THE ROLE OF ATTENTIONAL FUNCTIONS IN PROSPECTIVE TIMING

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Abstract

It is well known that attention plays a critical role in prospective timing. Recently several attentional functions have been identified, such as: selective attention, orienting attention, sustained attention and executive attention. Each one of these functions has unique characteristics and a different impact on behavior. The current study was aimed at identifying the role of each one of the attentional functions on prospective timing. Participants were diagnosed by a series of tests and their profile along the attentional functions was defined. In a second phase each participant was tested on a series of temporal tasks, like production and reproduction of short and long time intervals with and without attentional distractions. Statistical analyses clearly revealed that sustained attention is the one attentional function which is most related to prospective timing. This finding is compatible with the Attentional Gate model of prospective timing.

It is well accepted in the literature that prospective timing is dependent on the amount of attentional resources allocated for timing (e.g., The Attentional - Gate Model, Zakay , 2000) . However, attention was until recently considered to be a general function which reflect mental energy and which any individual has a limited capacity for. Consequently, tasks which are conducted concurrently compete for attentional resources. Timing is one such task and therefore attentional resources have to be divided between any mental activity and timing. The more timing is relevant in a specific context, the more attentional resources are allocated for it and this in turn, will increase the perceived durations of intervals when the duration estimation is prospective (Zakay, 2005).

Recent developments in the study of the attentional system (e.g., Posner, 2004), have led to the understanding that this system is not a unified one and that it is composed of several different attentional functions.

Despite this development, the role of specific attentional functions on prospective timing was not tested. Following Tsal, Shalev and Mvorach (2005), the following attentional functions were considered: sustained attention, selective attention, executive attention, and orienting attention. The general idea was to examine which one of these functions impacts prospective timing.

Method

Participants

About 100 first degree students from Tel-Aviv University participated in the study as partial fulfillment of course requirements. Participants' ages ranged between 20 to 42 years. The number of males and females was almost the same. All participants were naïve regarding models and theories of attention and timing and no one had a history of attention deficit of any sort.

General procedure

Each participant was tested individually in two different meetings, separated by one week. In the first meeting, the attentional profile of the participant was characterized. This was done via a series of tests which were identified (Tsal, et al. 2005) as enabling a reliable and valid assessment of individual abilities in each one of the attentional functions.

Selective attention's ability was measured by a conjunction search task. Executive attention's ability was measured by the classical Stroop task. Sustained attention's ability was measured by a conjunctive vigilance task, and orienting attention's ability was measure by a cost-benefit task. In the second meeting. Each participant was tested on different timing tasks like reproduction of short (2 sec.) and long (50 sec.) intervals, with and without distraction of attention.

Results

Each participant was assigned the following scores:
A score for each one of the attentional functions which indicate the level of his/her ability in each function.

As for the timing tasks, each participant was assigned absolute and relative (subjective divided by objective duration) scores indicating how long the reproduced interval relative to the objective one was. This was done for each one of the timing conditions.
In addition, accuracy scores (absolute deviation of the reproduced interval from the objective one), were computed.

Since each one of the participants reproduced several intervals for the same objective duration the standard deviation of each series of reproductions was computed for each participant. This standard deviation is considered as reflecting the intensity of allocation of attentional resources for timing (Brown, 1997). The larger a standard deviation is, the lower the intensity of attention allocation for timing.

Findings

<u>The attentional-functions' profile</u>: Pearsons' correlation were computed between the scores of the four attentional functions. No significant correlation coefficients were found between any two of the functions. This indicated that the attentional functions are independent of each other.

Participants were divided to "high" and "low" groups based on their scores in each one of the attentional functions. Following this, temporal scores were compared between the "high" and " low" groups in each one of the attentional functions.

The main finding of the study was that only sustained attention's scores were significantly correlated with timing scores. The scores of the other three attentional functions were not significantly correlated with any of the timing scores.

Participants who were high in sustained attention's ability were found to be more accurate and less variable in reproducing both 5 sec. and 50 sec. intervals when compared with participants who were low in their sustained attention's ability. These last participants underestimated the 50 sec. interval and overestimated the 5 sec. interval.

The "high ability" participants showed a mirror effect: they underestimated the short interval and over estimated or were accurate in reproducing the long interval. The same pattern of results was obtained regardless of whether or not an attention- distraction manipulation was operated.

It was also found that the feedback on temporal performance, which was provided in some of the experimental trials, was helpful only in the "low" sustained attention group. "High" sustained attention participants did not benefit from the feedback, most probably because they were performing near their optimal level of performance.

Discussion

The findings which were obtained in the present study indicated that sustained attention is the major attentional function which is related to prospective timing processes. This finding is compatible with the Attentional-Gate model (Zakay, 2000; Zakay & Block, 2004) of prospective timing. According to the model, reproduced prospective durations are a function of the amount of attentional resources which affect an attentional gate. The more attentional resources are allocated for the gate, the longer the gate is opened allowing for more signals which are emitted by a pacemaker, to pass via the gate in a time unit and be accumulated and counted by an accumulator.

If sustained attention ability helps in keeping the gate opened for longer periods of time, then, longer intervals should be more accurately reproduced then when one has to close and reopen the gate frequently during an interval. This last state should also cause fluctuation in the process and this should lead to more variability than when the gate is opened continuously during an interval. Participants' level of ability in the other three attentional functions should not affect the ability to hold the gate opened. It is assumed that low sustained attention participants are typified by high attention activation at early stages of timing tasks while later on, with the progression of the timing task, they tire and can not maintain the same level of sustained attention. This causes a depletion of alertness and a premature closing of the attentional gate.

The findings of this study contribute to the expansion of the theoretical understanding of timing processes and deepens observations of the heterogeneous nature of attentional functions and its distinct involvement in various cognitive tasks.

Further research is needed in order to validate the mechanism by which sustained attentions controls the attentional - gate in prospective timing tasks.

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