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Orienting Task Performance between Young and Older Adults

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ABSTRACT

Ageing causes deterioration in wide spectrum of visual, cognitive, and attentional functions. The attentional functions comprise of selection of an object and orientation toward its location. The visuospatial orientation toward a target is driven by cues which can be informative or uninformative. Studies showed that older adults were more sensitive to cue information than young adults (Bryan & Luszcz, 2000; Langley, Friesen, Saville & Ciernia, 2011) however; few studies reported that orienting of attention remains intact with ageing (Hartley, 1993). Present study examined the differences in the orienting task performance of 10 young (Age 18-35 years) and 10 older adults (Age 55-65 years), using Posner's cuing paradigm. Reaction time and accuracy performance of the participants were recorded. Results revealed significant main effect of age for the reaction time measures and response accuracy where more orienting effect was observed among young adults in comparison to older adults.

Keywords: *Ageing, Orienting*

Ageing is linked with impairment of attention (McDowd & Shaw, 2000). The age-related attentional deficit is thought to be linked with the changes in the functioning of nervous systems that help in attentional processes. Attention plays a crucial role in theories of cognitive ageing (Hasher, Stoltzfus, Zacks, & Rypma, 1991) and that attentional functions have a great impact on quality of life and daily functioning of older population, especially people with dementia and Alzheimer's disease. However, it is still not clear whether this represents an overall attentional deficit or it is linked with a particular attentional network. The deficits in attentional abilities in older adults comprise of selection of attention and orientation toward location whether it is

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information or uninformative cues orienting. Orienting is the process of selecting information from sensory inputs. It is one of the largely distinct attentional control systems, which can be controlled primarily through exogenous or endogenous means (Posner, 1980).

Posner and Petersen proposed that sources of attention could be further divided down into three networks (Posner & Petersen, 1990) which carry out the functions of alerting, orienting, and executive control. The standard paradigm for studying orienting is the Posner's spatial cueing task (Posner, 1980). The attention network test (ANT) provides a measure of the efficiency of the alerting, orienting, and executive control networks (Fan, McCandliss, Sommer, Raz, & Posner, 2002).This test is a combination of the spatial cueing task (Posner, 1980) and the flanker task developed by Eriksen and Eriksen (1974).

Several studies have used ANT to understand the functioning of attentional networks in a wide range of populations, but relatively mixed data have been reported with respect to age differences in three attention networks. The ANT utilizes differences in reaction times (RT) derived from the different experimental conditions to measure the alerting, orienting, and executive control networks (Fan, McCandliss, Sommer, Raz, & Posner., 2002).Orienting task have been used in various paradigm to explore different spatial attention.

Orienting and ageing

Previous studies demonstrated that the process of orienting as unaffected in the older participants and suggested that older adults benefit as much as younger adults from physical or symbolic cues that direct attention to the likely location or identity the upcoming target information (Greenwood & Parasuraman, 1994; Kramer & Strayer, 2001). Studies using a central cue (e.g., Hartley, 1993; Hartley, Kieley, & Slabach, 1990) found that orienting of attention remained intact with ageing, whereas Fernandez-Duque and Black (2006) found no age difference in orienting function. However, some researchers using the ANT found contradictory findings and they suggested that there was a significantly greater alerting effect in older adults with no difference in the orienting and executive networks (Fernandez-Duque & Black, 2006, Festa-Martino, Ott, & Heindel, 2004). On the other hand, some studies revealed larger cueing effects in case of older adults (Nissen & Corkin, 1985; Singh, Greenwood & Parasuraman, 2006; Waszak, Li, & Hommel, 2010), whereas other studies reported similar cueing effects for both young and older adults (Hartley, Kieley, &Slabach, 1990; Tales, Muir, Bayer, &Snowden, 2002).

