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# The Effects of Blocking on Selective Attention in Visual Search

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Abstract

In studies of attention in visual search, older adults consistently perform more poorly than young adults. In most visual attention computer tasks, simple, conjunction, and unconfounded trials are presented randomly. This study explores the possibility that older adults are slower than young adults at changing their search strategies to match each type of trial. If this is the case, blocking the trials together so that the subject sees a series of each type of trial should allow the older adults to perfect their search strategies, giving them reaction times similar to those of young adults. In this experiment, 14 young adults (mean age 18.6 years) and 5 older adults (mean age 68.6 years) were asked to perform a blocked computer search task. The results were then compared to a study performed last year. The results showed that blocking the trials significantly lowered the reaction times of older adults, but did not effect the reaction times of young adults.

The effects of blocking on visual search

Selective attention is the process employed in information processing to sort through the multitude of stimuli we are bombarded with every second. Plude, Enns and Brodeur (1994) defined four components that make up selective attention. They are orienting, (activities such as responding to a target after being given a cue), filtering, (processing only certain stimuli), searching, (identification and location of target stimulus), and expecting, (the use of advance information). Within these tasks, Plude et al. found that changes in performance occur over the life span. In the component search, on which the present paper will focus, Plude et al. found that search efficiency develops through childhood, peaks in young adults and then declines in old age.

The most common method for studying search (specifically visual search) in recent years has been based on Triesman's feature integration paradigm (Triesman and Gelade, 1980). In this paradigm, participants are required to search for a target which may or may not be present among a set of distractors. Display size is manipulated, as is the composition of the display, which consists of either feature or conjunction search trials. In feature search trials, targets share one feature and differ in one feature from distractors. In this condition search is thought to occur in parallel; all features are processed at once regardless of display size. In conjunction searches the target shares one feature with some distractors and another feature with the other distractors. Because more than one feature on the target may be confused with distractors, focused attention must be used and search is hypothesized to occur serially. Because serial search requires attention to each stimulus individually, reaction time should increase with display size for conjunction, but not feature searches.

Plude and Doussart-Roosevelt added an unconfounded search condition to the paradigm. An unconfounded trial is primarily a feature trial with a set number (3) of the second type of distractor added to every trial. Thus, participants should process the majority of the search area in parallel, then serially search the other three distractors. RT will be longer than in true feature searches, but RT should not increase with display size. Examples of each of the search trials can be found in fig. 1.

When older adults are tested in this paradigm, they are found to differ significantly from young adults in their performance. Plude and Doussard-Roosevelt (1989) found that older adults have an overall higher reaction time (RT) than young adults and that in conjunction searches their RT is more effected by display size, as is their error rate. Several other studies have found similar results (Tipper 1991, Plude et al. 1994).

There are many theories as to why visual performance declines with age. The elderly may simply have generalized slowing in cognitive processes (Plude and Doussard-Roosevelt, 1989), or they may have poor inhibition which would lead to increased distraction (Tipper, 1991, Rypma, 1991). If older adults cannot filter out distractions, they may get sidetracked and take longer to finish a task. Another possible explanation is that older adults may be affected by perseverative behavior, which is the inability to inhibit psychological processes (Prinz, Dustman and Emmerson, 1990). A person with perseverative does not know when to stop the task they are involved in. For example, in visual search a person with perseverative behavior would search through the display over and over again. All of these behaviors can be explained by a decline in frontal lobe functioning.

In their paper, Shapiro, Shapiro, Forbes and Cointin (1995) attempted to trace the lifetime changes in inhibitory efficiency by combining the fields of cognitive aging, child development and frontal lobe theory. Their purpose was to paint a comprehensive picture of life span development in visual search. To do this, they used Triesman's feature integration paradigm, with the added unconfounded trial. Shapiro et al. expected to find that in conjunction conditions children would have the slowest RT and would be more effected by display size. RT's and size effects would decrease into young adulthood and then increase once again in older adults. Their results supported the hypotheses, but only on target absent trials. In fact, in target absent trials, children and older adults had inordinately high RT's compared with young adults. In target present trials the RT's were much more similar.

