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Research article

# Greater learning transfer effect for avoidance of loss than for achievement of gain in Finnish and Russian schoolchildren

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ABSTRACT

Classification of behavior into principal categories of approach and avoidance is grounded in evolutionary considerations and multiple results of behavioral, self-report, and brain-activity analyses. Contrasted via measures of cognitive processes, avoidance is accompanied by greater cognitive engagement than approach. Considering outcome as a key constituent of behavioral underpinnings, we interpret approach/avoidance distinction in terms of structure of experience: avoidance domain provides more detailed interaction with the environment, than approach domain. Learning outwardly similar behaviors aimed at gain or loss outcomes manifests formation of different structures that underlie further learning. Therefore, we predicted difference of learning transfer between gain and loss contexts that was revealed here by introducing two tasks for different groups of schoolchildren in Finland and Russia. The cultural specificity of gain/loss differences was also evident with employed measures, including error rate and post-error slowing. The results support that avoidance-motivated behavior is organized as a more complex organism-environment interaction, than the approach-motivated behavior.

## 1. Introduction

Aiming at the desired and bypassing the unwanted are considered as basic categories that describe behavioral diversity (Schneirla, 1959) and reveal fundamental principles of psychological functioning (Carver, 2006; McNaughton et al., 2016). The approach–avoidance distinction includes interrelated oppositions of movements, motivations, outcomes (gain–loss), and emotions (Coyle et al., 2019). In humans, it is described in broader terms of motivational states or traits (Elliot Andrew et al., 2013; McNaughton et al., 2016) that manifest "systems" with corresponding putative neural correlates (Corr, 2013; Nummenmaa and Tuominen, 2018).

The approach and avoidance are characterized by differences of cognitive processes (Hengstler et al., 2014; Li et al., 2017; Phaf et al., 2014), including attention (Roskes et al., 2013), attentional flexibility (Calcott and Berkman, 2015), memory (Bowen and Spaniol, 2017; Murty et al., 2011), perception (Chan et al., 2019), cognitive control (Koch et al., 2009) etc. The avoidance of negative outcomes is linked to greater complexity, differentiation, greater cognitive load and engagement, than the achievement of positive outcomes (Alexandrov et al., 2007; Alexandrov and Sams, 2005; Bowen and Spaniol, 2017; Roskes et al., 2013; Schwarz, 1990; Yechiam et al., 2018) even if the tasks are similar. Accordingly, the same objects within gain or loss contexts have different value – the positive and negative outcomes are "asymmetric" (Alexandrov et al., 2007; Kahneman and Tversky, 1986; McNaughton et al., 2016).

Outwardly similar behaviors, one aimed at achievement of gain, and another aimed at avoidance of loss, are different with respect to their brain underpinnings (Calcott and Berkman, 2015; Li et al., 2017; Tanaka et al., 2014; Viinikainen et al., 2012; Zhang et al., 2016, 2019), systems

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organization (Alexandrov, 2008), and are characterized by positive and negative emotions, correspondingly (Alexandrov and Sams, 2005; Carver et al., 2000; Chen and Bargh, 1999; Davidson et al., 1990; but see Bowen and Spaniol, 2017; Miller et al., 2013). Therefore, we assume that coping with the same task for different outcomes is based on learning processes that have different utility. The approach and avoidance conditions have been shown to differ in speed and accuracy during learning (Luking et al., 2016; see also Scholer et al., 2019).

If approach and avoidance learning differ in cognitive effort, they would lead to different performance improvements (see Case and Olino, 2020; Gray, 1975). Accordingly, learning dynamics differs between gain and loss contexts (e.g., Alexandrov et al., 2007; Murty et al., 2011). The goal of the present study was to reveal how goals of outwardly similar behaviors shape their "inward" structure by assessing learning transfer. We employ methodology that is derived from direct correspondence between learning and its goal (Alexandrov Yuri et al., 2018; Shvyrkov, 1986). The united concept of consciousness and emotion (Alexandrov, 1999) maintains that approach and withdrawal behaviors differ emotionally, and are provided by systems that serve as elements of two domains of individual experience. System is a unity of co-organized elements of brain and body that subserves achievement of adaptive result (Anokhin, 1974). The "negative" domain is considered to be more complex, i.e. contains more elements, than the "positive" domain (Alexandrov et al., 2007). We imply that if the negative domain contains more elements than the positive domain, then the former should force transfer by providing more detailed prior experience in a similar task. To our knowledge, the approach and avoidance have not been contrasted via learning transfer in identical simple tasks.

The two contexts of gain and loss were created by the instruction. We presented identical tasks and manipulated the type of feedback declared in the instruction, expecting greater positive transfer in loss context compared to gain context. Prior comparison of learning and transfer measures between two age groups (Sozinov et al., 2015) partly involved data presented here and showed that the gain and loss contexts can be contrasted in adolescence. No feedback was presented to the participants during tasks to deliver motivation as a context and to avoid unequal effects of momentary salience of gain or loss. Since numerous emotion-related phenomena remain evident in absence of feedback (Chetverikov et al., 2017; Houtman et al., 2012), we expected achievement- and avoidance-oriented instructions to evoke subjective construal of outcomes.