In regard to the effect of ageing on orienting network, Jennings, Dagenbach, Engle, and Funke (2007) reported that elderly participants showed same orienting performance as young participants. Although studies reported no age differences with respect to orienting and executive effects (Jennings, Dagenbach, Engle, & Funke, 2007), contrary some studies reported that older adults demonstrated significantly less alerting than young adults (Jennings , Dagenbach, Engle, & Funke (2007). Although findings for age-related differences in orienting attention was quite inconsistent, it was reported that visuospatial attention is relatively unaffected by normal adult ageing at least up to about 75 years of age. A study showed that when demands on perception was low, as in simple detection tasks, clear effects of cue validity was seen, although there was a little effect of ageing on costs and benefits of location cueing (Greenwood, Parsuraman & Haxby, 1993). In contrast, when demands on perception was increased by the requirement to discriminate, the effect of ageing on location cueing emerged under certain conditions of stimulus onset asynchrony (SOA) and cue type (Folk & Hoyer, 1992; Greenwood & Parsuraman, 1994).

In view of the above, the present study examined differences in orienting task performance of young adults and older adults by using a spatial cueing attention network paradigm. More specifically, the study examined the effect of age on orienting attentional networks using reaction time and response accuracy for congruent and incongruent stimuli. Thus, by examining reaction time and response accuracy on a range of trials on spatial cuing task, it was hypothesized that younger participants would perform better on an orienting task than older adults. As competing hypotheses exist in the literature which explains age difference in orienting task, it was also hypothesized that there would be significant difference in reaction time and response accuracy of young adults and older adults on attention network task due to age, cue conditions and congruency. Further, it was hypothesized that the reaction time for incongruent trial would be greater in comparison to congruent trial in both young adults and older adults.

METHOD

Participants

The sample comprised of 10 young adults (Age range 18-35 years; Mean age= 23.5 years) and 10 older adults (Age range 55-65 years, Mean age= 59.63 years). All the participants had normal or corrected to normal visual acuity of 6/6 based on performance on a Snellen acuity chart.

Design

2 (Age group: Young and Old) x 2(Cue: Central and Spatial) x 2 (Target condition: Congruent and incongruent) mixed factorial design was used. There were 24 practice trials in 1 block and 96 experimental trials each in 3 blocks, thus making a total of 288 trials.

Apparatus and materials

The experiment was conducted on a 14-inch LCD computer screen using the INQUISIT Millisecond software package (Inquisit 4.0.9.0, 2013) which comprise of a set of arrows on the screen consisting of two types of trials (i.e., congruent and incongruent*)*. The Attention Network Test (ANT) is a tool used to assess the efficiency of the 3 attention networks (i.e., alerting, orienting, and executive control). It uses four cue conditions (no cue, central cue, double cue, spatial cue) and two target conditions (congruent and incongruent). The experiment started with

24 practice trial in 1 block (with feedback) and 96 experimental trials each in 3 blocks thus making a total of 288 trials (without feedback).

Experimental task

The ANT consists of five arrows which appear above the fixation point, but the participants have to respond to the central arrow. Participants' task was to identify the direction of the central arrow by pressing a key with the index finger of the left hand on 'E' for the 'left' direction and a key with the index finger of the 'right' hand on 'I' for the right direction. Participants were instructed to make their response to the direction of the central target as quickly and accurately as possible. They were given some practice before actual trial. There were 24 Practice trials of 1 block and 3 blocks of 96 experimental trials consisting of all possible combinations of stimuli. Participants were instructed to aim for an average RT of less than 1 sec and to maintain accuracy above 80% correct. They were given feedback on their accuracy and average RT.

The two cue conditions were as follows: (i) a central cue, which was at the central fixation point, and (ii) a spatial cue, in which the cue was presented on the target location (above or below the central fixation point).Each trial consisted of five events. First, there was a fixation period of duration (400-1600 msec). Then, a cue was presented for 100 msec. There was a short fixation period for 400 msec after the cue and then the target arrows appeared simultaneously. The target arrows were on the screen until the participant responded, but for no longer than 1700 msec. After this interval the next trial began. Each trial lasted for 4000 msec. The distance between participant and screen was 65 cm. The distance between target and fixation cross was 1.06^{o} visual angle while flankers/target ratio was 0.06^{o} visual angle (area covered by all: 3.08^{o} visual angle).

