The Comparative Study of Cued and Implicit Anticipatory Attention During the Performance of Visual and Auditory Versions of the Temporal Order Judgment Task

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Abstract. The aim of the study was to assess the influence of cued and implicit anticipatory attention on the performance of visual and auditory versions of the temporal order judgment task. A total of 20 right-handed healthy adults (10 males and 10 females) aged 23±5.7 years participated in the study. The experiment consisted of two sessions: cued attention and serial learning. In the cued attention session, a participant was informed by a warning signal about the modality of upcoming stimuli. In the serial learning session, a fixed sequence of eight trials (visual and auditory) was repeated 30 times.

Results showed that reaction times (RT) and accuracy of performance in the temporal order judgment task improved during the serial learning session with its fixed order of visual and auditory stimuli pairs. Participants were unaware of any regularity in stimuli presentation. This finding is in favor of implicit anticipation of the forthcoming stimuli modality. The performance in the serial learning session was modality-specific: a significant improvement in accuracy was observed for both modalities, but a decrease in RT was observed only for the auditory modality. No significant influence of explicit anticipation on task performance was found in the study.

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Introduction

Any goal-directed behavior requires attentional modulation of information processing, which may be directed not only to the present event but to past or future ones as well. This paper is dedicated to the investigation of anticipatory attention or "attention to future stimuli" (Näätänen, 1992, p.7).

There are at least two types of conditions in which an individual can anticipate the appearance of relevant stimuli. The first condition requires a cue which informs the individual about an upcoming stimulus; this is referred to as voluntary cued attention. The influence of prestimulus characteristics on reaction times (RT) was studied by Sanders and Wertheim (1973). They discovered that the presence of a warning stimulus presented prior to an imperative signal decreased mean RTs in comparison with a simple RT task without any prewarning.

Posner (1980) developed a special experimental paradigm to study the influence of cueing on performance efficiency. This paradigm implied the presence of a special stimulus (central cue), which informed participants about definite characteristics of a relevant stimulus (e.g., possible location on the computer screen). The information contained within a cue could coincide or not coincide with the real stimuli characteristics; furthermore, a cue might contain no information concerning a relevant stimulus. It was discovered that participants responded faster when stimuli occurred in an expected place than in the situation when a cue did not contain any information about the stimulus location. The decrease in RT was regarded as a beneficial impact of cued anticipation. However, the RT was longer when a stimulus occurred in an unexpected place than when a cue was neutral and not informative. The prolonged reaction time associated with an incongruent cue was regarded as being based on false anticipation.

One of the most popular and useful examples of this experimental paradigm is the flanker test, which was created by Eriksen and Eriksen (1974) and developed by Posner and Fan (2008). In this test, special arrows on the screen served as cueing stimuli pointing to the location of a target stimulus (below or above the central cue) which represented right- or left-oriented arrows. Subjects should push the right or left button according to a target they had seen. The target arrows could be surrounded by congruent or incongruent peripheral stimuli (arrows of the same or opposite directions). This experimental tool with different modifications helped researchers to discover that congruent cueing has a significant positive influence on the rate and accuracy of task performance in comparison with other cueing conditions. In addition, this influence was observed in test-retest experiments on the same participants (Hahn et al., 2011). It is known that explicit cueing within a task-switching paradigm has a positive impact on task performance (for a review, see Monsell, 2003). Task switching causes a decrease in the response rate and accuracy — an effect known as the 'switch cost effect'. A study of the dual classification of visually presented digits (odd/even or low/high) showed that the inclusion of a warning stimulus indicating an upcoming task resulted in switch cost reductions and improved participants' performance in both repeated and random task-switching conditions (Monsell, 2003).

The other possible condition in which a participant might predict the appearance of a relevant event and be prepared for it is a serial reaction time task (Nissen & Bullemer, 1987; Cleeremans, Destrebecqz, & Boyer, 1998; Reber, 1993; Lewicki, Hill, & Bizot, 1988). Nissen and Bullemer (1987) were interested in the investigation of implicit learning. They created a popular tool to study implicit sequence learning called the Serial Reaction Time (SRT) task. In the SRT task, participants responded to successive stimuli that follow a definite sequence consisting of 10 elements. Participants were not informed about the experimental features; however, reaction times decreased significantly with training and increased when the basic sequence was replaced by another one. These RT shifts were explained by the presence of serial learning. This serial learning could be called implicit, as the participants did not consciously perceive the hidden sequence. Thus, it was suggested that anticipation was implicitly caused by the regularity of stimuli in SRT and positively influenced the performance of subsequent cognitive tasks.

