research note

Repeated Errors in Complex Motor Coordination Tasks

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Abstract. The present paper describes repeated errors in complex motor coordination tasks and the effect of irrelevant stimulus features on such repeated errors. Participants were presented with a video of dance movements which they had to repeat synchronously with a videotaped presenter. The same set of eight easy movements was repeated 20 times, with a break after the first 10 repetitions. In the first experimental group, there was a change of presenter on the video (from female to male or vice versa) after the break. In the second experimental group, a color effect was used (highlighting the presenter) after the break. The control group continued the task without any changes. We compared the number of repeated errors within groups on different parts of the experiment and between groups. It was shown that in all groups there were fewer repeated errors after the break. There were no differences in the frequency of repeated errors between groups before the break. After the break, there were fewer repeated errors in the experimental groups than in the control group. Thus, it appears that the change of irrelevant features led to decreased error repetition.

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Introduction

A tendency to repeat one's own errors has been shown for different motor and cognitive tasks. Some authors suggest that the repetition of errors can be attributed to a limitation of resources or the implicit learning of an erroneous state (VanRullen & Koch, 2003; D'Angelo & Humphreys, 2015). D'Angelo and Humphreys (2015) investigated whether the tip-of-the-tongue effect tends to reoccur on particular words. The authors found that participants tend to experience a tip-of-the-tongue effect during the test despite the fact that they had been given the correct answer directly before. VanRullen and Koch (2003) in their experiments asked participants to memorize photos of city views containing various objects. It was shown that when participants cannot recall a particular object, such as a bus, they tend to make more errors in subsequent tasks and perform a task more slowly if it involves the missed object.

In his work, Allakhverdov (1993, 2019) pays attention to the fact that the repetition of errors may occur even if

these errors are unconscious. The author considers responses in perceptual tasks, such as detection or recognition, to be decisions. Once a decision is made, it influences the processing that follows, which leads to stable awareness (positive choice aftereffect) or unawareness (negative choice aftereffect) of items in the task. He shows that once they are missed or misidentified, items tend to be the subject of error more often than new stimuli in subsequent trials.

Studies in the field of sport psychology show that athletes often repeat their errors under conditions of stress or high cognitive load (Hanin et al., 2002). Meanwhile, Beilock and colleagues found that athletes tend to make and consolidate errors even when they know about their typical mistakes (Beilock et al., 2001). Therefore, the knowledge about typical errors does not help to correct them and even can inhibit correction. In the field of motor skill learning, a number of works are devoted to the phenomenon of errorless learning. For example, Poolton, Masters and Maxwell (2005) showed that in the case of hypothesis testing strategies participants were less successful in motor skill tasks than they were after a brief period of errorless learning. Thus, errorless learning is more effective since it allows participants to avoid the repetition and consolidation of errors.

In our previous study (Andriyanova & Ivanchei, 2015) it was shown that people tend to repeat their errors in perceptual tasks. When participants recognize a stimulus incorrectly, they tend to make an error on the same stimulus in the following series more often than in random cases. We found that changes in a task's irrelevant features (e.g., the color of stimuli) led to the activation of conscious control, causing a reduction of repeated errors. Thus, the alteration of irrelevant features led participants to consider the task as new. We also used different types of irrelevant feature changes (regular and irregular). It was found that there were fewer repeated errors in the group with regular changes of irrelevant features than in groups with chaotic changes and with no changes. Thus, we suppose that participants began to unconsciously monitor regularity, therefore investing less into the repetition of a previously chosen response.

Our present work is aimed at detecting repeated errors in the performance of motor coordination tasks (dance exercises) and investigating the influence of irrelevant features on the repetition of errors in such tasks. To test our suggestion we carried out an experiment with two different types of irrelevant stimulus alterations.

Method

Participants

Ninety people participated in the study: 22 males and 68 females, all between 18–35 years old (mean age 25.4 years). All participants were randomly divided into three groups (30 participants in each group): two experimental groups, with whom we used irrelevant stimulus alterations in the course of the experimental session, and one control group without such changes.

Procedure and Design

Participants watched a video on the computer screen with dance movements in an acrobatic rock-n-roll style, which they had to repeat synchronously with the videotaped presenter. The same set with eight easy movements was presented 20 times with a 5-minute break after 10 repetitions. During the break, participants watched a video with their own performance from the first 10 repetitions.

In the first experimental group, the presenter on the video was changed after the break, from female to male or vice versa. In the second experimental group, we used a color effect of highlighting the presenter with blue after the break. In the control group, there were no changes after the break.

Analysis

The performance was recorded using a video camera and then analyzed by two experts. We consider a repeated error to be a repeated incorrect performance of an element, such as the omission of a movement or the extra movement of an arm or leg. At least two instances of the same erroneous movement on the same element counted as a repeated error (i. e., if a participant made three similar extra leg movements at different repetitions on the same element, the repeated error score was three). Performing the same erroneous movement on different elements did not count as a repeated error. We compared the frequency of repeated errors, calculated as the percentage of repeated errors from the total number of errors. Comparisons were made between the frequency of repeated errors within groups in the different stages of the experiment and also between the control and experimental groups.