One possible reason why this effect occurred is that perhaps younger people have an easier time altering the search strategies they employ for the different types of displays. There may be some strategy that younger people pick up on that allows them to search faster than older people. Because display type is given randomly, older people may not have the time to work out a similar strategy. This effect may only be seen on target absent trials because they are more difficult than target present trials. It has been shown that on simple tasks, there is not much of a difference in the performance of older people and younger, but as tasks get more difficult the gap in performance widens (Salthouse, 1991). For all ages, target absent trials have longer RT's and more errors than target present trials, which would indicate that it is a more difficult task. Thus, on the simpler target present trials, older people may be as adept as young people in employing a search strategy, but they may need more time on the more difficult target absent trials.

By this reasoning, if the types of trials were blocked together and participants saw a series of one search condition, then a series of another, older people should have the time to develop and/or change search strategies for different types of trials and their RT's should approach those of young adults. In the present experiment, the Shapiro et al. (1995) study will be replicated, but the feature, conjunction, and unconfounded trials will be presented in blocks. The data will then be analyzed with the data from the Shapiro et al. study and a comparison between blocked an unblocked trials will be performed. If it is true that older people do not have the ability to develop and/or change search strategies when the types of trials are given randomly, we should see a lowering of RT in the blocked, but not the unblocked conditions.

## Methods

### Participants

In the unblocked condition, participants consisted of 56 undergraduates (41 females, 15 males; mean age= 18.55 years, SD=1.1 years) and 15 older adults (11 females, 4 males; mean age 67.87 years, SD 6.60 years). In the blocked condition, participants consisted of 14 young adults (10 female, 4 male; mean age 18.6 years, SD=.90 years) and 10 older adults (6 females and 4 males; mean age 69.0 years, SD=7.1 years). Young adults were drawn from psychology classes at Illinois Wesleyan University and received extra credit for participating. Older adults were recruited from a list of Illinois Wesleyan University alums and were paid $10 for their participation.

All participants had normal or corrected to normal vision and were in good health. No participants reported past or current neurological problems.

All participants were individually administered the Kaufman Brief Intelligence Test (K-BIT) as a screening device (Kaufman and Kaufman, 1990), the Wisconsin Card Sort Test (WCST) to screen for any signs of perseverative behavior, and the Stroop Color Task as a measure of frontal lobe interference effects. Older and younger adults both performed within the normal range of K-BIT scoring. The mean IQ of older adults was 112.2, and the mean IQ of young adults was 109.36. A t-test revealed that t=.64, showing that there is no significant difference between the two groups.

Materials and Apparatus

The visual search task was administered on a Macintosh Powermac 8500 computer. The computer was adapted for the task by placing "yes" and "no" stickers on the "5" and "6" keys on the number pad, respectively. A set of Sony headphones was used to present feedback tones of correct or incorrect during the task.

The K-BIT, the WCST and the Stroop color task were administered to each participant individually. The order in which the tests were presented was counterbalanced.

All trials of the visual search task consisted of arrays of letters including differing numbers of "distractor" letters and some including a "target" letter. The target was always a sideways "T" and distractors were either "T"s or sideways "P"s. All stimuli were 1cm by 2cm in size, and displays were located approximately 18 in. from the viewer. In contrast to the Shapiro et al. study, all displays contained 15 letters. In data analysis, only the size 15 trials from the Shapiro et al. study were used. To distribute targets randomly, the visual field was divided into 8 sectors and the target occured equally in each sector throughout the trials.

Procedure

Each participant was required to read and sign a consent form prior to participation in the study. This form explained the visual search computer task, as well as the pretests, and informed the participants of their rights. The order of pretests and the visual search task was counterbalanced. For the visual search task, participants first read an introductory instruction screen explaining the procedure. Verbal instructions were also given to ensure each participant understood the task. The participants then saw a plus sign in the center of the screen, accompanied by a warning tone. Five hundred milliseconds later, an array of letters appeared. Participants were instructed to press "yes" if the target was present, and "no" if the target was absent. The target remained the same for all trials. Participants were instructed to answer as quickly and accurately as possible.

Feedback was given in the form of tones. A high tone (880Hz) signaled a correct answer and a low tone (449Hz) meant that the answer was incorrect (either a "no" when the target was present or a "yes" when the target was absent).

When the participant indicated an understanding of the instructions, 6 practice trials were given. If the participant was comfortable with the procedure, the study proceeded with 3 blocks of 32 trials administered. Each block contained only one search condition; feature, conjunction, or unconfounded. Participants received a 1-minute break between blocks.