Kushner, Cleeremans, and Reber (1991) also investigated changes in the efficiency of task performance during serial learning. They conducted an experiment in which participants were asked to predict the location of the sixth stimulus based on the observation of five previous elements of the set. Participants were not informed about the rule underlying the sequence, but their prediction significantly exceeded the rate of accidental reactions at the end of the experimental session which consisted of 2400 trials. Taking into consideration the fact that participants were unaware of the experimental features and were unable to verbalize their knowledge of the sequence, the researchers suggested that their predictions were based on implicit leaning.

In the present study, we use the term 'anticipatory attention' in relation to two types of prestimulus processes that (1) imply the presence of warning signals (classical attentional paradigm) and (2) take place during an implicit learning (SRT) task. However, there is no consensus about the relation between attention and serial implicit learning in cognitive psychology. The role of attention in implicit learning has usually been investigated with a help of a secondary task, e.g. participants being asked to monitor auditory stimuli presented during the interval between visual reaction time (RT) trials. Some studies demonstrated the interference effect of a secondary task on implicit learning; it was explained by a negative influence of the attraction of attentional recourses on additional tasks. (Nissen & Bullemer, 1987; Frensch, Buchner, & Lin, 1994). Conversely, Cohen, Ivry, and Keele (1990) showed that sequence learning could remain unaffected by distraction when the sequence was simple. Frensch, Lin, and Buchner (1998) suggested that the interference produced by dual-task conditions concerned only the expression of the learned sequence but not the acquisition of a stimuli sequence. Stadler (1995) referred to the effects of tone-counting secondary tasks as a disruption of the temporal organization of a sequence, but not to the deficit of attentional recourses. According to Jimenez and Mendez (1999), two different aspects of attention — mental effort and selective processing — could differently affect implicit learning. They investigated the role of attention in implicit sequence learning in terms of these two aspects and revealed the following:

> Selectively processing [of] to-be-associated elements [was] necessary to produce implicit learning of complex sequences embedded in the material of a serial reaction time (SRT) task. On the contrary, decreasing participants' attentional resources (i. e., increasing the required mental effort by adding a simultaneous task) produc[ed] little or no effects on this form of implicit sequence learning (Jimenez & Mendez, 1999, p.236).

The authors pointed out that selective attention to predictive stimuli was necessary to learn the association between the predictive and predicted stimuli.

These two types of prestimulus attention (cued and implicit) can occur in different daily situations and according to the above data can differently influence the efficiency of information processing. The major goal of the present study was to explore the specific influence of cued and implicit anticipation on task performance. Another important issue was whether anticipation of an upcoming target signal was modality-, domain- or feature-sensitive (i.e., selective). We conducted an experiment in which the cued and implicit anticipation were explored and compared under experimental conditions that were equal in terms of stimuli and cognitive task characteristics. To address the selectivity issue, we used target stimuli varying in two modalities: visual and auditory.

Materials and Method

Participants

A total of 20 right-handed healthy adults (10 males and 10 females) aged 23 ± 5.7 years participated in the study. They had normal or corrected-to-normal vision, and no history of neurological disorders. Informed consent was obtained after the task was explained.

Task

This experiment was designed to be a part of a neurocognitive study of anticipatory processes during the prestimulus period via estimation of intracortical functional connectivity based on HD EEG recordings. This kind of analysis implies the existence of a relatively long period of stationary EEG reflecting the process of anticipation. To meet the requirement, we modified the original SRT task first, varying the interstimulus interval, and then used a modality-specific temporal order judgment task instead of a simple choice reaction time task.

Participants performed the temporal order judgment task (see, for example, Correa, Sanabria, Spence, Tudela, & Lupianez, 2006) in visual and auditory modalities. In this task, a participant should detect which of two stimuli was presented first and then respond manually by pressing a response key. In the cued attention condition, anticipation was evoked by showing a signal indicating the modality of the upcoming target. In the implicit condition, anticipation was induced by the regular alteration of modalities across trials.

