	☐
34. Shy	☐	☐	☐	☐
35. Fearful	☐	☐	☐	☐
36. Excessive Demands for teacher's attention	☐	☐	☐	☐
37. Stubborn	☐	☐	☐	☐
38. Anxious to please	☐	☐	☐	☐
39. Uncooperative	☐	☐	☐	☐

Considering the child's functioning before treatment, how would you evaluate him now. Please rate the child as he has been for the past 10 days only, and not earlier.

	Much Improved	Improved	Minimally Improved	No Change	Minimally Worse	Much Worse
Academic Achievement	/_/	/_/	/_/	/_/	/_/	/_/
Overall Behavior	/_/	/_/	/_/	/_/	/_/	/_/
Group Participation	/_/	/_/	/_/	/_/	/_/	/_/
Attitude Toward Authority	/_/	/_/	/_/	/_/	/_/	/_/
Self-Confidence	/_/	/_/	/_/	/_/	/_/	/_/

Please add any information about this child's home or family relationships which might have bearing on his attitudes and behavior, and add any suggestions for improvement of his behavior and adjustment. (Use other side of paper.)

Please leave Blank

/_/ Baseline

/_/ Post 4 Weeks

/_/ Post 8 Weeks

/_/ Post 12 Weeks

/_/ Post 18 Weeks

/_/ Other__________

APPENDIX C

SAMPLE OF PARENTS' COMMENTS ON THE BEHAVIOR OF THEIR HYPERACTIVE CHILD

Code Number	Comment
2	He doesn't think of the consequences of what he does. He can't sit still for long without becoming destructive.
9	As a toddler he was into everything and was very active.
10	He runs through the house. He is messy, disorganized and destructive.
11	At home he rocks continuously. When he was in a crib he would bang his head violently against the sides and rock on his hands and knees.
13	His behavior is horrendous. He has always been extremely active and difficult. He has been hyperactive since he was born.
16	As a toddler he was very active and destructive and had to be watched every minute. He broke through the bottom of his crib.
17	R. runs through the house screaming and running like a fire engine.
20	He climbed out of his crib constantly, starting

Code Number	Comment
	at 10 months of age. He's a constant behavior problem.

APPENDIX D

NON-HYPERACTIVE CHILDREN

Code #	Ethn. Race	SES[a]	Age	Grade	WISC VIQ	WRAT YR-MO
1	W	4	8-1	2.6	111	2.4
2	W	3	8-11	3.5	105	3.2
3	H	4	9-0	3.6	87	2.6
4	W	4	10-1	4.5	118	4.2
5	W	4	7-6	2.6	123	2.4
6	W	1	9-2	4.5	124	4.4
7	W	3	9-3	4.5	121	3.6
8	H	5	7-3	2.6	101	2.8
9	W	1	8-1	2.6	105	3.6
10	W	3	9-10	4.5	96	3.6
11	W	2	7-6	2.6	131	2.8
12	B	4	8-2	3.6	87	3.2
13	W	4	8-2	2.6	115	3.0
14	W	1	8-9	3.6	119	4.6
15	W	2	8-2	3.6	130	3.6
16	B	3	8-6	3.6	86	3.2
17	H	---	9-1	3.6	88	3.9
18	B	---	7-11	2.6	106	2.4
19	H	3	7-9	2.6	88	2.8
20	W	2	8-6	3.6	107	4.2
M		2.94	8-6	3.4	107	3.3
SD		1.21	-9	.7	14.7	.4

Note: Teacher rating scale scores and classroom observation scores were not obtained for the non-hyperactive children.

[a]Socioeconomic Status derived from the Hollingshead Index of Social Position (SES).

APPENDIX E

Task Stimuli

The task stimuli were grade level arithmetic problems chosen by second, third, and fourth grade teachers at P.S. 321 in Brooklyn, New York. A set of eight problems from each level of difficulty were chosen. The following problems were used in the study:

Second grade	4	8	7	6	6	1	8	2
	-1	-3	+1	-3	+2	+5	-2	+3
Third grade	2x4=	14	2x3=	16	9	6	4	5
		-3		-8	+4	+7	+2	+6
Fourth grade	5x3=	6	11	17	4x2=	7	7	3x4=
		+6	+4	-9		-3	+8	

The following response choices were shown on the four-button response box:

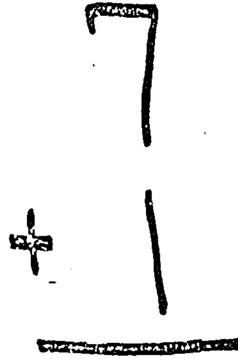
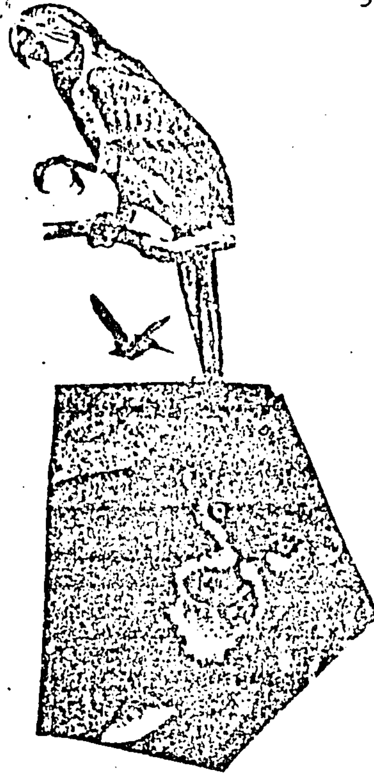
Second grade: 3, 5, 6, 8

Third grade: 6, 8, 11, 13

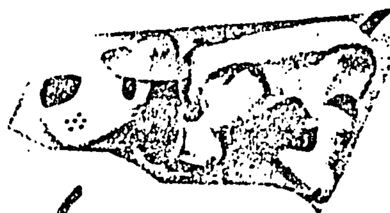
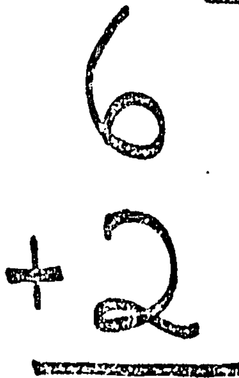
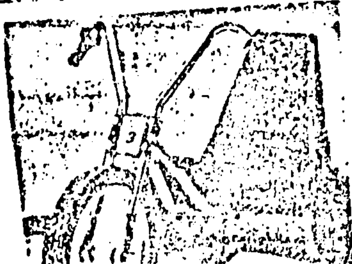
Fourth grade: 4, 8, 12, 15

Appendix F

Examples of Stimulus Cards

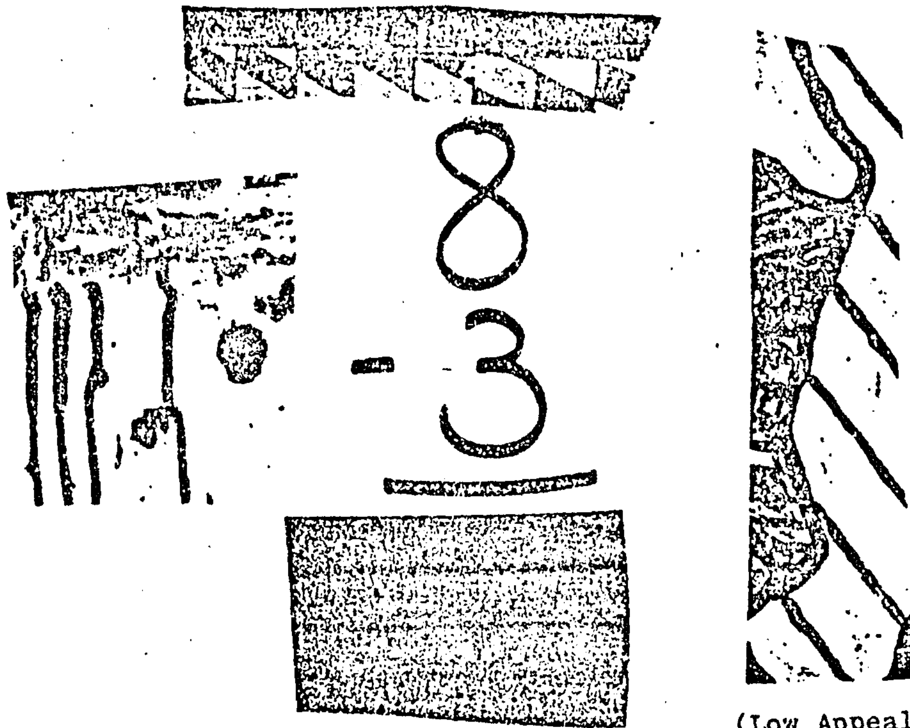



(High Appeal, in color)