According to our framework, the avoidance-oriented behavior has more complex organization, than the approach-oriented behavior (and requires greater cognitive engagement, according to the literature cited above). Since the post-error processes manifest modification of behavior (e.g., Holroyd and Coles, 2002), we employed it as an indirect measure of this complexity. We expected post-error slowing to be greater in the loss context compared to the gain context.

There is cultural specificity related to approach and avoidance, revealed via individual measures (Elliot et al., 2001; Hamamura et al., 2009; Niles, 1995; Wang et al., 2017; Yamazaki, 2005). Social and motivational aspects of transfer have long been proposed (Dweck, 1986; McKeachie, 1987; Pea, 1987; Prather et al., 1972), although clear evidence on the relation between the learning transfer and cultural peculiarities of learning for achievement and avoidance is still lacking. If the attitude to gains and losses has cultural specificity, then the approach-avoidance differences of learning and performance indices would be affected by culture, too. This was verified here by comparing task-performance indices between Finnish and Russian schoolchildren. The two countries were shown to have different assessment systems (Hufton and Elliott, 2000; Räty et al., 2011). Namely, assessment in Russia is more motivational, more collective and explicit, and socialization is more school-based compared to Finland. Although what makes praise motivating differs between cultures, Russian teachers were shown to use less praise and more criticism than their Western colleagues (Hufton et al., 2003). If the avoidance learning experience is more prevalent in Russian culture, then the gain-loss differences that we expect might be more pronounced in Russian than in Finnish participants.

### 1.1. Overview of the present study

Here we compared the learning transfer effects assessed with speed and accuracy measures of simple task performance between gain and loss contexts. The idea that achievement and avoidance behaviors manifest individual experience formed within two domains that differ in the extent of differentiation presumes gain-loss differences in utilization of prior memories. We argue that the "negative", or avoidance, domain of experience has more elements and provides more distinctive interaction with the environment than the "positive", or approach, domain. Accordingly, the positive transfer effect was higher in the loss than in the gain context for one of two tasks employed in our setup. This was true for Finnish and Russian participants. However, other measures have revealed differences, possibly attributable to cultural practices and/or task difficulty.

## 2. Methods

### 2.1. Participants and design

The participants were 138 students, including 60 students (29 female) from the 5$^{th}$ and 6$^{th}$ grades of Teacher Training School of Oulu, Finland (mean age = 11.95 years, SD = 0.52), and 78 students (38 female) from the corresponding grades of schools in Moscow, Russia (mean age = 11.98 years, SD = 0.79). Written consent was signed by the parent(s) of each participant. The participants had no history of psychiatric or neurological disease, normal or corrected to normal vision, and reported good health. They were briefed about the tasks before the procedure. The experimental setup had been approved by the Ethical Committee of the Institute of Psychology, Russian Academy of Sciences, and implemented in correspondence with the Declaration of Helsinki. The between-group design was 2 Contexts (gain and loss) x 2 Orders of tasks x 2 Countries (see details below).

### 2.2. Tasks

Two tasks consisted in discrimination of words by pressing a button after presentation of a word (Figure 1). The Task N was to define the *number* of letters in the presented word. The Task S was to define its font *size*. Only two possible answers, assigned to "g" and "h" buttons on a standard keyboard, were possible in the tasks. In Task N all words were either 4 or 5 letters long (and all had font-size 30). In Task S, the words (also 4 or 5 letters long) had either "big" font-size (34), or "small" font-size (26). The order of words in the tasks and the font-size in Task S had been randomized (see Sozinov et al., 2012 for more details).

### 2.3. Procedure

The participants were requested to sit in front of the standard computer monitor at approximately 60 cm and perform the tasks according to given instructions. The 3.5-degree visual angle sufficed the task performance. It was necessary to hold the space bar with the index finger of the dominant hand during the whole task, releasing it only for pushing the answer key with the same finger. This keyboard skill was trained in a separate block of trials before the tasks ("keyboard skill" block). An intertrial interval (ITI, 1 s) was initiated at pressing the space bar after the answer key. Presentation of a word, pressing the answer button, and the ITI constituted one trial.

