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The relationship between attentional inertia and recognition memory.

John J. Burns
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THE RELATIONSHIP BETWEEN ATTENTIONAL INERTIA
AND RECOGNITION MEMORY

A Thesis Presented
by
JOHN J. BURNS

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of
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Psychology
THE RELATIONSHIP BETWEEN ATTENTIONAL INERTIA AND RECOGNITION MEMORY

A Thesis Presented

by

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ABSTRACT

THE RELATIONSHIP BETWEEN ATTENTIONAL INERTIA AND RECOGNITION MEMORY

SEPTEMBER 1988

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Attentional inertia has been hypothesized to index engagement with a stimulus. In this study, the hypothesis that attentional inertia indicates increased cognitive processing of television is tested. College students were videotaped while watching two hours of commercial TV. Immediately after viewing, they were given a recognition test using a test tape constructed of 232 audiovisual bits, half of which had been presented while the viewer was in the test room while the other half served as foils. Results demonstrated that recognition memory performance for bits seen at or after 15 seconds of continuous looking was significantly better than recognition performance for bits seen after less than 15 seconds of continuous looking. With respect to looks away (pauses), results demonstrated that recognition performance for bits presented before a pause that had lasted 15 seconds was significantly better than recognition performance after 15 seconds into a pause. These findings offer qualified support for the hypothesis that attentional inertia indexes cognitive engagement with the television.
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CHAPTER I
INTRODUCTION

In studying television viewing behavior, Anderson and his colleagues have reported a phenomenon they labeled attentional inertia. Anderson, Alwitt, Lorch and Levin (1979) observed that the longer a child maintains a look at TV, the greater the probability that the look will be maintained. For looks longer than 15 seconds, Anderson et al. argued that the child exhibits a tendency to become progressively locked onto the TV screen.

Anderson et al. (1979) go on to report evidence of attentional inertia in adults as well as children. In fact, the phenomenon has proven to be a consistently robust finding (Anderson et al., 1979; Anderson and Lorch, 1983; Anderson, Choi, and Lorch, 1987).

The initial evidence for attentional inertia was based on conditional survival probability (CSP) curves commonly used in engineering and biological research. For a given population of items (e.g. organisms, mechanical components) the CSP curve is the conditional proportion of items that survive through each successive interval of time following a given zero point (e.g. birth, manufacture, onset of disease process). The numerator of the proportion for a given interval is the number of items surviving that interval. The denominator is the number of items functioning at the beginning of the interval.

One easily understood CSP curve can be found in its application to human life span calculations. This CSP curve plots the probability that a person will survive through an interval of time given that he or she has already survived to the beginning of that interval. This curve shows a rise from infancy through early childhood and then a steady decline from middle through old age.

In contrast to human life span survival curves, a CSP curve for looks at television shows an initial sharp rise, followed by a more gradual increase. Figure 1 is one such CSP curve based on data collected from 60 3-, 4-, and 5 year old children (Anderson et al., 1979). These children watched nearly 3 hours of heterogeneous children's programs at the University of Massachusetts Child Study Center in Springfield, Massachusetts. The ordinate
Figure 1. CSP Curve
of this graph represents the probability of a look remaining in progress at time \( t+i \) given that it had already survived to time \( t \). That is, the ordinate represents the number of looks that survived a given interval \( i \) (3 seconds in the example) over the number of looks that survived to the beginning of that interval. The abscissa of the graph simply represents time to the beginning of the interval.

There were a total of 26,664 looks at the TV, 12,162 of which continued beyond 3 seconds. The probability of a look lasting beyond 3 seconds then is \( 12,162/26,664 \), or .456. Similarly, the probability of a look lasting beyond 6 seconds, given that it reached the beginning of that interval, is \( 7,806/12,162 \), or .642. The survival probability for the next interval is \( .738 \) (\( 5,763/7,806 \)). This graph demonstrates the increasing probability of maintaining a look at the TV, the longer a look is in progress.

What underlies this phenomenon? In an attempt to more fully understand attentional inertia, Anderson and Lorch (1983) looked at it in relation to TV program content. Since Alwitt, Anderson, Lorch, and Levin (1980) observed that abrupt changes in TV program content had strong terminating effects on looks, two possibilities about the nature of attentional inertia were suggested. If attentional inertia was content specific, then changes in content should have a strong terminating effect on looks at the TV regardless of how long they were in progress. Alternatively, if attentional inertia is a more general non-specific attentional arousal, then the terminating effect of a content boundary should be reduced the longer a look was in progress prior to the content boundary.

Anderson and Lorch (1983) re-analyzed data from 3- and 5- year-old children (149 3-year-olds and 150 5-years-old). Each child viewed one of 15 different Sesame Street programs. Sesame Street was chosen for its magazine format as a typical program consists of approximately 40 discrete bits. If attentional inertia is a content specific phenomenon, Anderson and Lorch (1983) reasoned that the length of a look prior to a bit boundary would be unrelated to the length of that same look after the bit boundary. If, on the other hand, attentional inertia involves increased attentional engagement with the source of information
and not just the information itself, then look length prior to the bit boundary should be positively correlated with look length following the bit boundary.

Anderson and Lorch (1983) reported that attentional inertia did not seem to be content specific. They observed that the average look length after a bit boundary increased as a function of look length prior to the bit boundary. Anderson and Lorch suggest that attentional inertia serves to "drive" looks across bit boundaries.

Anderson and Lorch go on to argue that attentional inertia is not a voluntary, strategic aspect of attention. This is based on the findings described above as well as on previous work in which Anderson et al.(1979) reported attentional inertia in children as young as 1 year. Anderson and Lorch have conceptualized attentional inertia as the opposite of habituation. Whereas habituation is the attentional response to a static, not necessarily meaningful stimulus, attentional inertia is viewed as the attentional response to a dynamic, complex stimulus (Anderson and Lorch, 1983).

The finding that attentional inertia drives looks across content boundaries (Anderson and Lorch, 1983) provides an interesting insight into the nature of attentional inertia. Earlier Lorch, Anderson, and Levin (1979) looked at comprehension differences between two groups of children where attention to the TV for one group was twice that for the other group (87% and 44% respectively). Lorch et al.(1979) reported no significant differences in comprehension between the two groups. This finding led them to conclude that, contrary to popular belief, attention to the TV by young children does not necessarily predict comprehension. Rather, attention to the TV may in part be predicted by the comprehensibility of the stimulus material. In light of this, Anderson and Lorch (1983) argued that attentional inertia may be a functional component in children's cognitive arsenal. Attentional inertia may cause them to attend to information beyond their ability to understand with the end result being acquisition of new information.