The study used a 3x2x2x2 mixed factorial design. The independent variables (IVs) consist of search condition ( feature, conjunction, or unconfounded), target condition (present or absent), age group (older adults or younger adults), and blocking condition (blocked or unblocked). Target condition was randomized as were the order in which the blocks were presented.

## Results

Reaction times (RTs) were summarized for each participant, and incorrect trials were not included in RT calculations. A mixed analysis of variance (ANOVA) on age group, search condition, blocking condition, and target condition was conducted on each primary dependent variable.

The ANOVA revealed significant main effects of age $F=18.36$ $(35,1)$ $p<.001$, search condition, $F=25.71$ $(70,2)$ $p<.001$, and target condition, $F=116.36$ $(35,1)$ $p<.001$. Mean RT and standard deviation can be seen in table 1. Older adults were slower overall than younger adults, and conjunction searches took the longest, followed by unconfounded and simple trials, respectively. Target absent trials took much longer than target present trials.

Four interactions were significant. Both younger and older people are affected by search condition and target condition; RT increased from simple to unconfounded to conjunction trials, respectively and RT goes up in target absent trials. But older adults are affected by the search condition and target condition to a greater degree than young adults, $F=4.86$ $(70,2)$ $p<.05$, $F=14.42$ $(35,1)$ $p<.001$, respectively. Older adults RTs go up more than young adult RTs in conjunction and target absent trials.

Target absent trials take longer than target present trials, and RT increases with search condition; simple, unconfounded and conjunction, respectively. But when the target is absent, the search condition has more effect on the RT, $F=21.43$ $(70,2)$ $p<.001$. RT increases through search condition more in unblocked, target absent trials than it does in blocked, target absent trials.

Finally, a 3-way interaction of age x target condition x search condition $F=3.85$ $(70,2)$ $p< .05$, revealed that while both younger and older adults are effected by search condition and target condition, older adults are affected more. Older adult RTs increased through search condition to a much higher degree when the target was absent than when the target was present. In younger adults, this effect was not as prevelent. This can be more clearly seen in fig 2.

## Discussion

The results of this study do not support the hypothesis that blocking the search conditions together would give older adults RTs similar to those of young adults. If the hypothesis was supported, we would have expected to see older adult RTs become more similar to those of young adults in blocked trials, but this was not the case. We saw no significant difference whatsoever between blocked and unblocked trials.

We did see a replication of the Shapiro et al (1995) study. Older people were more affected by search condition and target condition than younger adults, and the 3-way interaction still showed that older adult RTs are inordinately higher than young adult RTs through search conditions in the target absent trials.

These results are suprising because they are in contrast to the enviromental support theory. This theory says that age differences in performance are minimized when the task provides support in the area of cognitive functioning(Salthouse, 1991). In this study, the blocked trials required less in the area of cognitive strategy planning and processing; the older adults were not required to move quickly from one strategy another. Thus the task was easier. Because less was required cognitively of the older adults, their RT's should have become more similar to those of younger adults.

But if older adults are not having trouble switching their search strategies between trials, the question remains, why are older adult RT's so much longer on target absent trials? One possible explanation is that of perseveration and frontal lobe decline.

According to Dempster (1992), the frontal lobe is very important in controlling perseverative behavior, because it tells us when to stop a task. The frontal lobes grow rapidly between the ages of 4 and 7, but are not fully myelinated until early adolescence. Thus, inhibitory efficiency is hypothesized to increase towards adulthood. At approximately the age of 70, the frontal lobe begins to lose mass and blood flow which would cause a decrease in inhibitory efficiency in older adults.

The frontal lobe is involved in cognition, planning, problem solving, inhibition, and memory (Levin, Eisenberg, Benton, 1991). People with frontal lobe damage are often seen to have planning defecits, problems with strategy application and perseverative behavior. As the frontal lobe ages and begins to lose efficiency, older adults may also find difficulty in these areas. The effects would not be as clear as in brain damage patients of course, but they may still be salient enough to produce differences in visual search tasks.