Each task consisted of two blocks: practice and test. In total, five blocks were performed by each participant: "keyboard skill" (28 trials), practice of the first task (14), test of the first task (60), practice of the second task (14), test of the second task (60) – 176 trials in total. A short break for new instructions was given before each of these blocks. In

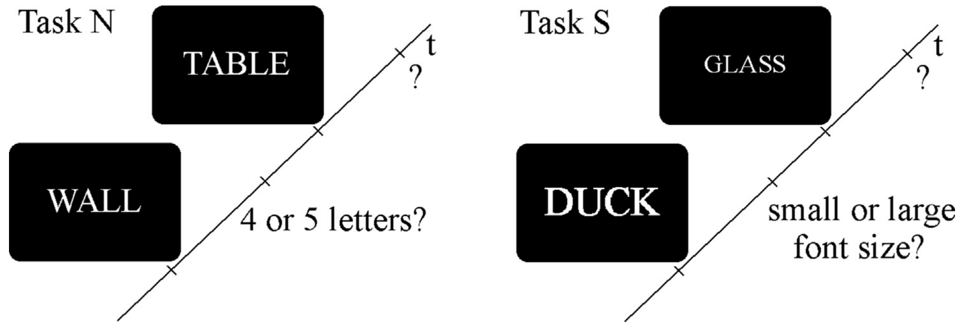


**Figure 1.** In consecutive trials presented on a timeline the participants were asked to discriminate between 4- and 5-letter words (presented in the native Finnish or Russian language) in Task N (left) and between small and large font sizes in Task S (right). (Proportions of words and screen are distorted for visibility.)

contrast to our previous study (Sozinov et al., 2012), a 3-days interval separated the test block of the first task and practice of the second task.

The goal of both tasks was to earn as many points as possible. Final score depended on the accuracy only. The instruction declared reckoning of the points only in the test blocks. The trials were not followed by feedback in any of the blocks. The instructions were pronounced by the experimenter and were accompanied by briefings on the screen.

Gain and loss contexts were shaped by the rule specified in the instructions. The context was assigned randomly once, and remained in both test blocks of a given participant. In the gain context the participants were informed to have zero points at the start, receive points for correct answers, and get no penalty for errors. In the loss context, the participants had maximum points at the start; they lost points after each error, and there was no way to earn more. Note that the scores of any two participants who made equal number of errors in different contexts would be equal. The only difference between the contexts is the declared way of calculation: either addition to zero, or subtraction from maximum.

Upon completion of the two tasks the participants were also requested to fill in a valence questionnaire that included the 120 words from the test blocks (data not presented here), and to report demographic data. We also asked to report approximate average time spent in front of computer daily (reduced to ordinal scale) to account for possible differences of user experience.

### 2.4. Measures and analysis

The tasks, contexts, and countries were contrasted via accuracy and speed measures of the first tasks, as well as the transfer rate calculated using measures of both tasks (below). The error rate (ER) was calculated for each block as error probability (the first trial excluded). The median time from the word onset to pressing the answer button (RT) was calculated (excluding the first and the second trials of each block) for error trials, correct post-error, and correct post-correct trials separately. We used medians to decrease the effect of outliers, especially in case of error trials that were rare. The medians were count only if not less than four measurements were available.

Data from 5 participants were removed from the analysis due to outlying (exceeding 3SD) ER (>0,45) and/or RT (>2000 ms) in the first task. Data from 2 more participants were removed as outlying in the second task measures. Three more participants did not attend school on the day of the second task. Consequently, data from 133 participants were used for analysis of the first task measures, and 128 participants were included into analysis that involved the second task measures (see also Table 1). Since the errors were infrequent, the sample size for RTs in error and post-error trials was reduced.

There was a tendency for the second post-error RT in Task N to differ from RT in subsequent correct trials (Wilcoxon's $W = 395$; $p = 0{,}074$ and $t(1{,}47) = 1{,}81$; $p = 0{,}076$). Given that the number of correct trials was sufficient, we excluded both the first and the second post-error correct trial RTs from the RT analysis to avoid contribution of post-error slowing.

To assess the extent to which the first task experience shapes the second task performance we estimated the difference between the second-task measures of each participant and corresponding measures of the same task performed by those with the opposite order of tasks, analogous to Tallet and colleagues (Tallet et al., 2010, Experiment 1). However, due to between-group differences of the first-task measures (see Results) we expressed the transfer rate with indices that compared the second-task ER and RT of each participant to the first-task median ER and RT of participants within the subgroups with identical context and country, but another order of tasks. For example, if a Russian participant had loss context and performed Task N first, then his/her transfer rate for the ER ($T_{ER}$) is the individual error rate ($ER_i$) in task S subtracted by median ER in the first task S of Russians with loss context ($Med(ER)$), expressed in the units of that median, i.e. $T_{ER} = -(ER_i - Med(ER))/Med(ER)$. Similarly, transfer rate for the RT: $T_{RT} = -(RT_i - Med(RT))/Med(RT)$. The negative of the value was used, so that the positive transfer effect would be manifested in positive *Ts*.

The gain-loss effect of the instructions was assessed via 7-point Likert-type scale presented after the task execution to Russian participants to compare emotional evaluations of task execution between the context presented to the participant and the other context (the latter was explained after assessment of the former). The effect of the instructions had also been shown previously in an analogous approach-avoidance setting with Finnish participants (Alexandrov et al., 2007).