Anderson et al. (1987) have suggested that attentional inertia may reflect increasing concentration of attentional resources. This characterization of attentional inertia suggests
differences in cognitive processing within the time course of a look. Such an approach also reflects the view that attentional capacity is limited (Kahneman, 1973).

Kahneman proposed that attention is a capacity for arousal and performance of mental work. He states that "a capacity theory assumes there is a general limit on man's capacity to perform mental work." Kahneman goes on to suggest that different mental activities impose different demands on this limited capacity. These differences are characterized by ease of the task(s) and, in the dual task situation, the degree to which the two tasks draw upon the same resources.

An important implication of this theory is that performance on the secondary task in a dual task situation will reflect, in part, the degree to which the attentional system is engaged with the primary task. Thus, when the attentional system is sufficiently engaged with the primary task, performance on the secondary task will falter or fail (Kahneman, 1973). This finding has been borne out in a number of studies utilizing simple and complex primary tasks in which elevated secondary task reaction times were reported in relation to increases in processing demands of the primary task (e.g., Britton, Piha, Davis, and Wehausen, 1978; Thorson, Reeves, and Schleuder, 1985).

If attentional inertia reflects an underlying increase in attentional engagement, then distractibility should decrease as inertia builds, simply because less capacity is available for processing external stimulation. In order to examine this characterization of attentional inertia, Anderson et al.(1987) looked at the effects of an external distractor as a function of look length during TV viewing. Preschool children were used in the study as they have generally been characterized as relatively distractible. Each child viewed a one hour episode of Sesame Street in a comfortably furnished room. The child's mother was present but instructed not to influence the child's viewing. A set of slides projected intermittently on a screen to the right of the TV served as the distractor. Finally, each child's viewing was videotaped for purposes of analysis.

The findings of primary interest concerned the analyses of head turns to the slide distractor. First, if a look at the television was maintained longer than 15 seconds, there
was a significant reduction in the probability that a child would be distracted. Second, when distracted from long looks (looks lasting longer than 15 seconds), head turns were significantly slower than head turns from short looks (looks less than 15 seconds). The same pattern of results was reported for looks away from the television as well. Hence, if a look away was maintained longer than 15 seconds, there was a significant reduction in the probability that a child would be distracted. Finally, when distracted from long looks away from the screen (looks lasting longer than 15 seconds), head turns were significantly slower than head turns from short looks (looks lasting less than 15 seconds).

The findings concerning distractibility and speed of reaction (head turn) relative to long and short looks at the TV support the idea that attentional inertia reflects an increase in attentional engagement, and are further buttressed by results of a recent experiment in which Lorch and Castle (1986) had 5-year olds perform a secondary task while watching TV. The secondary task entailed pushing a button as quickly as possible when a buzzer sounded. Lorch and Castle report that reaction times were longer for probes occurring after a look at the TV had been in progress for 15 seconds than for probes occurring earlier in a look.

In summary, Anderson and his colleagues found that while bit boundaries generally have a terminating effect on looks, this effect decreased as a look at the TV progressed (Anderson and Lorch, 1983). Anderson, Choi, and Lorch (1987) found that 3-and 5- year olds became less distractible as a look at (or away) from the TV continued. Also, they reported that reaction times of head turns to the slide distractor increased as look length (or pause length) increased. Finally, Lorch and Castle (1986) found that 5-year-olds’ reaction times to a secondary task were significantly longer for probes coming after 15 seconds than for probes coming before 15 seconds. Taken together, these studies suggest that the CSP curve indexes an underlying cognitive state which changes over time. The most parsimonious explanation linking these studies characterizes this change as an increase in attentional engagement, attentional inertia, as the look progresses. If this characterization is an accurate one, what then are the implications for cognitive processing of TV?
Arguing from a capacity point of view, as attentional inertia builds, children have less capacity to devote to a secondary task or irrelevant information. This is borne out by the findings that they were less distractible as a look progressed and that their reaction times increased as a look progressed. This line of reasoning suggests that an increasing amount of capacity was being directed to the TV. If so, recognition and/or recall of the TV programs may be related to attentional inertia if memory for a program increases with capacity devoted to processing it. The present research examines recognition memory as a function of look length. If capacity is increasingly devoted to processing the TV program as a look is maintained, then recognition should increase.

Previous work examining the relationship between attention to TV and memory has not addressed the current question. Reeves, Thorson, Rothschild, McDonald, Hirsch, and Goldstein (1984) reported a significant negative correlation between alpha and recognition and recall in a study utilizing alpha as a measure of on-line cognitive processing. However, Reeves et al, were interested only in the momentary relationship between memory and visual attention and they did not look at this relationship over time as the current study proposes to do.

A number of studies have found that recognition and recall of television content is correlated with visual attention (Calvert, Huston, Watkins, and Wright, 1982; Field and Anderson, 1985; Lorch et al., 1979; Pezdek and Stevens, 1983; Zuckerman, Ziegler, and Stevenson, 1978). This relationship has been found to hold not only for visual and audiovisual content, but for purely auditory content as well (Field and Anderson, 1985; Lorch et al.1979; Pezdek and Hartman, 1983). The latter finding indicates that viewers may listen to the TV primarily when they look at it. In all these studies, however, no attempt was made to examine the relationship between look length and recognition. All this research, furthermore, has been done with children. With the exception of the work of Reeves et al., (1984), there is virtually no published research with adults which relates visual attention and memory for content.
In the present study the focus is the relationship between recognition memory and attentional inertia. Subjects were videotaped while watching 2 hours of taped commercial television. Subsequent testing examined the relationship between look length and recognition memory. In the recognition phase of the experiment, subjects viewed brief audio-visual units taken from the stimulus materials along with foils taken from programs in the same series as the stimulus programs. For each unit, subjects were asked to make a yes/no judgement as to whether or not they saw or heard the unit and then to give that answer a confidence rating. In order to keep inferencing to a minimum, when subjects indicated that they did not remember hearing or seeing the unit, they were asked to respond yes or no to an inference question which asked if, based on their program knowledge, they thought the unit was presented but that they just did not hear or see it.