In present study, the orienting component has been introduced by adding spatial cue and central cue in a trial. A spatial cue followed by row of five stimuli was presented in one of two locations either above or below the fixation and these trials were compared with the stimuli which was presented at the central fixation point. Participants were required to shift attention from the fixation point to the target stimulus on each trial in order to determine the proper response. The cue conditions, target conditions and experimental processes are displayed in Figure 1.

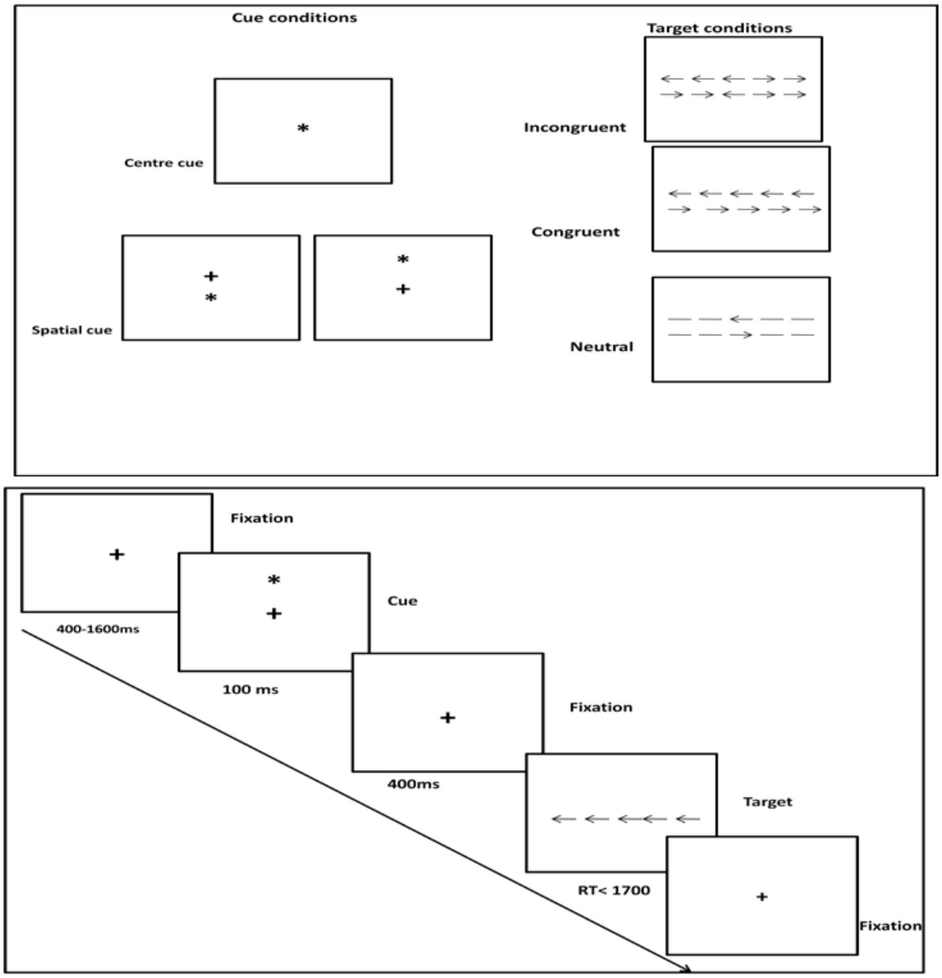

Figure 1. Stimuli, cue condition and target condition along with experimental process.

Procedure

Stimuli were presented on a 14-inch LCD computer screen (Lenovo G580). The instructions to the participants emphasized the importance of quick and accurate responding. They were instructed to focus on a centrally located cross throughout the task, and to respond as quickly and accurately as possible when the stimuli appeared. Subjects were encouraged to respond to the cue, as target was presented in the area indicated by the cue.