ANOVAs with three between-subject variables (Context: gain or loss; Order of tasks: S-N or N-S; Country: Finland or Russia), repeated-measures ANOVA for within-subject Trial type (post-error or post-correct), as well as non-parametric tests were employed with the 0,05

**Table 1.** Transfer indices assessed via ER and RT in gain or loss contexts in groups of Finnish and Russian participants.

| | | Finland | | | | Russia | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Gain | | Loss | | Gain | | Loss | |
| N-S | $T_{ER}$ | N = 17 | -.46 (.37) | N = 15 | 0.13 (.21) | N = 14 | -0.62 (.37) | N = 16 | 0.21 (.24) |
| | $T_{RT}$ | | .07 (.04) | | 0.11 (.02) | | 0.10 (.04) | | 0.07 (.04) |
| S-N | $T_{ER}$ | N = 15 | .07 (.23) | N = 13 | -1.00 (.53) | N = 18 | -0.44 (.30) | N = 20 | -0.70 (.42) |
| | $T_{RT}$ | | -.12 (.04) | | -0.07 (.07) | | -0.17 (.07) | | -0.11 (.05) |

*Note.* Mean (SE) $T_{ER}$ and $T_{RT}$ in two orders of task presentation (N-S and S-N).

significance level, two-tailed, and partial *eta* squared ($\eta^2_p$). The data was normalized where necessary to satisfy the requirements of parametric methods.

## 3. Results

### 3.1. Evaluation of gain and loss contexts

The ratings of the gain context were more positive than those of the loss context (Wilcoxon's W = 194,5; $p < 0,0001$; Figure 2). Likewise, the gain context was rated as more positive by greater part of the participants, compared to those who made opposite evaluation or rated the contexts equally (Pearson's $\chi^2 = 66,76$; $p < 0,0001$). Notably, the loss context was rated as more positive by the group with the loss context (Mann-Whitney U = 441,5; $p < 0,01$), whereas the gain context was rated equally by the groups with gain and loss contexts (U = 732; $p > 0,7$).

### 3.2. Task performance

Analysis of the first task performance measures showed that Task S is performed with greater ER, than Task N (first tasks only, main effect of Order, $F_{1,125} = 7,78$; $p < 0,01$; $\eta^2_p = 0,059$). This main effect was accompanied by Context × Country interaction ($F_{1,125} = 8,49$; $p < 0,01$; $\eta^2_p = 0,064$): Russian participants had ER in the loss context exceeding that in the gain context ($t_{1,71} = -2,85$; $p < 0,01$), while the difference in Finnish participants was not significant ($p > 0,1$, and in opposite direction). Separate analysis for each task has shown that this difference was evident only in Task S (Figure 3) with ANOVA (Context × Country interaction, $F_{1,62} = 11,47$; $p < 0,01$; $\eta^2_p = 0,156$) and pair-wise comparisons ($t_{1,39} = -3,14$; $p < 0,01$ in Russian participants). No significance was evident in the similar analysis of the second task ERs.

Order x Context x Country ANOVA for the first task post-correct RT did not reveal any significant main effects or interactions. However, Finnish participants tended to have greater overall speed than Russian participants (main effect of Country, $F_{1,125} = 3,87$; $p = 0,051$; $\eta^2_p = 0,030$). Although Order × Country interaction was not significant ($p > 0,3$), the following analysis that involved both the first and second task measures showed that this difference was evident in Task N (main effect of Country, $F_{1,120} = 7,75$; $p < 0,01$; $\eta^2_p = 0,061$), but not Task S ($p > 0,2$). The same analysis has also revealed Order main effects, discussed in the Transfer rate section. Therefore, Task N was performed with greater overall speed by Finnish participants than by Russian ones. The average reported time spent in front of computer, that could potentially explain this difference, was higher in Russians (Mann-Whitney U = 1632,5; $p < 0,05$), this index being 1,5 h in majority of Russians and 1 h in majority of Finns ($\chi^2 = 8,96$; $p < 0,05$).

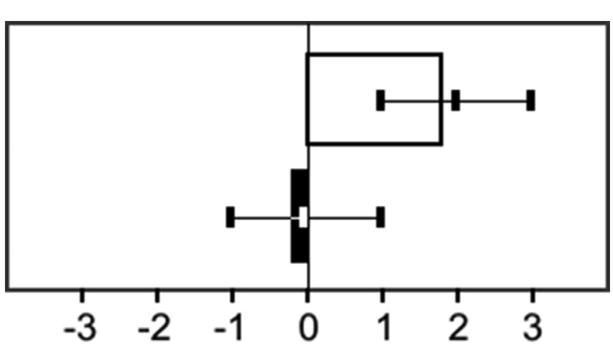


**Figure 2.** The gain context was rated as more pleasant than the loss context. Ratings of pleasantness or unpleasantness of task performance in the contexts of gain (white) and loss (black) on a -3 to 3 Likert-type valence scale: mean (bars), median and quartiles (aligned markers).