In analyzing the data, we looked at subjects' correct responses to units they did see (hits) using the following notation: EL, a hit in response to a unit that fell in the early part of a long look (a look more than 15 seconds in length); LL, a hit in response to a unit that fell in the latter part of a long look; SL, a hit in response to a unit that fell in a short look (any look less than or equal to 15 seconds in length). The use of the 15 second mark in differentiating long and short looks was based on previous work (Anderson et al., 1979; Anderson and Lorch, 1983; Anderson et al., 1987). It has been found that the CSP curve for looks asymptotes around 15 seconds. In previous analyses Anderson and his colleagues have found significant differences in terms of distractibility, the correlation between look length prior to and after bit boundaries, and in terms of reaction time when comparing looks less than 15 seconds to looks 15 seconds or longer.

There are four models to be examined in the present study relevant to the relationship between attentional inertia and recognition memory. Before discussing these models, however, it is necessary to consider the possibility that the measure we are relying on is not sensitive enough to index underlying changes in cognitive processing. In other words, our subjects may be able to correctly identify all or nearly all of the units they saw and correctly reject all or nearly all of the units they did not see.
One possible interpretation of a ceiling effect on recognition is that visual information is automatically encoded. That is, if the subject was looking, the image was automatically encoded without effortful processing. Shepard's (1967) work on recognition memory with adults supports such a strong view of recognition memory.

Alternatively, Hasher and Zacks (1979) have suggested that for anything to get into long term memory, effortful processing must take place. They consider a host of cognitive processes which vary in attentional requirements. The attentional requirement of a particular process will determine the degree to which the process can be considered automatic. Encoding frequency of an input is one process Hasher and Zacks consider automatic while encoding of an image requires further attentional effort and cannot be considered automatic.

In the present study, given the complex nature of the stimulus (TV) we did not anticipate a ceiling effect.

Based on the Anderson et al. (1987) finding that subjects were less distractible as a look progressed and on the Lorch and Castle (1986) finding that subjects had slower reaction times as a look progressed, the first model to be tested is that engagement with the stimulus builds within the time course of a look.

If increasing engagement with the stimulus characterizes subjects' cognitive state during a look, we can characterize this as a one process enhancement model with the prediction that the proportion of LL hits would be significantly greater than the proportion of EL hits which would be equal to the number of SL hits. This model suggests that as a look progresses, attentional engagement with the stimulus increases. Thus, attentional engagement would be roughly equal for short looks and the early part of long looks and less than the amount of attentional engagement present in the latter part of long looks. Such a finding supports Anderson's et al. (1987) claim that as a look progresses, attentional engagement with the stimulus increases.

We believe these findings to be the most likely given the research done by Anderson and his colleagues to date. Explicit in the one process enhancement model is the contention that
attentional inertia indexes increasing cognitive involvement with a complex stimulus over time.

The second model to be examined is a two process enhancement model. During short looks, cognitive processing relative to the TV could be characterized as superficial or at a level sensitive enough to pick up relevant cues. The viewer’s cognitive state during the entire span of long looks would then be characterized as deeper. Thus the length of a look at the TV, in this model, would be indicative of the depth of processing going on throughout the look. Here, the proportion of LL hits would be equal to the proportion of EL hits and both would be significantly greater than the number of SL hits. These results would strongly suggest that look lengths are somewhat predetermined due to underlying attentional states. Such an argument suggests that short looks and long looks are qualitatively different in terms of cognitive processing. Engagement with the stimulus during short looks in this model could be viewed as superficial monitoring enabling the subject to pick up on cues relevant to the ongoing show while being engaged with some other cognitive activity.

The third model is a one process diminishing model. Such a model follows from popular characterizations of TV viewing as a "passive" or "mindless" activity. Here, the proportion of LL hits would be significantly less than the proportion of EL hits which would be equal to the proportion of SL hits. Findings such as this would suggest that attentional engagement decreases over the time course of the look or a unitary process opposite of that suggested by model 1.

The fourth model to be examined is a two process diminishing model. Here, the proportion of LL hits would be equal to the proportion of EL hits and both would be significantly less than the proportion of SL hits. This model suggests that the amount of attentional engagement associated with long looks and short looks is qualitatively different and predetermined as in model 2. However, contrary to model 2, this model suggest that more attentional engagement is associated with short looks than is associated with long looks.
Pauses (looks away from the TV) are also of interest and while the viewer's overt behavior is not necessarily of a unitary nature during a pause, as is the case during looking, a CSP plot reveals a curve similar in shape to the CSP for looks at the TV (Anderson et al., 1979). While initial data reduction does not include coding of specific behaviors during pauses, an exploratory analysis of the relationship between pause length and recognition memory will be carried out. A tentative prediction maintains that the subject will have better recognition scores for units that fall in the early part of long pauses and for units that fall in short pauses than for units that fall in the latter part of long pauses. This is a qualified hypothesis because attentional inertia could apply to engagement in activities during a pause. Such engagement would lead to less capacity devoted to listening to the TV program and, therefore, lower recognition.
CHAPTER II

METHOD

Materials  Stimulus materials were two episodes each of the Cagney and Lacey and Magnum P I series, including commercials, videotaped during the fall of 1985. Both shows are one hour dramas and were taped in color, using 3/4 inch videotape.

One recognition test tape was created from the four episodes. The test tape consisted of 232 units, randomly ordered, with 1/4 of the units from each episode. From a particular episode, then, 50 units were chosen along with 8 units from four commercial blocks (one from the first commercial and one from the last commercial of each block). A unit was defined as a portion of an episode lasting between 2 and 5 seconds during which there is video as well as pertinent audio information. Pertinent audio was defined as dialogue or audio that is meaningful to the particular show (e.g. squealing tires or a slamming door).

Units were chosen with the aid of an interactive computer program. The program enables the computer to interface with a control box which is operated by a rater. Prior to unit selection, SMPTE (Society of Motion Picture and Television Engineers) time-code was recorded on one of the two audio tracks of each videotape. Thus each frame of the tape is numerically identified in terms of minutes, seconds, and frames. As the tape plays, either backward or forward, a SMPTE time-code reader provides the computer with the current videoframe number. During unit marking, the rater controls the tape deck with the button box. When a unit is selected, a button signalling unit onset is pushed. This signals the computer to read and store the time-code laid down on that frame of the tape. Similarly, at the end of the unit the same button is pushed marking the offset of the unit.