Stimuli

Visual stimuli were light gray and dark gray elongated hexagons with 2.5 × 2.5° angular size presented one by one at 40 millisecond (ms) intervals at the center of a black display screen; the angle between hexagons was 90 degrees (see Fig. 1A). Every stimulus from the pair was presented for 15 ms. The task was to decide which signal from the pair occurred first, and to push one of three buttons corresponding to the three possible answers: *a light gray hexagon occurred first; a dark gray hexagon occurred first;* or *I cannot give an answer.* Participants had to respond within a two-second response window.

Auditory stimuli were short sounds of two different frequencies (300 Hz and 3,000 Hz) presented in a binaural way, one by one, at 40 ms intervals. Every stimulus from the pair was presented for 25 ms. The task was the same as for the visual stimuli.

The inter-stimulus interval for cognitive tasks was defined after a preliminary experiment involving nine healthy right-handed adults (20–50 years old). Participants solved both the visual and auditory tasks with a 60–70 percent probability when a 40 ms inter-stimulus interval was applied.

Apparatus

The experiment was conducted on a computer with the help of "EEGExProc" software, specially designed in the Laboratory of Neurophysiology of Cognitive Processes at the Institute of Developmental Physiology (Moscow, Russia). This program allowed for the design of an experimental model and the control of an experimental process. Participants' responses and the sequence of experimental events were registered automatically in .txt format. Stimuli were presented via a computer display with a resolution of 800 × 600 pixels. Participants used a game pad as a response device.

Procedure

The two anticipation conditions were implemented in the two experimental sessions, referred to as *cued attention* and *serial learning*. The order of sessions was counterbalanced across participants to eliminate the systematic influence of experimental duration and session order.

In the cued attention session, the presentation of the target stimuli was preceded by a cue with a schematic image of an ear or an eye, which informed participants about the upcoming stimulus modality (see Fig.1B). Every experimental trial began with the presentation of a fixation cross at the center of the display. A modality-specific cue (see Fig. 1B) was presented at 1000–1500 ms for 80 ms at the center of the display. Target visual or auditory signals appeared at 3500–4000 ms after cueing. The sequence of auditory and visual stimuli was pseudorandom; a participant had two seconds to give a response. The number of visual and auditory stimuli was equal (40 presentations); the session included 80 trials. The order of events in one experimental trial is illustrated in Fig. 1C.

Sensory tasks with the same characteristics were used in the serial learning session. The main feature of this session was the repetition of experimental trials, with a fixed order of sensory modalities and the absence of cued stimuli. The sequence of presented pairs of target stimuli did not change during the session.

A repeated set of eight stimuli pairs is shown in Fig. 1D. The particular set length was chosen in order to prevent explicit learning of the trial sequence. On the one hand, it is known that an implicit learning effect is observed for a sequence with eight elements (Heuer, Schmidtke, & Kleinsorge, 2001; Coomans, Vandenbossche, & Deroost, 2014). On the other hand, eight elements is close to the upper limit of short-term memory capacity (Miller, 1956). Taking into consideration the fact that the duration of the set of eight trials (plus inter-stimulus intervals) exceeded 30 seconds, an explicit strategy of task performance was regarded as hardly possible.