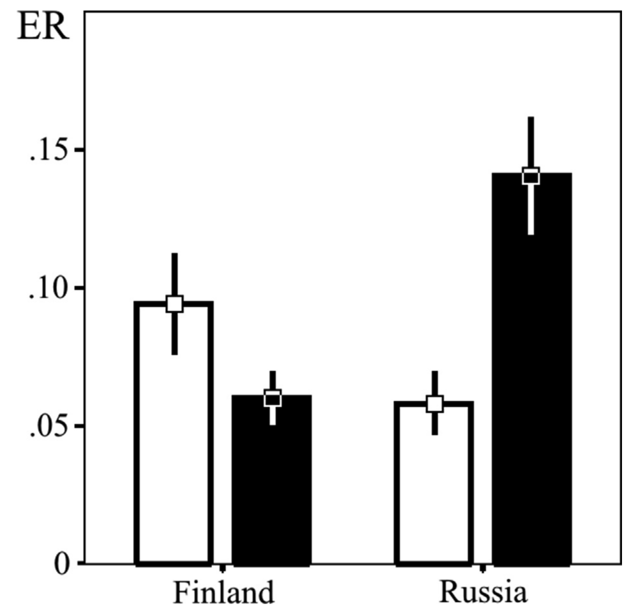


**Figure 3.** Error rates reveal cultural differences of approach and avoidance learning. Error rate in the first Task S in the contexts of gain (white) and loss (black) for the Finnish and Russian participants (mean ± SE).

### 3.3. Transfer rate

The Order x Context x Country ANOVA has revealed that in case of N-S order $T_{ER}$ in the loss context is greater than in the gain context, whereas the S-N order shows the opposite relation (Order × Context interaction, $F_{1,120} = 7,16$; $p < 0,01$; $\eta^2_p = 0,056$). Unlike the accuracy measure of transfer, the speed $T_{RT}$ predominantly differed between the task orders ($F_{1,120} = 34,61$; $p < 0,0001$; $\eta^2_p = 0,224$), the N-S order exerting high $T_{RT}$ (positive transfer effect) and the S-N order showing low $T_{RT}$ (negative transfer effect). Analysis that involved both the first and second task measures also showed that Task N was performed with lower speed after Task S (main effect of Order, $F_{1,120} = 4,37$; $p < 0,05$; $\eta^2_p = 0,035$), whereas Task S was performed faster after Task N ($F_{1,120} = 14,50$; $p < 0,01$; $\eta^2_p = 0,108$). Since these carryover effects were opposite and emerged from the tasks of different difficulty, we performed two separate analyses for the two tasks (Figure 4; Table 1).

The Context x Country ANOVA has not revealed significant effects or interactions for $T_{ER}$ or $T_{RT}$ of Task N. In the case of Task S $T_{RT}$ has also not revealed any significant effects or interactions. However, $T_{ER}$ has shown greater positive transfer in the loss context compared to gain context (main effect of Context, $F_{1,58} = 4,82$; $p < 0,05$; $\eta^2_p = 0,077$).

### 3.4. Post-error slowing

The analysis of post-error slowing was performed with RTs from Task S only (Figure 5; Table 2) to avoid effects of the lack of errors and the above speed differences in Task N. The main effect of Trial type ($F_{1,58} = 20,10$; $p < 0,0001$; $\eta^2_p = 0,257$) was accompanied by Trial type × Context interaction ($F_{1,58} = 4,31$; $p < 0,05$; $\eta^2_p = 0,069$), showing greater post-error slowing in loss context than in the gain context. There was also a less expected Trial type x Order × Country interaction ($F_{1,58} = 6,26$; $p < 0,05$; $\eta^2_p = 0,097$) that reflected greater slowing in Finnish participants than in Russian ones in the first task and opposite relation in the second task. Paired samples T-tests have confirmed both differences ($t_{1,13} = 2,78$; $p < 0,05$ and $t_{1,11} = 2,29$; $p < 0,05$ correspondingly), as well as greater post-error slowing in the loss context only in Finnish participants ($t_{1,11} = 2,37$; $p < 0,05$). There was also a tendency in this analysis for RTs