Internal validity in this experiment may be affected by the small sample size. Because of the small size of the sample, variance becomes more pronounced. This means that since the study produced so many significant effects and interactions, the effects we studied may be very powerful. On the other hand, small sample size could also mean that data has been skewed. For example, if there was one older adult who had extremely slow RTs, this could cause the mean RTs for older adults to seem slower than they really are, because there are not enough data points to compensate. To be more internally valid, this study needs to be conducted with more participants.

Internal validity may also be effected by the use of a computer for the search task. Because most older adults are not experienced in the use of a computer, they may not be comfortable using one in the experiment, which may effect their performance. To compensate for this, the study was simplified as much as possible. The keyboard was pushed under the desk and the "yes" and "no" keys were located on a small number pad. Thus, participants had only to look at the screen and press two keys. This simplification should have been enough to keep the computer from influencing the results of the study.

One final way in which internal validity may have been affected was that though this study replicated the study from last year, this study had fewer trials. The Shapiro et al. (1995) study consisted of 8 blocks of 36 trials each, while this study consists of only 3 blocks of 32 trials. This may have produced a difference in fatigue effect.

In regards to external validity, the small sample size is again a consideration. Because there were so few participants and all were Illinois Wesleyan University students or alumni, there may be a problem in generalizing the results to a larger population, since the population at Illinois Wesleyan can be considered more educated. However, the majority of studies in the field of visual attention are conducted with a small number of participants, and the results of these studies are not thought to differ much across populations, because the tasks are largely perceptual.

Possible directions for future research, then, could be to replicate the present study with a larger, perhaps more diverse group of participants, to see if these results can be duplicated. Further research is also needed in the area of perseverative behavior in order to find if it is indeed the culprit of older adult's slower RTs. By learning about how older and younger adults differ in selective attention paradigms, it will be possible to develop practical applications, in order to assist older adults in coping with these changes in cognitive functioning in their daily lives.

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Table 1.

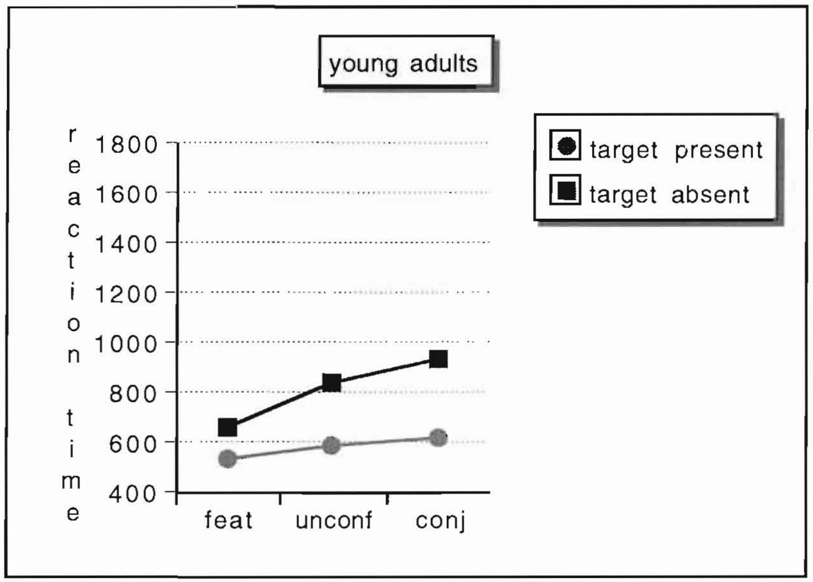
Mean reaction times(ms) and standard deviations for main effects of age group, search condition, and target condition.