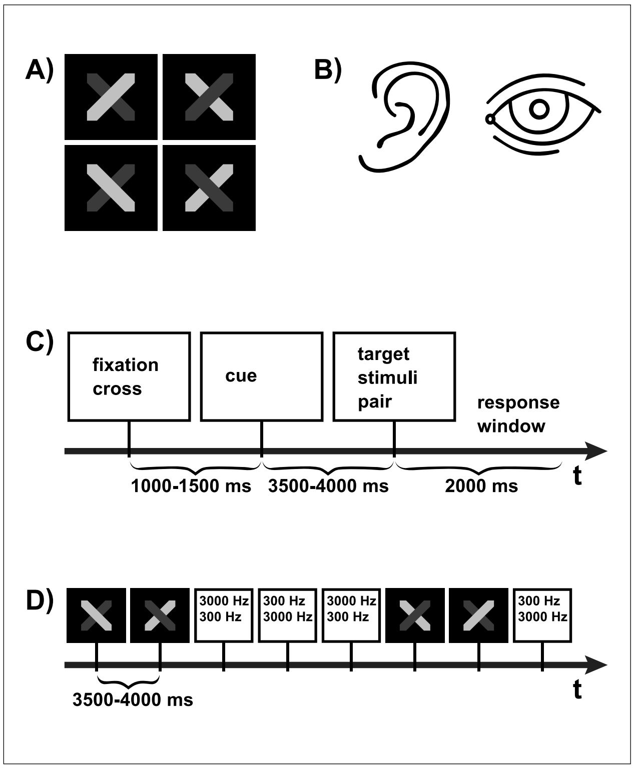

Figure 1. Experimental material and procedures. (*A*) All four variants of the visual stimuli pairs used in the order judgment task are shown. In each pair, the first stimulus is obscured by the second. (*B*) The drawings of an ear and an eye are used to cue the modality of the forthcoming stimuli pair ("warning stimuli"). (*C*) The sequence of events in a typical trial of the cued attention session. The timing of these events is shown along the horizontal time axis. (*D*) The fixed sequence of stimuli pairs (visual and auditory) that is repeated across the serial learning session.

After the session, we asked participants whether they had noticed any regularity in the trial sequence. Only one participant out of 20 reported that he had noticed the regularity in stimuli order by the end of the session. However, when he was asked to reproduce the sequence of visual and auditory stimuli, he could not do so. Therefore, we did not get any indication of explicit learning involvement.

The serial learning session included 30 repetitions of the set and was divided into three stages for further analysis.

Results

Serial Learning Session

Reaction Time. The reaction time (RT) values, plotted against successive set numbers (n) are shown in Fig. 2 for the three consecutive stages of the experimental session. The figure shows that the RT reduction is more prominent in the auditory modality than in the visual modality. In the auditory modality, RT values remained almost unchanged during the first stage, leveled off virtually linearly during the second stage and stayed stable during the final stage. The linear regression analysis corroborates these observations. Unlike the second stage that showed a significant RT (n) slope $B = -0.017$, $(t(8) = -3.696$, $p = .006$, $R^2 = .631)$, the first and third stages did not reveal any significant slopes (all $p > .117$). In the visual modality, none of the stages showed a significant RT reduction (all $p > .260$). However, when we considered the whole session, a significant RT (n) slope (n=30) for both modalities was found: visual modality ($B = -0.003$ ($t(28) = -2.378$, $p = .024$, $R^2 = .168$)); auditory modality ($B = -0.013$ ($t(28) = -14.398$, $p < .0001$, $R^2 = .877$)).

Taking into consideration the departure of RT (n) from linearity across 30 trials for the auditory modality, linear regression analysis seems to be suboptimal. Therefore, to test RT values and accuracy scores (percentage of correct responses), we used general linear model (GLM) with MODALITY (visual and auditory) and STAGE (first, second, third) as the within-subject factors. The multivariate criteria of statistical significance were used.

This analysis showed the main effect of STAGE ($F(2, 18) = 6.486$, $p = .008$, $\eta^2_p = .419$). In Fig. 3A, the RT is shown for each cross-condition (MODALITY × STAGE). The observation that RTs at the first stage (RT1) are longer than at the second stage (RT2) and third stage (RT3)