Initially, 100 units from each episode were marked. The tape was then reviewed by two raters who assigned centrality ratings to each unit. A four point scale was used with a one given to units that were most central and a four given to those units that were least central. Centrality was determined using the following criterion: how would the comprehensibility of the plot (or subplot) from which this unit came from be affected if this unit were left out? The more comprehensibility was judged to drop, the more central the rating. The
correlation (Pearson product moment correlation) between two adult raters' centrality ratings of the four episodes' units was .85.

One criterion for inclusion of a unit in the test tape is that both raters must give the unit the same centrality score. Of 200 units taken from the actual shows (with an additional 32 taken from commercials), 43.5% received a rating of one, 13.5% received a rating of two, 15.5% received a rating of three, and 27.5% received a rating of 4.

Since each episode was naturally split into intervals by commercial blocks, it was decided that a proportionate number of units would be taken from each interval. Thus if a particular episode was 48 minutes long (excluding commercials) and the first interval between commercials was 12 minutes long, then 12/48 or 1/4 of the units would come from this interval.

The units were then combined in a random order on the recognition test tape with the aid of a Sony (BVE 500) video editor controlling two Sony BVU 200 professional editing videocassette recorders. With 10 seconds between each unit, the recognition test tape is approximately 54 minutes long.

Subjects College students from the University of Massachusetts were recruited to participate in the study for experimental credit. Subjects were told that we were interested in at-home leisure time activities. In order to ascertain possible effects of prior exposure to the shows, subjects were asked after viewing if they had previously seen either of the shows before. Those subjects who indicated they had seen one or both of the shows before (three people) were not included in any of the analyses reported here. Data from 48 subjects were collected with 41 providing usable data. In addition to the three subjects who had seen one or both the programs before, data from five other subjects was unusable due to experimenter error or equipment failure.

Setting Subjects were shown one episode from each of the two shows in a comfortably furnished, carpeted 3.8m x 3.1m room. Along with an easy chair there was a large pillow provided for subjects who wanted to lie on the floor. Refreshments, magazines, newspapers and a "Mind Magic" game were provided for subjects' use. Participants were videotaped
using two RCA (TC1025) cameras equipped with wide angle lenses and one RCA (TC1005) zoom camera which was set up in the viewing room. The cameras were connected to a Viscount video switcher (model 1107) located in an adjacent room. Pictures from each camera were sent to separate black and white monitors. The switcher was used to select the camera shot that gave the best view of the subject’s visual orientation to the TV. This image was then recorded using a 3/4 inch Sony (2610) videocassette deck. SMPTE time code synchronized with that from the stimulus tape was recorded on one audio track of the subject tape. This allowed precise analyses of subject behavior relative to program content.

Procedure  Prior to being taken into the viewing room, the subject was given the following introduction to the experiment:

We are interested in college students’ leisure time activities. In the following experiment, you will be taken into a room across the hall where there are magazines, refreshments, games and a television. We ask that you not do homework, but otherwise you are free to do whatever you would like. We will be videotaping you to facilitate data collection. This portion of the experiment will take about two hours and we will give you a five minute break after an hour so you can stretch out or go to the restroom. After the second hour, we will ask you some questions. This should take about 60 minutes. Do you have any questions?

Subjects saw one of two episodes of both Cagney and Lacey and Magnum P I. After viewing both shows, subjects were tested for recognition. They were given a test booklet with space enough for 232 responses and confidence ratings. The following instructions were given:

I am now going to show you some short audiovisual units, some of which were taken from the TV shows presented here today, and some from shows not presented here. In the booklet provided, I would like you to circle yes or no depending on whether you think you saw or heard the unit here today. After you do this, I would like you to indicate how certain you are of
the answer you just gave. Use the five point scale to the right of the response you circled. A 1 indicates that you are very sure about your answer and a 5 indicates that you are very unsure about your answer. If you don’t think you saw or heard the unit here today, that is if you circle no, I’d like you to tell me whether or not you think the unit was presented here today but you just did not notice it. Thus, if you do not remember seeing or hearing the unit, but based on what you know about the show, you think that the unit was presented, circle yes in the space to the right of the five point scale. You will have ten seconds between each unit to do your rating. If you have any problems let me know. Do you have any questions?

Upon completion of the recognition test phase of the experiment, subjects were given a written debriefing statement explaining the purpose of the experiment.
CHAPTER III
RESULTS

The presentation of the results begins with descriptive statistics. Following these will be main analyses which are broken into two parts, the first dealing with looks at the TV and the second dealing with pauses.

Descriptive analyses based on the 41 subjects who provided usable data are summarized in Table 1. Overall, visual attention to the TV ranged from 1 percent to 83.4 percent with a mean of 44.5 percent. The average length of a look at the TV ranged from 1.6 to 38.6 seconds with a mean of 12.5 seconds. The average length of a pause ranged from 3.1 seconds to 168.6 seconds with a mean of 22.3 seconds.

On the average, viewers looked at and away from the TV 264.3 times over the two hours ranging from a low of 39 to a high of 712. Subjects spent 9.5 percent of their two hours engaged in looks lasting less than 15 seconds (short looks) while spending 35 percent of their time in looks lasting 15 seconds or longer (long looks). Correspondingly, subjects spent 10.1 percent of their time during pauses lasting less than 15 seconds (short pauses) while spending 45.4 percent of their time in pauses lasting 15 seconds or longer (long pauses).

With regard to the recognition test, overall performance was quite good. The hit (correctly recognizing a unit that had been presented) rate ranged from 25 percent to 99 percent with a mean of 73 percent. The false alarm (incorrectly identifying a unit which had not been seen) rate was quite low ranging from zero percent to 32 percent with a mean of six percent.

The dependent measure of greatest interest in this experiment, recognition hit rate, was first analyzed in a 2 (state: look or pause) x 2 (show condition: a or b) x 2 (type of look or pause where the unit fell: before 15 seconds into a look or at or after 15 seconds into a look or pause) repeated measures analysis of variance.