Results

Within-group differences were analyzed by Student's *t*-test for paired samples. The frequency of repeated errors in the control group is significantly different before and after the break ($t(29) = 5.231$, $p<.001$, $d = 0.907$), and significant differences in the frequency of repeated errors before and after changes were also found in Experimental Group 1 ($t(29) = 10.735$, $p < .001$, $d = 1.889$) and Experimental Group 2 ($t(29) = 9.801$, $p < .001$, $d = 1.481$). All *p*-values presented above are adjusted values after Bonferroni correction for multiple comparisons. In all groups, participants made fewer repeated errors after the break (see Table 1).

Comparative analysis of the error frequency between groups was performed using one-way ANOVA. There were no differences in the frequency of repeated errors between groups before the break ($F(2, 87) = 1.237$, $p = .295$, $\eta^2 = .038$). After the break, there were significant differences in the frequency of repeated errors between the control and experimental groups ($F(2, 87) = 12.271$, $p < .001$, $\eta^2 = .289$). Then we compared the results of each experimental group with the control group to test the influence of irrelevant features, using Student's *t*-test for independent samples.

Table 1. The Frequency of Repeated Errors in Groups Before and After the Break (*SE* in Brackets)

	Before the Break	After the Break
Control Group	84 % (4.3)	61 % (4.7)
Experimental Group 1	75 % (4.3)	30 % (4.2)
Experimental Group 2	78 % (4.1)	44 % (4.3)

After the break there were significant differences between the control group and Experimental Group 1 ($t(58) = 4.096$, $p < .001$, $d = 1.265$), and also between the control group and Experimental Group 2 ($t(58) = 3.762$, $p < .001$, $d = 0.698$). Thus, in the experimental groups there were fewer repeated errors after the break than in the control group.

Discussion and Conclusions

The results of the experiment show that in the dance exercises people tend to consolidate both correct and erroneous reactions. The results allow us to make some conclusions about the difference between the frequency of repeated errors in the groups with and without irrelevant stimuli (change of presenter or color effect). A change of irrelevant features causes participants in the experimental groups to commit fewer repeated errors than in the control group where no changes appear in the task. Such changes of irrelevant features did not alter the task for participants. But we suppose that in the case of irrelevant feature changes, participants consider the very same task as a new one; therefore they can verify it once again and have fewer repeats of their consolidated actions. It is suggested that participants pay attention to the differing component of the task, including the context, and consider it as an important part. Changing an irrelevant feature makes the context different, therefore changing the participants' habitual actions.

These results correspond to our previous results in tasks with multiple presentations of similar visual stimuli for a short time (Andriyanova & Ivanchei, 2015). The difference in the results is that in our current experiment we also found a decline in repeated errors in the control group which had no changes in the task after the break. This result may be explained by the break in the middle of the task: during the break, participants could consider their actions and realize some errors. Or, it may be the result of learning during the experiment. In the current study we used sensorimotor tasks but in our previous study we used perceptual tasks. It is possible that the learning effect is more inherent for sensorimotor tasks.

In this study we investigated two different types of irrelevant features and found that both of them influenced the frequency of repeated errors. Thus, we can generalize and conclude that the change of irrelevant features led to decreased error repetition in complex coordination tasks. Such results may be important for applied fields (for example, for preparing new training methods for athletes).

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краткие сообщения

Повторяющиеся ошибки при решении сложнокоординационных двигательных задач

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Аннотация. В статье представлено экспериментальное исследование, посвященное возникновению повторяющихся ошибок в двигательных задачах и их коррекции с помощью изменения нерелевантных параметров задачи. Испытуемым предъявлялся видеоролик с записью танцевальных движений, которые необходимо было повторять синхронно с инструктором. Одна и та же связка из восьми простых движений повторялась 20 раз с перерывом после первых 10 повторений. В экспериментальной группе 1 после перерыва происходила смена инструктора на видео, показывающего движения (с женщины на мужчину или наоборот). В экспериментальной группе 2 после перерыва использовался цветовой эффект, выделяющий фигуру инструктора на видео синим цветом. В контрольной группе никаких изменений процедуры не происходило. Сравнивалось количество повторяющихся ошибок внутри групп на разных этапах эксперимента, а также между контрольной и экспериментальными группами. Результаты показали, что количество повторяющихся ошибок внутри как экспериментальных, так и контрольной группы до и после перерыва статистически значимо различается. Сравнение количества повторяющихся ошибок в контрольной и экспериментальных группах до перерыва или изменения не показало значимых различий. При этом были обнаружены статистически значимые различия между контрольной и экспериментальными группами после перерыва/изменения. То есть во всех трех группах после перерыва участники реже повторяют ошибки, однако в экспериментальных группах после изменений повторяющихся ошибок стало меньше, чем в контрольной. Таким образом, изменение нерелевантных параметров задачи привело к более эффективному снижению повторения ошибок.

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