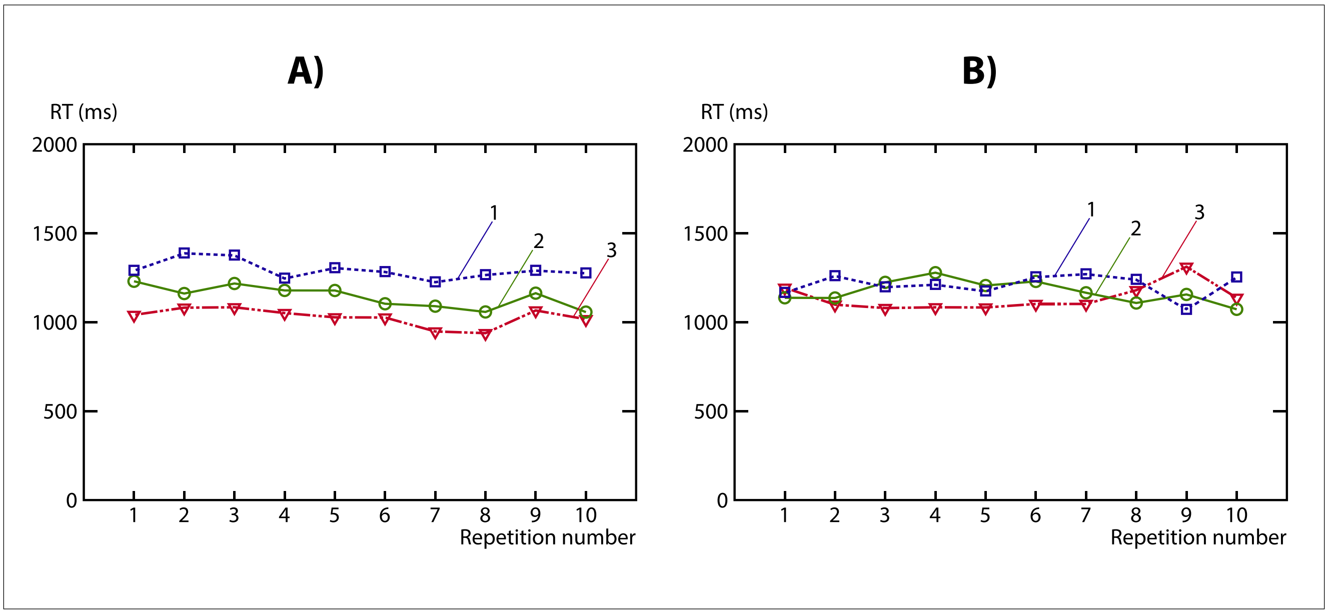

Figure 2. The reaction time (*RT*) values against a successive set number (*n*) in the serial learning session for *A)* auditory and *B)* visual modalities. The *1*, *2*, *3* digits correspond to successive stage numbers (see text for details).

is confirmed by the pairwise comparisons with RT1 vs RT2: $t(19) = 3.193$, $p = .014$, $R^2 = .349$, after Bonferroni corrected; and RT1 vs RT3: $t(19) = 3.385$, $p = .009$, $R^2 = .376$, after Bonferroni corrected.

No main effect of MODALITY was found ($F(1, 19) = 0.072$, $p = .791$, $\eta^2_p = .004$). In addition, a significant interaction of MODALITY and STAGE was found ($F(2, 18) = 5.194$, $p = .017$, $\eta^2_p = .366$). Separate one-way rmANOVA with STAGE as the only factor showed a significant decrease of RT for the auditory task ($F(2, 18) = 9.572$, $p = .001$, $\eta^2_p = .515$) but none for the visual task ($F(2, 18) = 1.274$, $p = .304$, $\eta^2_p = .124$).

The paired comparisons of RT at the different stages of learning during the auditory task showed that RT significantly decreased (after Bonferroni correction) at the second ($t(19) = 4.450$, $p = .001$, $R^2 = .510$) and at the third stage ($t(19) = 3.684$, $p = .005$, $R^2 = .417$), relative to the first stage.

Thus, a reduction in RT was observed for both auditory and visual modalities, although this reduction was statistically reliable only for the auditory modality.

Accuracy. The same GLM model was applied to accuracy scores. In Fig. 3B, the percentage of correct responses is shown separately for each cross-condition (MODALITY × STAGE).

The statistical analysis showed a main effect of MODALITY ($F(1, 19) = 7.930$, $p = .011$, $\eta^2_p = .294$). It turned out that participants performed the auditory task better than the visual one at all stages. There was also a main effect of STAGE ($F(2, 18) = 8.610$, $p = .002$, $\eta^2_p = .489$) for both modalities. Performance generally improved across the session. The paired comparisons showed significant differences (after Bonferroni correction) between the first and the third stages ($t(19) = -4.242$, $p = .001$, $R^2 = .486$), and between the second and the third stages ($t(19) = -3.049$, $p = .020$, $R^2 = .329$).

A separate one-way rmANOVA with STAGE as the only factor showed a significant increase of accuracy for the visual task ($F(2, 18) = 6.874$, $p = .006$, $\eta^2_p = .433$). The paired comparisons at the different stages of learning during the visual task showed that accuracy significantly increased (after Bonferroni correction) at the third stage comparing with the first ($t(19) = 3.490$, $p = .007$, $R^2 = .391$) and the second ($t(19) = 2.947$, $p = .025$, $R^2 = .314$) stages.

For the auditory task, a one-way rmANOVA with STAGE as the only factor also showed a significant increase of accuracy ($F(2, 18) = 5.596$, $p = .013$, $\eta^2_p = .383$). The paired comparisons showed the significantly increased accuracy (after Bonferroni correction) at the third stage comparing with the first one ($t(19) = 3.387$, $p = .009$, $R^2 = .376$)

Thus, the accuracy of performance improved for both modalities by reaching the last stage of the session.