Data from 37 subjects were included in this analysis. Data from four subjects were not included because they had missing values in one or more cells. The mean proportion
Table 1. **Descriptive Information**

<table>
<thead>
<tr>
<th></th>
<th>Look</th>
<th>Pause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean percent correct</td>
<td>44.5(22.4)</td>
<td>55.2(22.5)</td>
</tr>
<tr>
<td>Percent^*&lt; 15s</td>
<td>9.5</td>
<td>10.1</td>
</tr>
<tr>
<td>Percent $\geq$ 15s</td>
<td>35.0</td>
<td>45.4</td>
</tr>
<tr>
<td>Mean length</td>
<td>12.5(8.1)</td>
<td>22.3(8.0)</td>
</tr>
</tbody>
</table>

*Percent of total viewing session
correct for each type of event collapsed across show condition is presented in Table 2. There was only a marginal effect due to show condition of $F(1,35) = 3.152, p < 0.085$. As was expected, subjects demonstrated better recognition performance for units they had seen than for units they had not seen. Examination of state (look or pause) revealed a significant main effect of $F(1,35) = 130.846, p < 0.001$. There was also a significant main effect of time (before 15 seconds or at or after 15 seconds) of $F(1,35) = 4.962, p < 0.05$. This was qualified by a state by time interaction effect $F(1,35) = 34.819, p < 0.001$ (see Figure 2). Simply stated, when looking, recognition performance improved with time, while when not looking, it deteriorated. The main effect of time was due to the fact that while mean recognition performance improved slightly as a function of time within looks, it deteriorated markedly as a function of time within pauses. There were no other significant interactions.

A separate 2 (state) x 2 (show condition) x 2 (type of look or pause where unit fell) repeated measures analysis of variance on the same 37 subjects were included in this analysis and the mean confidence ratings for units that were presented can also be in found in Table 2. Based on a 5-point scale, mean scores closer to 1 represent more certainty in the recognition task. There was no effect due to show condition ($F(1,35) = 0.789, p < 0.381$). However, examination of state revealed a significant main effect in that subjects were more certain about recognition of units presented when they were looking than they were about units presented when they were not looking ($F(1,35) = 28.821, p < .001$). There was no effect due to time and there were no significant interaction effects.

Because recognition performance as well as confidence ratings differed significantly between look and pause data and because additional subjects were missing data only with with respect to looks or pauses and could be included, it was decided to separate looks and pauses in subsequent analyses. Also, since there was only one marginally significant main effect and no interaction effects with to show condition, data were collapsed across this variable.
Table 2.  Overall Recognition: Long vs. Short

<table>
<thead>
<tr>
<th></th>
<th>Looks</th>
<th></th>
<th></th>
<th>Pauses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 15 s</td>
<td>&gt;= 15s</td>
<td>&lt; 15 s</td>
<td>&gt;= 15s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean proportion correct</td>
<td>.869</td>
<td>.940</td>
<td>.617</td>
<td>.469</td>
<td></td>
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<tr>
<td>SD</td>
<td>.169</td>
<td>.100</td>
<td>.269</td>
<td>.249</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean confidence rating</td>
<td>1.191</td>
<td>1.145</td>
<td>1.574</td>
<td>1.601</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>.534</td>
<td>.287</td>
<td>.637</td>
<td>.573</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2 Interaction of state and time.
**Recognition performance while looking.** In order to examine recognition performance while looking, two levels of look duration at time of unit presentation were defined; less than 15 seconds or greater than or equal to 15 seconds) and a one way repeated measures analysis of variance was performed. Data from 39 subjects were included in this analysis. Data from two subjects were not included due to missing values in one or more cells. The mean proportion correct as a function of time in progress when the unit was seen can be found in Table 3. As has already been demonstrated, subjects’ recognition performance when looking was quite good overall, regardless of how much time had elapsed before the onset of the unit. As had been predicted, recognition performance for units seen 15 seconds or later into a look was significantly better than recognition performance for units seen in the early part of looks (a significant effect of $F(1,38) = 7.635, p < 0.01$.

A similar one way repeated measures analysis of variance examining confidence ratings was also carried out on the same 39 subjects’ data. Mean confidence ratings for units seen prior to 15 seconds into a look and for units seen at or after 15 seconds into a look can be found in Table 3 as well. Subjects in general were extremely confident, and did not indicate that they were more certain regarding their recognition judgment as a function of the length of time that had elapsed in the look when the unit occurred, $F(1,38) = 0.689, p < 0.412$. Our proposed analysis called for separation of subjects’ data for looks and pauses of less than 15 seconds. We hoped to be able to equate performance for units that fell in the early part of a long look (ELs; before 15 seconds into a long look) with performance for units that fell in short look (SLs; looks lasting less than 15 seconds). Examination of the average time in progress, of ELs and SLs at unit presentation however, revealed a confound. This one way repeated measures analysis of variance revealed that the average time in progress of ELs when a unit occurred was 7.391 seconds, whereas the average time in progress of SLs when a unit occurred was 3.803 seconds (see Figure 3). This difference was significant, $F(1,37) = 139.743, p < 0.001$.

Even though time in progress was less than 15 seconds for both these categories (SL and EL), there was in fact an unavoidable bias such that EL units had a greater time in
Table 3. **Look Recognition: Long vs. Short**

<table>
<thead>
<tr>
<th></th>
<th>&lt; 15 s</th>
<th>&gt;= 15 s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean proportion correct</td>
<td>.874</td>
<td>.943</td>
</tr>
<tr>
<td>SD</td>
<td>.169</td>
<td>.100</td>
</tr>
<tr>
<td>Mean confidence rating</td>
<td>1.184</td>
<td>1.141</td>
</tr>
<tr>
<td>SD</td>
<td>.534</td>
<td>.573</td>
</tr>
</tbody>
</table>
progress. This confound severely impaired our ability to examine alternative models. Results of exploratory analyses regarding 3 such models can be found in Chapter V. The results of these analyses are generally, but not conclusively, consistent with a single process increasing engagement model.

Recognition while not looking. As a first step in analyzing recognition performance during pauses, a one way repeated measures analysis of variance was performed. Data from 39 subjects were included with two subjects' data dropped because of missing values in one or more cells. Mean proportion correct for units presented when subjects had been looking away for less than 15 seconds as well as mean proportion correct for units presented when subjects had been looking away for 15 seconds or longer, are presented in Table 4. The difference between these two proportions was significant, $F(1,38) = 27.456, p < 0.001$, supporting the claim that subjects were more engaged with the TV early in pauses than they were later in pauses.