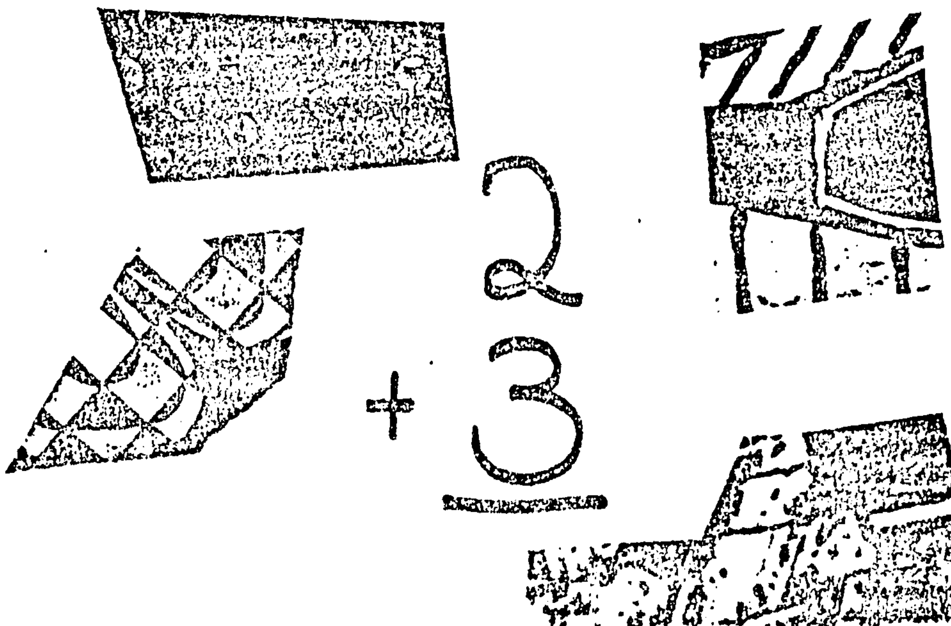




(High Appeal, in color)

Appendix F
(continued)



(Low Appeal, in color)



Appendix F
(continued)

$$\begin{array}{r} 4 \\ -1 \\ \hline \end{array}$$

(High Appeal, in color)

1 2 3

B C I

B C I

B C I

---

1 2 3 4

B C I

B C I

$$\begin{array}{r} 2 \\ +3 \\ \hline \end{array}$$

(No Appeal)

APPENDIX G

PILOT STUDY I: DEFINITION OF STIMULUS APPEAL

A pilot study was run to determine the appeal level of each of three types of stimuli. Four hyperactive and four non-hyperactive boys between the ages of 7 and 9 were each asked to trichotomize 15, 6" x 8" stimulus cards. Five of the cards were blank, five of the cards were bordered with six fragments of abstract art designs and five cards were bordered by six colorful pictures of toys, comic book characters, spacecraft, TV characters, animals, etc. Each card was shown to each child.

The cards were spread out randomly on a table before each child. Each child was tested individually and was told

> Here are a number of cards. Those that you find interesting and fun to look at put in a pile on this side (indicate). Those that are a little bit interesting put in the middle pile, and those cards that aren't interesting or fun to look at at all put into this pile on this side.

With eight subjects and five cards for each type of stimulus, there were 40 presentations of each type of stimulus. The three piles were labelled according to their interest level. The "interesting and fun to look at" pile was labelled High Appeal; the "little bit interesting to look at" was labelled Low Appeal and the "not interesting or fun to look at at all" pile was labelled No Appeal.

The results of the stimulus categorization are presented in Table 2 (page 44).

Based on these results, cards bordered with magazine pictures of toys, comical animals and people, food, etc. were referred to as High Appeal stimuli; cards bordered with abstract art fragments were referred to as Low Appeal stimuli and blank cards were referred to as No Appeal stimuli.

APPENDIX H

Pilot Study II: Confirmation of Stimulus Appeal

Using a larger sample of stimulus cards, a second pilot study was run at the completion of the experimental study to confirm the appeal level of the stimulus cards.

In the experimental study a total of 900 stimulus cards were used. Pictures of toys, etc. were taped to 300 stimulus cards, fragments of abstract art designs were taped to another 300 cards, and the final 300 cards were left blank.