In summary, in the course of the serial learning session, participants showed a significant improvement in their performance. The significant changes in RT were observed by the second stage of the session and, somewhat later, by the third stage of the session, in terms of accuracy. It seems that no substantial serial learning occurs during the first stage of the experimental session, and therefore no implicit anticipation takes place. Thus, the first stage of serial learning is considered as a *baseline condition*.

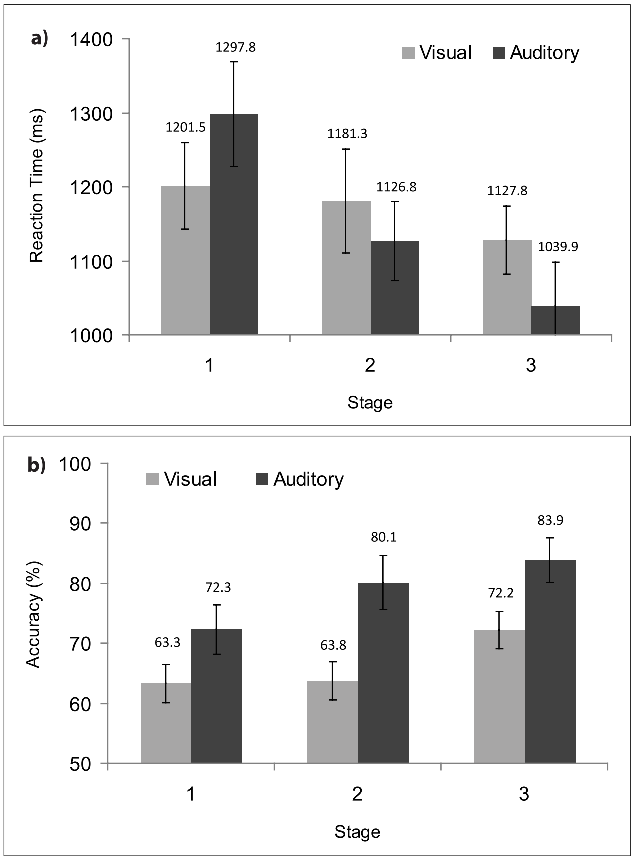

Figure 3. Averaged RT in milliseconds (*a*) and accuracy score percentage (*b*) for visual and auditory tasks are shown for the three successive stages of serial leaning. The *1*, *2*, *3* digits correspond to successive stage numbers (see text for details). Error bars represent the standard error of mean (SEM).

Exploring the Impact of Anticipation of Different Types

Taking into consideration the above data, we compared the indices of task performance (RT and accuracy) in the three experimental conditions: (1) the baseline condition, without implicit anticipation (the indices collected in the first stage of the *serial learning* session), (2) cued anticipation, (3) implicit anticipation (the indices taken from the third stage of the serial learning session).

To test RT values and accuracy scores (percentage of correct responses), we used GLM with MODALITY (visual and auditory) and experimental CONDITION (baseline condition, cued anticipation, implicit anticipation) as the within-subject factors. The multivariate criteria of statistical significance were used.

Reaction time. In Fig. 4A, the RT values are shown separately for each cross-condition (i.e., condition/modality pair).

The statistical analysis revealed a main effect of the factor CONDITION ($F(2, 18) = 6.549$, $p = .007$, $\eta^2_p = .421$). In addition, the paired comparison showed that the influence of this factor was linked with the difference of RT in the baseline and implicit anticipation conditions. The difference between these conditions was described earlier.

Mean RT values in the condition of cued anticipation were lower than in the baseline condition (1,287 ms vs. 1,297 ms, correspondingly); however, this difference was not significant. A significant interaction of MODALITY and CONDITION was found ($F(2, 18) = 4.098$, $p = .034$, $\eta^2_p = .313$). This interaction reflects the presence of sig-