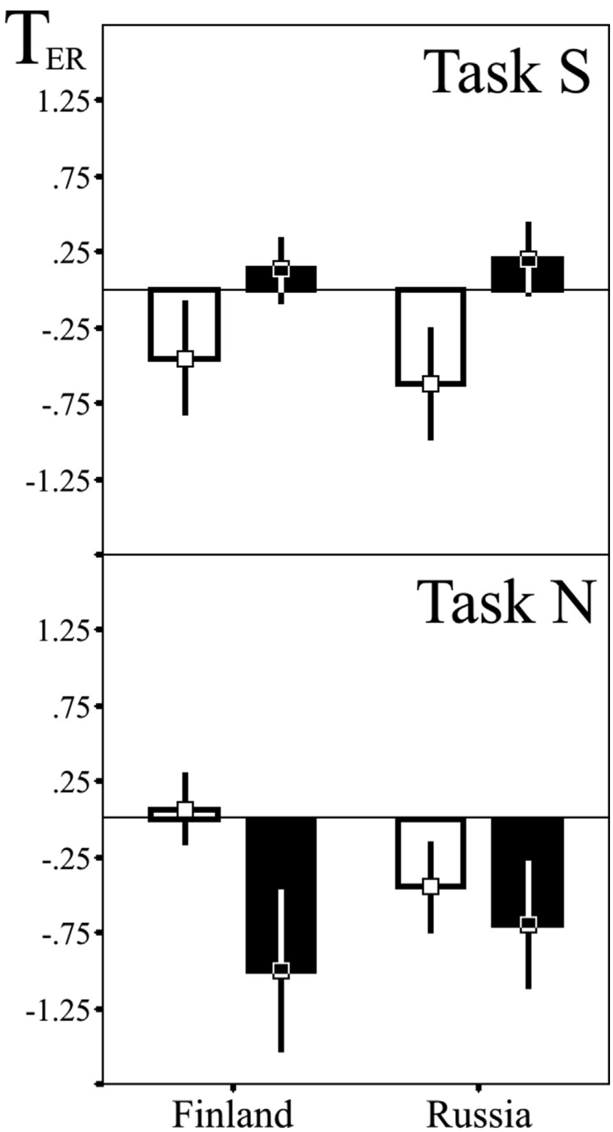


**Figure 4.** Greater carryover in the loss context compared to the gain context in Task S. $T_{ER}$ transfer index for Task S and Task N shows the extent of learning transfer in Finnish and Russian participants. All designations as in Figure 3.

to be greater in the loss than in the gain context revealed with main effect of Context as between-subject effect ($F_{1,58}$ = 3,41; p = 0,070; $\eta^2_p$ = 0,056).

## 4. Discussion

We assessed speed and accuracy of simple task performance to contrast carryover effects in gain and loss contexts. This research question has been based on the idea that approach and avoidance behaviors are underpinned by two domains of individual experience that differ in the number of elements. In our view, the "negative", or avoidance, domain of experience is more itemized, provides more distinctive interaction with the environment, has more complex structure than the "positive", or approach, domain. Therefore, we hypothesized that utilization of remote prior memories in the loss context is greater than in the gain context. Positive transfer effect, assessed with accuracy measures and evident when Task N preceded Task S, was higher in the loss than in the gain context in Finnish and Russian participants. This result highlights the link between behavioral outcome and learning dynamics and supports our main hypothesis.

### 4.1. The transfer effect and approach-avoidance learning

Most of the effects we describe were either revealed only with Task S measures, or were significant only in Task S. Presumably, Task N measures can be described with floor effect due to low difficulty. The difference between counting letters and discrimination between two quite proximal font sizes is that the latter is achieved by trial and error. Therefore, the demonstration of differences between the domains of experience has become possible with a task of considerable difficulty. Also, as noted by one of our reviewers, in Task N the irrelevant dimension of font size was not modulated, while in Task S the number of letters irrelevant for task performance was varied. Therefore, Task N and Task S can be considered as univalent and bivalent, correspondingly (Rogers and Monsell, 1995). We introduced this intentionally to diversify possible effects in the two orders of tasks: the N-S order requires ignoring the number of letters that becomes irrelevant in the second task, while S-N order does not. We believe that the inhibition of the irrelevant aspects of signals in the N-S order could lead to mainly negative transfer rates in the gain context and brought forward the groups with the loss context in which "cognitive engagement" is more pronounced (see Introduction and Figure 4).

We have earlier elaborated that there are differences of learning transfer between gain and loss contexts. We presented the same tasks and found negative transfer effect in the loss context, but not in the gain context, in Finnish participants when the second task was presented straight after the first one (Sozinov et al., 2012). The results were less reliable in that no differences of speed, accuracy, or transfer rates had been revealed between the contexts, but the utilization of prior experience was diminished in the loss context in contrast to our present results. We assume that if the avoidance domain contains more itemized task representation, then the modification of recent experience is demanding, and the immediate transfer is more confined in the loss context, than in the gain context (see also Patil et al., 2017). A 3-days interval between the tasks was introduced in the present setup to ensure consolidation of the first-task memory by the time of the second task acquisition (e.g., Forcato et al., 2010).

The effect of context, created by instructions that emphasize gain or loss, required confirmation due to absence of feedback during the tasks. The effect was assessed with a self-report valence scale. It has revealed that the loss context is appreciated less positively than the gain context – the ratings of the latter were higher.