Before the experimental session, all participants received a brief practice session and three different tasks in experimental session. Snellen visual acuity test was performed on each participant. Before the beginning of each run, instructions were given orally using a paperboard illustrating target and response condition and participants were reminded to respond as quickly and as accurately as possible. Throughout the experimental session, participants were asked to respond to the stimuli by pressing a separate response key with the left or right index finger. The experimenter was present only at the beginning of each session in the testing room to start the experiment and to answer participants' questions regarding the instructions. In the practice trials of the task, feedback following errors was given visually. The complete session was lasted about an hour.

RESULTS

To examine the group differences in performance on attention network task mean RT were calculated for each cue conditions and congruency type. For examining differences in orientation of attention among young and older adults scores of central cue and spatial cue were used. Mean and *SD*s of the reaction time and accuracy measures of young and older adults were presented in Table 1.Mean RT scores clearly indicated that young adults performed better than older adults irrespective of cue location. Furthermore, younger adults were also outperformed the older adults on the accuracy measure (see Table 1).

Table 1, Mean Reaction time and accuracy scores and SDs in parenthesis of young and older adults.

	Young adults	**Older adults**	**Total**	**ANOVA**	
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**F(1,18)**	***P***
Age groups				18.868	0.023
Age	23.5	59.63			
Cue conditions				45.63	0.042
Central Cue	423.30 (81.39)	599.54 (108.5)	511.42 (129.99)		
Spatial Cue	425.18 (80.27)	613.52 (105.03)	519.35 (132.71)		
Congruency				16.28	0.013
Congruent	434.48 (78.85)	619.86 (97.80)	527.17 (128.53)		
Incongruent	465.62 (101.18)	643.76 (97.81)	554.69 (133.16)		
Accuracy	98.60 (1.16)	85.85 (5.66)	92.23 (7.65)	48.614	0.027

Results of within subjects analysis of variance for the group differences in orienting performance was found statistically significant, $F(1,18)= 18.868$, $p= 0.023$)showing better performance for younger adults (M = 423.30, SD = 81.39) in comparison to their counterpart(M = 599.54, SD = 108.59).Similarly, the effect of cue type on orienting performance was also found to be significant, $F(1,18)= 45.63$, $p = 0.042$) as orienting performance was found better under central cue condition (M = 511.42, SD = 129.99) than under spatial cue condition (M = 519.35, SD = 132.71). Moreover, main effect of congruency was also found to be significant, $F(1,18) = 16.28$, $p=0.013$) which showed that irrespective of ageing group participants were performed better on congruent trials(M = 527.17, SD = 128.53) in comparison to incongruent trials(M = 554.96, SD = 133.16).

Two-way interaction of cue x congruency was found to be significant, $F(1,18) = 16.28$, $p = 0.013$). It means that older adults were not differentially affected by cue type and congruency-in congruency trial as compared to young adults. However, two-way interactions of age x cue type, F (1,18) = 1.20, $p = 0.76$), as well as age x congruency $F(1, 18) = 3.96$, $p = 0.62$) were miss the level of significance marginally. Additionally, three-way interaction of age x cue x congruency was also miss the level of significance marginally, $F(1,18) = 1.136$, p = 0.71). This shows that cue conditions could not influence orienting task performance differently in young and older adults irrespective of changes in congruency level.