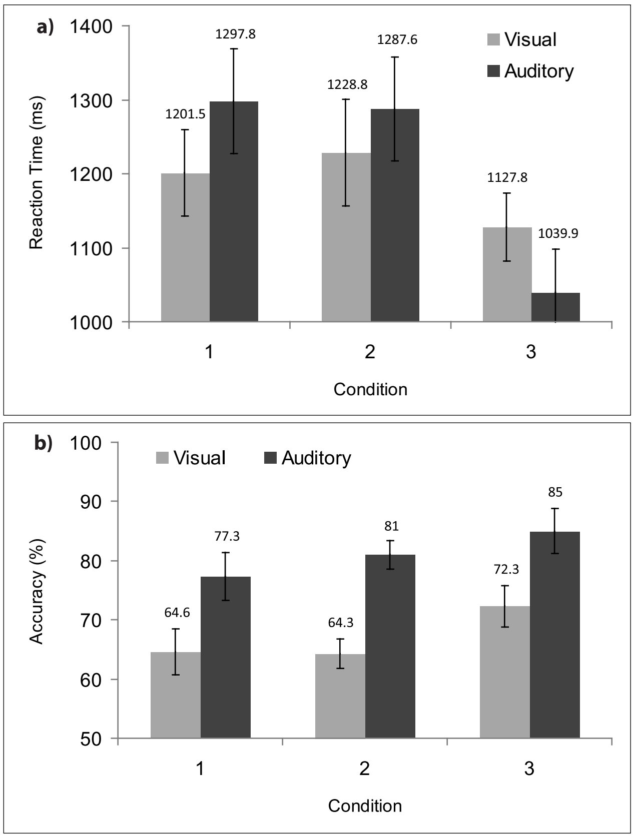

Figure 4. Averaged RT in milliseconds (*a*) and accuracy score percentage (*b*) for visual and auditory tasks are shown for different experimental conditions: (*1*) baseline condition, (*2*) cued attention and (*3*) implicit anticipation. Error bars correspond to the standard error of mean (SEM).

nificant RT differences for the auditory modality ($F(2, 18) = 7.337$, $p = 0.005$, $\eta^2_p = .449$) and simultaneously the absence of any impact of CONDITION for the visual modality ($F(2, 18) = 2.130$, $p = .148$, $\eta^2_p = .191$). The pairwise comparison of RT for the auditory modality showed significantly (after Bonferroni correction) shorter RT in the implicit anticipation condition compared with either the baseline ($t(19) = 3.684$, $p = .005$, $R^2 = .417$) or cued attention condition ($t(19) = 3.196$, $p = .014$, $R^2 = .350$).

Accuracy. There were a number of participants who failed to respond in a designated time, which is why it was impossible to identify their percentage of correct responses. The data obtained from those subjects were excluded from further analysis. Thus, the data for 16 subjects were analyzed.

In Fig. 4B, accuracy is shown separately for each cross-condition.

The analysis of variance revealed the main effect of MODALITY ($F(1, 15) = 12.598$, $p = .003$, $\eta^2_p = .456$): the auditory task scores were better than those for the visual task. Additionally, a main effect of CONDITION ($F(2, 14) = 5.896$, $p = .014$, $\eta^2_p = .457$) was found: the lowest accuracy scores were observed in the baseline condition (71%), higher scores were found in the condition of cued attention (72.65%) and the highest scores were reached in the condition of implicit anticipation (78.67%). The differences reached a significance level between *baseline condition* and *implicit anticipation* ($t(15) = -3.532$, $p = .009$, $R^2 = .454$, Bonferroni corrected). The positive, though nonsignificant, impact of cued attention was observed only for the auditory task. In the latter case, the mean percentage of correct responses in the baseline condition was 77.3% versus 81% in the condition of cued attention.

Thus, within the framework of this experimental model the positive impact of cued attention was not significant. In addition, it should be mentioned that this effect was observed only for the auditory task and concerned both RT and accuracy.

Discussion

The behavioral data analysis showed a performance improvement (RT decreased and accuracy increased) at the third stage of the serial learning session. We attributed the improvement to a result of implicit learning.

Taking into consideration the fact that the temporal order judgment task was solved by participants with a near-threshold probability (60–70%), the identification of the regularity in stimuli pairs was hampered. Therefore, neither the order of stimuli within pairs nor the identity of motor responses to those stimuli could provide reliable information on the trial regularity. The only reliable source for that was stimuli modality.

It seems that we may exclude the possibility that the RT reduction was due to the learning of responses or visual stimuli per se. The point is that the stimuli used in the study represented simple geometric figures and audio signals with a minimum number of perceptual features. These primitive signals are usually found as constituents of natural stimuli experienced by human beings. Similarly, motor responses (keystrokes) are simple actions that are ubiquitous in daily life. Thus, there are no reasons to expect that, during the serial learning session, any other form of learning except for serial perceptual/motor learning would occur (Abrahamse, Jimenez, Verwey, & Clegg, 2010). We suggest that, for the most part, the implicit learning effect could be caused by anticipation of the modality of the forthcoming stimulus.