Given that academic learning is more avoidance-motivated in Russia than in Finland (Hufton et al., 2003; Räty et al., 2011), we also predicted greater gain-loss context differences in Russian participants, compared to Finnish participants. Greater asymmetry between achievement- and avoidance-motivated behaviors in Russians than in Finns that we expected was mainly evident in the first task. Presumably, the first tasks were performed with greater influence of cultural context than the second tasks. In the latter, the context and experience of the experimental setup and task rules, including the motivational context, was presumably more dominant. Thus, greater transfer rate in the loss context by Russians was only numerical, whereas greater accuracy in the first Task S in the gain context by Russians was significant. The same measure in Finnish participants did not reveal significant difference between the gain and loss contexts (similar to the results of our prior study (Sozinov et al., 2012)). Moreover, their accuracy was somewhat greater in the loss context. In a related study Finnish participants also showed better performance (greater speed increase) in punishment condition compared to neutral and reward conditions (Alexandrov et al., 2007). Given that Russians may have more avoidance experience in educational settings than Finns (Hufton et al., 2003; Räty et al., 2011), the result seems contrary to a common-sense view that the more experience we have, the better performance we should demonstrate in the corresponding context. However, the more complex set of related experience allows for greater amount of possible ways of behavior and requires greater modification with respect to formation of new experience. Therefore, we believe that

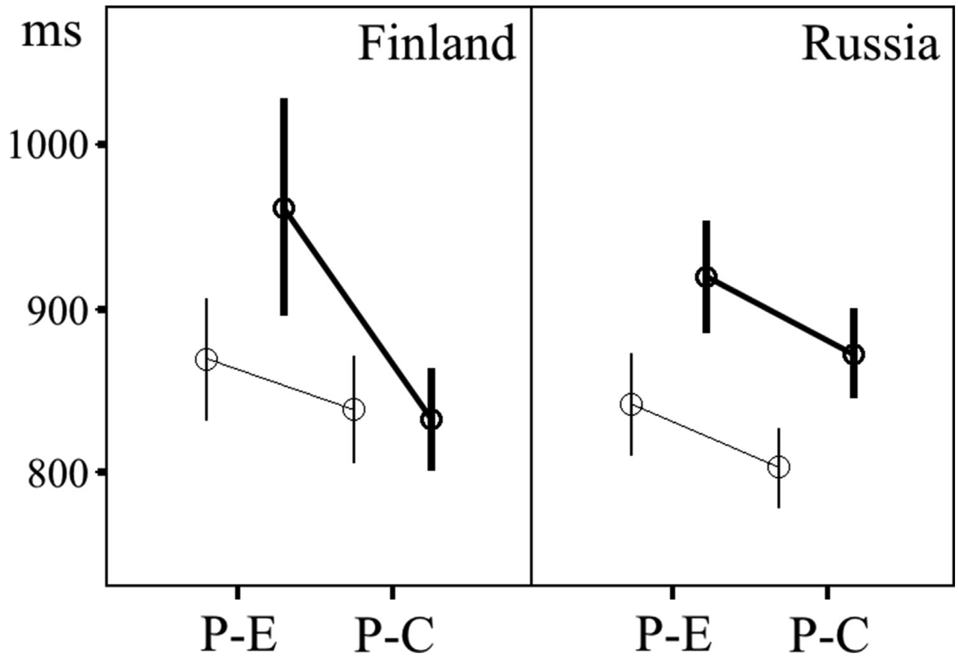


**Figure 5.** Post-error slowing is greater in the loss context than in the gain context, and is more sustained in Russians than in Finns. Post-error (P–E) and post-correct (P-C) RTs in the contexts of gain (thin lines) and loss (bold lines) in Finnish and Russian participants (mean ± SE).

**Table 2.** Post-error and post-correct RTs in Task S in gain or loss contexts in groups of Finnish and Russian participants.

| | Finland | | Russia | |
|---|---|---|---|---|
| | Gain | Loss | Gain | Loss |
| P-C | 802 (24) | 820 (18) | 851 (27) | 841 (23) |
| P-E | 868 (37) | 962 (66) | 841 (31) | 919 (34) |

*Note.* Mean (SE) RTs. P-C = post-correct, P-E = post-error.

one of the sources of high error rate in the first task in Russians is greater complexity of structure of experience in the "negative" domain, more intrinsic to Russian participants.

Speed is often reported to be more sensitive measure of performance, than the accuracy (Anderson, 1981; Osgood, 1948). In view of results of our previous studies (Sozinov et al., 2012, 2015), RT was expected to reveal the motivational context effects. However, between-group differences of the first-task performance and of the transfer effect were revealed with error-rate indices. In contrast to the prior study, we removed post-error and even the second post-error trials from calculation of the post-correct RT (see Methods). Although the error rate was low in all tasks, we sought to avoid possible post-error slowing contribution to the effects of our main interest. Notably, RTs were higher in the loss context in Russian participants (Figure 5), consistent with our earlier findings (Sozinov et al., 2012), albeit this difference was evident as a tendency in between-group main effect of Context in a repeated-measures post-error slowing analysis.