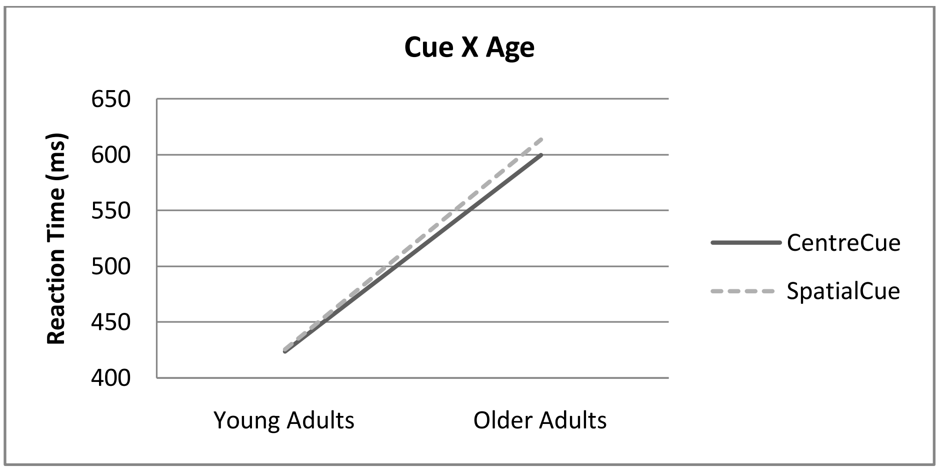

Figure 3(a): Reaction time as a function of age and cue.

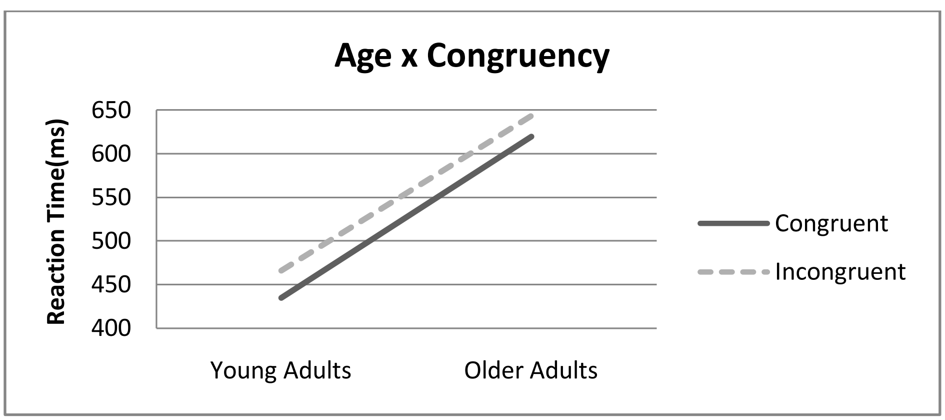

Figure 3(b): Reaction time as a function of age and congruency

Orienting Task Performance between Young and Older Adults

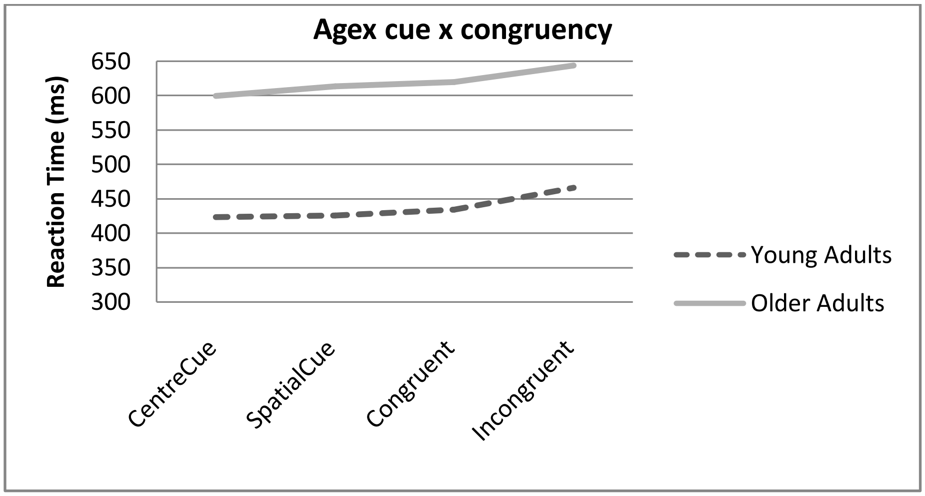

Figure 3(c): Reaction time as a function of age, cue and congruency.