To assess the possible impact of nonspecific learning on the results (a concern raised by one of our anonymous reviewers) we performed the following additional test. We contrasted the performance speed (measured with RT) between the subgroup of participants who began the experiment with the cued attention session versus participants who performed that session after an extensive training during the serial learning session. In these two subgroups, RT was compared for the cued attention session. Unlike the serial learning session, the cued attention session cannot show any effect for learning except for general nonspecific learning.

The comparison of the two subgroups showed no significant differences in the RT averaged across two modalities ($t(18) = 0.901$, $p = .380$, $R^2 = .043$), across the auditory modality alone ($t(18) = 0.958$, $p = .351$, $R^2 = .048$) and visual modality alone ($t(18) = 0.731$, $p = .474$, $R^2 = .029$). The absence of a significant practice effect rules out any significant contribution of general learning, either sensory or motor, to the performance speed.

The comparison of task performance in the three experimental conditions (cued attention, serial learning and baseline) showed no significant impact of cueing on either performance accuracy or response rate. This came as a bit of surprise, given the literature findings of the reliable positive influence of central cueing on task performance (Posner, 1980).

It seems that the first stage of the serial learning session might not be an appropriate baseline for the cued attention condition. Regular modality alteration, even though it does not cause the implicit learning, might reduce the RT and error rate (Monsell, 2003) to the level comparable with that caused by explicit cueing. The session with randomly varying modalities would be a better choice for the baseline condition.

The present study revealed that performance in the serial learning session was modality-specific: the decrease in RT was observed only for the auditory modality, while the significant accuracy increase was observed for both modalities. What might underlie the modality-related difference in task performance is the difference in the selection of visual and auditory information described in Neumann, van der Heijden and Allport (1986). According to that paper, auditory attention represents a single process with 'limited capacity' which is more suited (in comparison with visual attention) to select signals from the noise. In the processing of auditory information, "the main task of the selection mechanisms is to decide whether or not an auditory event in the environment should be chosen for the potential control of action" (Neumann et al., 1986, p. 2).

Our study has shown that implicit learning can be observed beyond the serial reaction time task in tasks as complex as the temporal order judgment task. As far as using the temporal order judgment task in the study of modality-specific explicit cueing, care should be taken to provide an adequate baseline condition, which, in turn, requires additional research to be done.

Conclusions

The rate and accuracy of performance in the temporal order judgment task improved during the serial learning session, which had a fixed order of visual and auditory stimuli pairs. This finding is in favor of the implicit involvement of anticipation of the forthcoming stimuli modality.

The participants' performance in the serial learning session was modality-specific: while a significant improvement in accuracy was observed for both modalities, the RT decrease was observed only for the auditory modality.

No effect of explicit cueing was found in the study.

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Сравнительное исследование направленного и имплицитного предвосхищающего внимания при решении зрительного и слухового вариантов задачи на определение порядка следования стимулов в паре

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Аннотация. Целью данной работы было исследование влияния направленного и имплицитного предвосхищающего внимания на успешность решения зрительного и слухового вариантов задачи на определение порядка следования стимулов в паре (temporal order judgment task). В исследовании приняли участие 20 здоровых взрослых правшей (10 мужчин и 10 женщин) в возрасте 23 ± 5.7 лет. Эксперимент состоял из двух сессий: «Направленное внимание» и «Серийное научение». В сессии «Направленное внимание» предупреждающий стимул информировал испытуемого о модальности целевого сигнала. В сессии «Серийное научение» многократно повторялась фиксированная последовательность из восьми пар зрительных и слуховых стимулов.

Было показано, что скорость решения задачи, а также процент правильных ответов увеличивались в ходе сессии «Серийное научение». При этом испытуемые не осознавали существования закономерности чередования целевых сигналов, что говорит в пользу формирования имплицитного предвосхищения. Изменения поведенческих параметров при имплицитном научении зависели от модальности стимулов: значимое увеличение процента правильных ответов наблюдалось как для зрительной, так и для слуховой модальности, а сокращение времени реакции — только для слуховой модальности. Значимого влияния эксплицитной преднастройки на успешность решения задачи обнаружено не было.

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Ключевые слова: задача на определение порядка следования стимулов в паре, сенсорная модальность стимулов, предвосхищение, направленное внимание, имплицитное научение

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