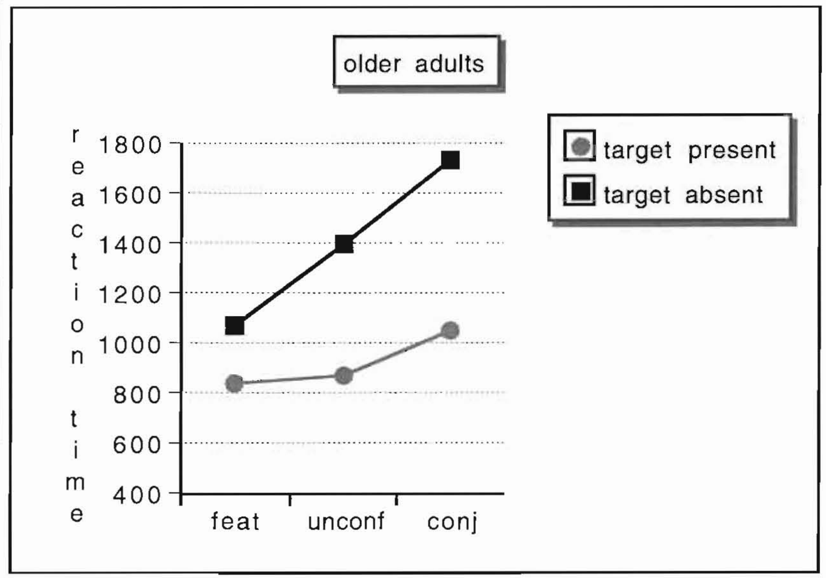
| Variable Condition | Mean RT | SD |
|---|---|---|
| age group | | |
| young adult | 698.90 | 145.13 |
| older adult | 1162.28 | 336.45 |
| search condition | | |
| feature | 776.66 | 212.25 |
| unconfounded | 927.20 | 311.31 |
| conjunction | 1087.83 | 414.78 |
| target condition | | |
| target present | 744.99 | 224.05 |
| target absent | 1107.94 | 375.34 |

Figure Captions

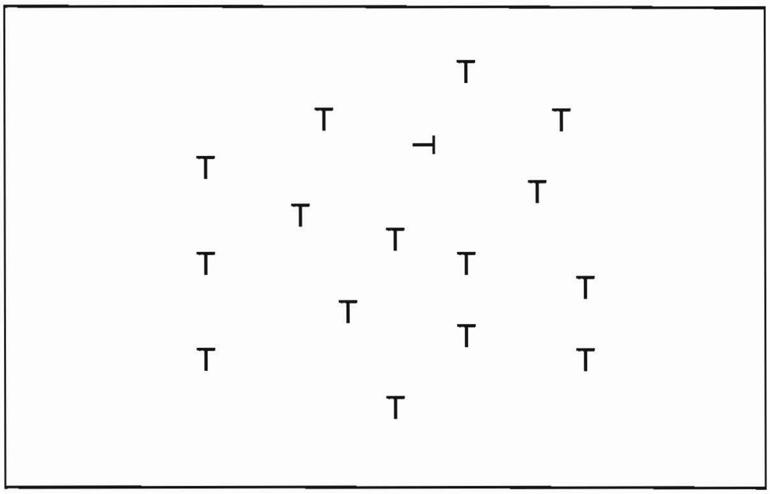
Figure 1. Examples of search conditions: feature, unconfounded, and conjunction. All have display sizes of 15 and all have targets present.

Figure 2. Median reaction time (ms) as a function of age group, search condition, and target condition.

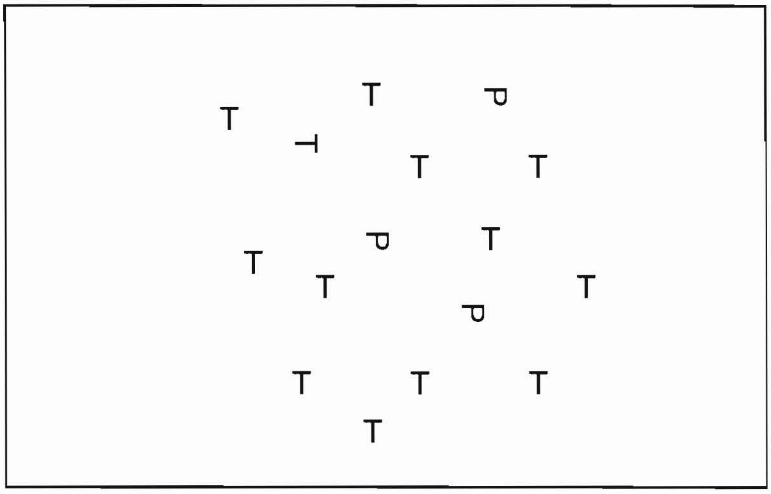

young adults
target present
target absent
reaction time
1800
1600
1400
1200
1000
800
600
400
feat
unconf
conj


older adults
target present
target absent
reaction time
1800
1600
1400
1200
1000
800
600
400
feat
unconf
conj

Simple trial



unconfounded
trial



conjunction
trial