Further, mean scores of accuracy performance on ANT showed that young adults have performed more accurately (*M* = 98.60, *SD* = 1.16) than older adults (*M* = 85.85, *SD* = 5.66). Main effect of age group on accuracy measure was found significant, $F(1,18) = 48.614$, $p=0.027$). It shows a broader advantage for detection of target for young adults, whereas benefit for older adults may be more narrowly restricted to only certain categories of cue conditions i.e. central cue conditions (*M*= 599.54, *SD* = 108.59) with respect to spatial cue conditions (*M*=613.52, *SD* = 105.03).

DISCUSSION

The aim of the present study was to investigate whether and how ageing differentially affects orienting performance. Using a spatial cueing paradigm, orienting performance of young and older adults was compared in relation to performance on two cue conditions (central vs. spatial), as indicators of orienting effect. It was assumed that performance of young adults would be better as a function of orienting effect than their counterpart.

Findings of the present study revealed significant difference between orienting performance of young and the older adults where young adults outperforming older adults on the spatial cueing paradigm. This clearly indicates that orientation in spatial cueing tasks is particularly vulnerable to age-associated changes. Findings of the present study are inconsonance with previous studies (e.g., Bryan & Luszcz, 2000) where older adults were slower than the young adults i.e. older adults took more time to respond which may be due to the age related general slowing in cognitive task thus, confirming the hypothesis of this study regarding orienting task performance difference between young and older adults. Compelling neurological evidence indicates that arrow-triggered orienting have primarily assessed orienting to informative targets (cued) and found orienting to be largely intact with age (Tellinghuisen, Zimba, &Robin, 1996; Madden,Whiting, Cabeza, & Huettel, 2004).

Results of the present study regarding observed differences between spatial and central cue conditions and congruency level in young and older adults, is consistent with the second hypothesis that there would be significant difference in reaction time and accuracy of young adults and older adults on attention network task due to age, cue conditions and congruency as a factor and the reaction time for incongruent trial would be more in comparison to congruent trial in young adults and older adults. However, non-significant three-way interaction of age x cue x congruency level clearly indicate that cue conditions could not influence spatial cueing task performance differently in young and older adults irrespective of level of congruency. Previous studies (e.g., Greenwood, 2000) have also support the current finding showing no influence on the orienting network due to age and congruency.

Although findings show significant main effect of age group and non-significant three-way interaction, previous studies have reported that the older adults show numerically greater orienting effects. Present study focused on spatial and central cue orienting endogenously, however, in previous studies trials were different on aspects such as task differences (identification and detection), type of endogenous cue (central arrow and informative peripheral stimulus), age group (young adults, older adults), group (diseased group, healthy group) and SOA (50–3000 ms). However, in the present study the non-significance age differences in orienting could be due to selection of longer SOA levels and healthy elderly group exhibiting intact performance on all cognitive domains. Moreover, in the present study age seems to have a clear effect on orienting on the spatial cueing task, given that this reliance also occurs in young adults. Thus, present findings are more consistent with the idea that this phenomenon is mainly determined by task demand and individual limits than by ageing only.

In summary, findings of the present study clearly indicate age differences in orienting performance of young and older adults and that the older adults were more influenced by the cue type. Interaction effect for the reaction time data reveals that there was no difference in orienting effect between older and younger adults on congruency of trials. Also older adults were more influenced by cue type of trials as compared to young adults in terms of performance accuracy on ANT. The present results indicate qualitative difference on orienting performances in young and old adults. Performance of both young and old adults is similar when detection accuracy is considered in a spatial cued task but young adults are faster in making the responses. Further, present findings clearly indicate that there is an independent effect of age and cue type on reaction time i.e., age influences the performance on spatial cueing paradigm but when the combined effect of age and cue type were taken into consideration than the result showed no influence of cue type on RT measure whether the person belongs to young adult or older adult. Finally, the present results showed that although cues provide advance knowledge about the location of the target thereby reducing spatial uncertainty and improving target detection during cueing task, but the orientation towards the cue in space do affect the performance and changes with age by increasing the reaction time.

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Conflict of Interests
The author declared no conflict of interests.

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