A set of 100 of these cards were randomly chosen for use in the present pilot study. Thirty-two had magazine pictures, 32 had abstract designs and 36 were blank.

Seven hyperactive and seven non-hyperactive boys, ages 7 to 9 were individually shown the 100 stimulus cards presented in random order through the window of a BCI teaching machine. The subjects controlled the rate of presentation. Each card was rated by the subject according to a three choice scale:

1. High Appeal: "This card is very interesting to look at."
2. Low Appeal: "This card is a little bit interesting to look at."
3. No Appeal: "This card isn't interesting to look at."

Based on the findings of Pilot Study II (See Appendix B) cards with magazine pictures were labelled High Appeal, cards with abstract art fragments were labelled Low Appeal and Blank cards were labelled No Appeal stimuli. The present pilot study, which employed a larger sample size for each type of stimulus, confirmed the appeal levels established in Pilot Study II. Table 3 (p. 45) presents the percentage of each type of stimulus card assigned by the two groups to the stimulus categories bearing their names. For example, 78% of the High Appeal stimuli (magazine pictures) were assigned to the High Appeal category by the hyperactive group.

Responses to stimulus cards that failed to be assigned to their expected category were examined. There was no consistent pattern in the assigning of these cards. An abstract design card, for example, when not assigned to the Low Appeal category, might have been described as having either High Appeal or No Appeal. In addition, the specific cards that were not placed in the expected category differed from subject to subject.

Based on the figures presented in Table 3, the decision to refer to the picture cards as High Appeal, the abstract designs as Low Appeal stimuli and the blank cards as No Appeal stimuli was confirmed.

APPENDIX I

PILOT STUDY: RATE OF PRESENTATION OF TASK STIMULI

The purpose of this pilot study was to determine the rate of stimulus presentation that would achieve a level of difficulty sufficient to assure enough errors so that the difference between conditions could be detected.

Four rates of presentation were tested: 2 sec., 3 sec., 4 sec., and 5 sec. One hundred arithmetic problems were presented sequentially to four hyperactive and four non-hyperactive boys between the ages of 7 and 9. Twenty-five problems were presented at each of the four rates and the order of presentation of the four rates was randomized for each child.

The rate which yielded a score closest to 85% correct for the total group of 8 children was selected for the study. A 3 sec. rate of presentation satisfied that criterion.

APPENDIX J

NUMBER OF ERRORS ON ARITHMETIC TASK

Code #	Hyperactive Stimulus Appeal High	Low	No	Non-Hyperactive Stimulus Appeal High	Low	No
1	56	53	49	26	24	22
2	65	51	47	21	18	21
3	41	33	35	56	44	48
4	40	42	34	13	9	9
5	12	12	11	73	61	64
6	25	28	15	15	16	15
7	53	45	48	41	39	39
8	31	22	23	13	11	11
9	72	68	62	25	25	24
10	76	73	72	43	42	43
11	46	43	35	38	26	33
12	80	79	83	39	34	40
13	51	45	43	34	26	25
14	34	28	26	46	45	40
15	72	63	43	65	60	56
16	22	21	20	20	20	12
17	66	62	50	35	32	40
18	4	7	11	60	60	62
19	50	54	41	41	32	30
20	50	43	36	12	12	11
M	47.30	43.60	39.20	35.80	31.80	32.25
SD	21.40	20.00	19.12	18.03	16.26	17.09

Note: There are 100 trials within each stimulus appeal condition.

APPENDIX K

CHANGE IN NUMBER OF ERRORS ACROSS TRIALS

	Hyperactive Trials		Non-Hyperactive Trials	
Code #	51 - 100	251 - 300	51 - 100	251 - 300
1	30	27	8	15
2	34	23	7	7
3	19	14	33	22
4	24	15	9	3
5	11	2	36	32
6	15	8	7	3
7	18	32	25	15
8	11	9	12	2
9	42	30	12	15
10	33	38	21	15
11	20	14	15	24
12	45	36	23	14
13	28	22	16	15
14	16	11	31	33
15	28	31	38	26
16	12	2	18	11
17	27	31	20	16
18	7	2	35	23
19	34	21	21	20
20	21	18	8	3
M	23.75	19.36	19.75	15.55
SD	10.91	11.27	10.12	8.90