A similar one way repeated measures analysis of variance examining confidence ratings was performed on data from the same 39 subjects. These mean confidence ratings can also be found in Table 4. There was no significant difference between mean confidence ratings as a function of time into the pause; $F(1,38) = 0.095, p < 0.759$.

At this point it was necessary to determine if the same confound of time in progress existed for the pause data as had for the look data. To this end, a one way repeated measures analysis of variance was carried out examining possible differences in time in progress between SPs (units that occurred in short pauses) and EPs (units that occurred in the early part of long pauses). Data from 35 subjects were included in this analysis and as was the case with the look data, a significant main effect of time was found; $F(1,38) = 74.480, p < 0.001$. The average time in progress for units seen in SPs was 3.663 seconds while for units seen in EPs, the average time in progress was 6.564 seconds (see Figure 3). As was the case with the look data, this unavoidable confound rendered subsequent comparisons uninterpretable. For further information, see Chapter V.
Table 4. Pause Recognition: Long vs. Short

<table>
<thead>
<tr>
<th></th>
<th>Long</th>
<th>Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean proportion correct</td>
<td>.607</td>
<td>.464</td>
</tr>
<tr>
<td>SD</td>
<td>.269</td>
<td>.249</td>
</tr>
<tr>
<td>Mean confidence rating</td>
<td>1.162</td>
<td>1.644</td>
</tr>
<tr>
<td>SD</td>
<td>.637</td>
<td>.537</td>
</tr>
</tbody>
</table>
Figure 3  Mean time of event at unit onset and proportion correct.
CHAPTER IV
DISCUSSION

Based on earlier research, we hypothesized that attentional inertia indexes cognitive engagement with the TV. The results of this study provide qualified support for this hypothesis. Recognition performance for units seen 15 seconds or more into a look was significantly better than recognition performance for units seen before 15 seconds into a look. This finding along with the Anderson et al. (1987) finding that subjects were less distractible as a look progressed and the Lorch and Castle (1986) finding that reaction time to a secondary task increased as a look at the TV progressed, suggests that visual orientation to the TV is dynamic and characterized by increasing cognitive engagement with the medium over time.

The recognition memory finding supports the Anderson and Lorch (1983) claim that viewers are actively engaged with TV and refutes the popular conception that television induces a hypnotic state in viewers. Here, the term "active" is used to denote the change in engagement which is reflected in the increase in recognition performance at and after 15 seconds into a look. This study also allows us to reject the claim made by Reeves et al. (1985) that adults look away from the TV infrequently. Our observations revealed an average of over 260 looks at and away from the TV over the two hours of viewing.

Although the main focus of the present study was recognition performance for units occurring during looks at the TV, we were also interested in recognition performance for units falling during pauses. We tentatively hypothesized that engagement with the TV would diminish as a pause progressed. The pause analyses lend parallel support to such a hypothesis. Recognition performance for units occurring before 15 seconds in a pause was significantly better than recognition performance for units seen at or after 15 seconds.

In summary, this study provides support for the hypothesis that attentional inertia indexes cognitive engagement with the TV. The finding that recognition performance improved significantly for units seen 15 seconds or more into a look further weakens the argument that attentional inertia is merely a statistical artifact. Indeed, the ease of the
recognition task as reflected in the high hit rate and low false alarm rate may have constrained our ability to fully assess differences in engagement as a function of time-in-progress of a look. A more cognitively demanding task, such as free recall, may be needed in future work with this paradigm.

This study also offers support for the use of visual orientation to the screen as a methodology for studying attention to TV. While some have criticized this methodology (e.g., Reeves et al., 1985) arguing that it is not sensitive to moment to moment changes in attention, the results of this study offer compelling evidence to the contrary. Alternative methodologies such as the use of EEG alpha may well provide additional information but it is doubtful that the use of visual orientation to the screen will be replaced by this or another methodology.

We expected that confidence ratings, like recognition performance, would reflect increasing engagement with the stimulus over time. Thus, we expected that viewers would be more certain of judgments made for units that fell 15 seconds or further into a look than for units that fell prior to 15 seconds into a look. This prediction was based on the principle that confidence ratings, like recognition judgments, reflect the strength of the memory (Kintsch, 1970; Lockhart and Murdock, 1970). While the mean confidence ratings showed the pattern we predicted, the differences were not significant. Examination of confidence ratings for pause data resulted in parallel findings. As with the look data, we cannot determine if this non-significant finding represents a true measure of no difference or merely reflects the insensitivity of our measure.

Nevertheless, the results of this study are in agreement with the hypothesis that attentional inertia indexes increasing engagement with TV over the time course of a look, and diminishing engagement with the TV over the time course of a pause. In addition, the results offer further support for the validity of attentional inertia as a construct.

There are, however, important limitations of the present study which require us to qualify our acceptance of these findings. Although we had hoped to more precisely specify the relationship between look length and recognition memory by testing alternative models, the
confound of mean time-in-progress when a unit was seen with classification of the look (early vs short) prevents us from doing so.

There is an alternative method of analyzing these data which would eliminate this confound. The finding that the average time-in-progress of both SLs and SPs was significantly earlier than ELs and EPs respectively, suggests that the use of a multiple regression analysis may provide more detailed information about the development of engagement with television content. Multiple regression analyses would allow us to more clearly delineate the pattern of recognition performance over time by examining performance as a function of time-in-progress of an event (look or pause). Based on the results discussed above and those presented in Chapter V, it seems most likely that the equation which would best describe recognition performance would have a strong linear component of time. Such an analysis would allow us to test a one process enhancement model by comparing the resulting equations for recognition performance for units seen in short looks with units seen in the long looks.

The use of a multiple regression analysis for the pause data would be equally as informative. We would hypothesize that it would result in an equation which would predict diminishing recognition performance as a function of time-in-progress of the pause, again supporting our initial hypothesis of a one process diminishing model for pauses.