### *4.2. Post-error slowing*

Analysis of Task S RTs showed that post-error slowing in the loss context is greater than in the gain context. This points to the difference of the salience of outcomes between the contexts (Riesel et al., 2012; see also Alexandrov et al., 2007 for comparison of feedback ERP latencies between the contexts) and, in our view, to a greater experience reorganization in the loss context due to higher complexity of the corresponding domain of experience. This interpretation resembles the framework that attributes post-error slowing to processes that manifest modification of behavior (e.g., Holroyd and Coles, 2002). However, since the errors were rare, we cannot exclude that post-error slowing resulted from orientation of attention from the task (Notebaert et al., 2009). Within both accounts of post-error slowing the achievement-avoidance asymmetry that we show points to differences between the process that reengages correct performance aimed at achievement of gain and the one aimed at avoidance of loss. In other terms, greater positive transfer in the loss context requires more resources and "cognitive effort" (Paschke et al., 2015; Roskes et al., 2013)

Greater post-error slowing was more evident in Finnish participants in the loss context via pair-wise comparisons. Higher first-task error rate in the loss context compared to the gain context in Russian participants accompanied by corresponding lower post-error slowing would be expected by the orientation account of error slowing (Notebaert et al., 2009). However, we attribute lower post-error slowing in Russian participants to higher post-correct RTs, visible in Figure 5 and revealed on the level of tendency. This excess can also be a sign of more complex experience structure that underlies task performance in the loss context in contrast to gain, implicated by us earlier (Sozinov et al., 2012).

The post-error slowing has been shown to retain its characteristics in the absence of immediate feedback (Houtman et al., 2012), although this has not been shown for young age. In a similar way, the difference of learning transfer between gain and loss contexts was revealed in spite of the absence of feedback during task performance. Based on the view of domains of individual experience (Alexandrov, 1999), we intended to present contexts without effects of momentary salience of gain or loss.

Besides, the effects were expected in relatively simple tasks, and in adolescence – the age when individuals could have inconsistent sensitivity to feedback (Ferdinand et al., 2016, but see Icenogle et al., 2017). Post-error slowing differed between the first and the second tasks, and Finnish and Russian participants revealed opposite direction of this dynamics. This could be either derived from cultural specificity of (teaching for) transfer (Pea, 1987) or uncontrolled events within the inter-task interval. Therefore, the controversy on the positive and negative feedback sensitivity development in adolescence (Ferdinand et al., 2016) requires more direct cross-cultural examination, considering that the sensitivity is to substantial extent is a result of learning (Riesel et al., 2012).

### *4.3. Stable aspects of approach and avoidance*

We acknowledge that approach and avoidance can be considered from the personality perspective, and our study lacks self-reports measurements of this kind. The assessment of individual differences with existing achievement and avoidance-related questionnaires (e.g. Carver et al., 2000; Coyle et al., 2019) would make our conclusions more grounded and could explain some of the differences between effects in Finnish and Russian participants that we explain by educational systems. However, the use of self-report instruments in schoolchildren of this age would not guarantee a reliable measure of individual tendencies and/or experience related to gain and loss and would go beyond the time window of one lesson. This limitation is to be overcome in our subsequent studies of structure of gain- and loss-related experience in adults.

## 5. Conclusion

The differences of task performance measures revealed here show that the units, that underlie outwardly similar behaviors in the gain and loss contexts, form different structures, or domains of individual experience. The avoidance-motivated behavior is organized as a more complex organism-environment interaction, than the achievement-motivated behavior. Consequently, at the expense of "cognitive effort" the avoidance domain may prevail upon the long-term exercise of prior experience, which might be an advantage of the avoidance motivation on the strategic level (Scholer et al., 2019). We also assume the the approach domain provides superior transfer within shorter time window due to easier modification of prior experience. Since the gain-loss difference of learning transfer is evident in simple task performance, we consider the approach-avoidance distinction as indicating basic categories of the structure of individual experience. Cultural specificity of the achievement-avoidance discrepancy described here calls for further investigation of links between the structure of acquired experience and culture-specific social practices.

## Declarations

### *Author contribution statement*

Sozinov A.A.: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Laukka S.: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

Lyashchenko A.I.: Performed the experiments; Analyzed and interpreted the data.

Siipo A., Nopanen M.: Performed the experiments.

Tuominen T.: Conceived and designed the experiments; Performed the experiments.

Alexandrov Yu. I.: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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### *Competing interest statement*

The authors declare no conflict of interest.

### *Additional information*

Data associated with this study has been deposited at Mendeley data at https://doi.org/10.17632/b5c8fwmymm.1.

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