A second methodological concern which provides further support for adopting a multiple regression framework is the problem of unequal N in our analyses. For both the look and pause data, it was the case that, on the average, subjects contributed about twice as many events occurring at or after 15 seconds than before 15 seconds. For example, subjects saw a mean of 15.05 units occurring before 15 seconds into a look. In contrast, a mean of 30.61 units occurring at or after 15 seconds were seen. Correspondingly, an average of 16.27 units were shown when subjects had been engaged in a pause for less than 15 seconds while an average of 36.61 were shown after subjects had been looking away for 15 seconds or longer.

This necessarily meant that there was more variability in the data corresponding to recognition performance before 15 seconds into a look or pause than there was for the data
corresponding to performance at or after 15 seconds into a look or pause. The repeated measures analysis of variance model used in this study assumes homogeneity of variance within subjects. A multiple regression framework for analyzing this data would necessarily involve differentially weighting events within subjects, but would allow for a more precise test of our models. The application of a multiple regression framework is an obvious next step in examining this data set and will be applied in subsequent analyses.

One important issue not addressed in this study is the relationship between content centrality of the recognition units and look length. The possibility exists that long looks were significantly correlated with content essential to understanding the story line. If so, content centrality and not time-in-progress of the look may account for a viewer's superior recognition performance for units falling in the late part of a long look. The analyses required to resolve this issue are planned for the future.

Despite these limitations, this study produced results that add to the aggregate of findings in support of attentional inertia as an index of cognitive engagement, and help dispel the notion that the attentional inertia represents an experimental artifact.

If attentional inertia is a viable phenomenon, it is important to consider its possible function. Elsewhere, Anderson and Lorch (1983) have suggested, that for children, attentional inertia may serve to drive looks across content boundaries. One of the possible implications of this aspect of attentional inertia is that it may result in children attending to material beyond their understanding and, thus, facilitate acquisition of new information. Within the context of the present study, if attentional inertia can be characterized by increasing cognitive engagement with the stimulus, then we could argue that it functions to increase the probability that an adult viewer will comprehend the material being presented.

Given that television viewing typically takes place in an environment full of distractions (e.g., others entering and leaving, alternative activities engaged in by the viewer), the existence of a phenomenon such as attentional inertia which diminishes the distracting impact of concurrent activity is highly adaptive. This becomes clear when we consider the implications of the absence of this phenomenon. Since it is a well established fact that
people respond to environmental stimuli such as movement and sound, someone in a typical TV viewing environment would likely experience great difficulty in establishing cognitive continuity with respect to the medium in the face of others entering and leaving for example.

Recently, in exploring the nature of attentional inertia, Choi (unpublished dissertation) demonstrated the likely existence of attentional inertia in episodes of children’s free play with toys. This finding suggests that the phenomenon may be of a more general nature. If so, it again could be argued that it would be highly desirable if engagement with the stimulus increased over time. Not only would this facilitate learning about the stimulus, but it would serve to reduce the probability that outside stimuli would distract the individual. That increasing engagement should develop over time is desirable because it is the case that not every stimulus in the environment requires sustained processing.

An additional strategy to investigate the importance of attentional inertia would be to examine a population in which this phenomenon does not occur at the level of the general population. One such group is children with attention deficit disorder (ADD). Although research on the television viewing of ADD boys is sparse, Lorch, Milich, Walsh, Yocum, Bluhm, and Klein (1987) found that while ADD boys and their typical controls both averaged about the same number of looks over a 15 minute viewing session, the ADD boys averaged only half as many looks longer than 15 seconds when contrasted with their typical controls (2.9 versus 6.1 seconds).

Lorch et al. (1987) reported that while the typical boys’ visual attention to the TV was just over fifty percent (51.7%), the ADD boys’ visual attention was about half that (28.5%). These findings, taken in concert with this study’s finding that attentional inertia indexes cognitive engagement with the stimulus, gives rise to the hypothesis that, compared to typical controls, the ADD group may well have had more difficulty in understanding what they saw. Lorch et al. (1987) however, report that comprehension differences between the two groups were non- significant when IQ was controlled. This finding may be explained by the fact that the stimulus material was easy to understand, and therefore, despite the lower
level of attention and the paucity of long looks, comprehension was not affected in the ADD group.

While additional analyses are needed to more precisely detail the relationship between attentional inertia and recognition memory, this study extends our knowledge about the nature of attentional inertia in the context of television viewing. In addition, it offers a number of questions that need to be addressed in future research. Future work in using this paradigm should attempt to extend study of attentional inertia to activities other than TV viewing.
CHAPTER V

EXPLORATORY ANALYSES

In order to test the models proposed above, data for units that fell prior to 15 seconds into a look were split into two categories: units that fell in looks of less than 15 seconds and units that fell in the early part of long looks (prior to 15 seconds into the look). The mean proportions correct across these three types of looks are presented in Table 5. It is important to note that these mean percentages are based on an unequal number of occurrences across event type. This is reasonable when we consider that when subjects were looking, for instance, the vast majority of their time was spent in long looks. Further examination of Table 5 allows us to see more the nature of this problem.

In order to assess the stability of recognition performance reflected by the mean proportions reported in Table 3, 10 pseudo-subjects were created by collapsing the data set with the following restriction; each pseudo-subject included data from 4 subjects such that the total number of units seen by each pseudo-subject while in a short look added up to 17. As can be seen in Table 5, essentially the same pattern emerged as mean percent correct ranged from .949 to .907 to .901 for units seen in the late part of long looks, the early part of long looks and in short looks respectively.

The look data were analyzed in a one way (type of look unit fell in: LL, EL, SL) repeated measures analysis of variance. Data from 38 subjects were included in this analysis. There was a main effect of look type of $F(2,74) = 3.484, p < 0.05$. At this point, a set of planned comparisons were carried out in order to determine which model best fit the data. The first set of comparisons fall out of the one process enhancement model described earlier and were designed to test what was believed to be the most likely outcome—that recognition would be better when subjects were engaged in looks greater than 15 seconds. In order to control the overall comparison error rate, the Bonferroni procedure was employed and alpha (.05) was divided by the number of planned comparisons (2) resulting in an alpha of .025 needed to attain significance. The first contrast compared performance on ELs to performance on SLs and resulted in a non-significant finding of $F(1,37) = 0.334, p < 0.567$. The second contrast
<table>
<thead>
<tr>
<th></th>
<th>LL</th>
<th>EL</th>
<th>SL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean number of units</td>
<td>30.61</td>
<td>10.83</td>
<td>4.22</td>
</tr>
<tr>
<td>SD</td>
<td>21.38</td>
<td>6.03</td>
<td>2.54</td>
</tr>
<tr>
<td>Mean proportion correct</td>
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<td>.878</td>
<td>.859</td>
</tr>
<tr>
<td>SD</td>
<td>.01</td>
<td>.165</td>
<td>.255</td>
</tr>
<tr>
<td>Mean confidence rating</td>
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<td>1.183</td>
<td>1.189</td>
</tr>
<tr>
<td>SD</td>
<td>.287</td>
<td>.324</td>
<td>.953</td>
</tr>
<tr>
<td>Pseudo-subjects proportion</td>
<td>.949</td>
<td>.907</td>
<td>.901</td>
</tr>
</tbody>
</table>
compared performance on LLs to performance on ELs and SLs combined and revealed a significant finding of $F(1,37) = 6.501, p < 0.025$. Taken together, these two findings support the one process enhancement model's prediction that attentional inertia indexes the growth of cognitive engagement during the time course of a look.

The second two process model predicts that recognition performance for units seen during long looks would not vary as a function of time in progress of the look. This prediction was tested by comparing performance on ELs to performance on LLs and the resulting significant finding of $F(1,37) = 5.521, p < 0.024$ does not support this model. This model also predicts that performance on ELs would be significantly better than performance on SLs and this prediction is also not supported as described above for the one process enhancement model.

The third and fourth models are mirror images respectively of the first and second models and therefore need not be considered. Clearly recognition performance does not worsen as a look progresses nor is recognition performance better for units seen in short looks than for units seen in long looks.

A separate one-way-analysis of variance examined confidence ratings given by subjects as a function of the type of look they were engaged in when the unit was presented. Data from 38 subjects were included in this analysis. Examination of Table 5 reveals that subjects were more certain, on the average, of ratings made for units presented in LLs than they were of ratings made when units were presented in ELs or SLs. This trend, however, was not statistically significant as evidenced by the lack of a main effect; $F(1,37) = 0.415, p < 0.524$.

In order to examine the pause data in the same fashion as the look data, data for units that fell before 15 seconds into a pause were split into two categories: units that fell in pauses of less than 15 seconds and units that fell in the early part of long pauses (prior to 15 seconds into a long pause).

The mean proportion correct across these three types of pauses are presented in Table 6. In a situation analogous to the one discussed with regard to the look data, because subjects
spent the greatest portion of their non-viewing time in long pauses, the mean number of units presented when subjects were not looking was greatest for the late part of long pauses. Examination of Table 6 reveals that when subjects were looking away, an average of 35.61 units fell in LPs while an average of 11.32 units fell in EPs with 4.95 units falling in SPs.

Because units were not distributed equally across the three types of pauses, ten pseudo-subjects were created by collapsing data from groups of four (and in one case, five) subjects. The rationale for doing so was the same as for the look data and in similar fashion, the same pattern of results emerged (see Table 6) with recognition performance for units falling late in long pauses (LPs) at .445, for units falling early in long pauses (EPs) at .598, and for units falling in short pauses (SPs) at .829.

When the pause data were analyzed in a one way (type of pause unit fell in: LP, EP, SP) repeated measures analysis of variance, mean recognition scores across pause types were similar to those reported above as can be seen in Table 6. Data from 33 subjects were included in this analysis. Data from eight subjects were not included due to missing values in one or more cells. There was a main effect of $F(2,64) = 27.325, p < 0.001$. Subsequent contrasts revealed that all three mean recognition scores were significantly different from each other: (LPs vs. EPs, $F(1,32) = 11.994, p < 0.005$; EPs vs. SPs, $F(1,32) = 18.056, p < 0.001$; LPs vs. SPs, $F(1,32) = 44.074, p < 0.001$).

A one way (type of pause unit fell in: LP, EP, SP) repeated measures analysis of variance examined confidence ratings given by subjects. Data from the same 33 subjects as above were included in this analysis. There was a main effect of $F(2,64) = 3.231, p < 0.05$. Examination of Table 6 reveals that subjects were more certain, on the average, of ratings made for units presented in short pauses than for units presented in the early part and late part of long pauses. With alpha reset to 0.016 (using the Bonferoni procedure) however, subsequent contrasts revealed no significant differences (EPs vs. LPs, $F(1,32) = 0.001, p <$.
<table>
<thead>
<tr>
<th></th>
<th>LP</th>
<th>EP</th>
<th>SP</th>
</tr>
</thead>
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<td>Mean number of units</td>
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<td>4.93</td>
</tr>
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<td>SD</td>
<td>20.07</td>
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<td>3.73</td>
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<td>.464</td>
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<td>.807</td>
</tr>
<tr>
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<td>.862</td>
<td>.069</td>
<td>.071</td>
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<td>.573</td>
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<td>.829</td>
</tr>
<tr>
<td>Pseudo-subjects proportion</td>
<td>.445</td>
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<tr>
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<td></td>
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</tbody>
</table>
0.001; EPs vs. SPs, \( F(1,32) = 4.424, p < 0.05 \); LPs vs. SPs, \( F(1,32) = 4.127, p < 0.1 \).

While comparisons between SLs and ELs as well as SPs and EPs were ultimately rendered uninterpretable because of the confound of average time in progress, analysis of this same data set within a multiple regression framework would be one method of treating this confound. We can however speculate on the analyses reported here and in light of the confound reported, there is an argument to be made in favor of a one process enhancement model for the look data and in analogous fashion, an argument to be made for a one process diminishing model for the pause data.

Given that there was no difference in recognition performance between SLs and ELs within the present analysis, there is every reason to expect that this would remain the case if the data were examined within a multiple regression framework. This type of framework would also give us a more precise picture of the relationship between look and pause length and recognition memory than the current framework as analyses revealed the average time in progress of LLs was 77.283 seconds and the average time in progress of LPs was 125.705 seconds.

With respect to the pause data, using the multiple regression approach described earlier may well result in an analogous finding, an equation which predicts decreasing recognition performance as a function of time. The finding in the present analysis of a significant difference between SPs and EPs may well reflect the fact that engagement falls off much quicker when viewers are not looking.

Finally, while it may well be that confidence ratings are not sensitive enough to capture changes in engagement over time (as discussed earlier), the use of a multiple regression framework would allow for a more precise test of this.
REFERENCES


