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Transfer of simple task learning is different in approach and withdrawal contexts

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Abstract

Academic achievement, subjective well-being, and effectiveness of training are known to be dependent on motivation. Correspondingly, the utilization of prior knowledge for learning is shown to differ in approach / withdrawal contexts for complex tasks and educational settings. How can this be explained on the level of psychological structures? We assume that approach and withdrawal behaviors are supported by distinct asymmetric domains of individual experience. Hence, we proposed that the transfer-motivation relationship is also valid for *simple* task learning. Two word discrimination tasks were performed by 58 schoolchildren either to get "reward" or to avoid "punishment" with points. We show that the difference of transfer effect between approach and withdrawal motivational contexts is evident for simple tasks. The implications of these results for an instructional context and normative evaluation are discussed.

learning transfer, approach, withdrawal, reward, punishment, memory domains, individual experience

1. Introduction

It is well-developed in education-relevant approaches to learning, that prior experience contributes to ongoing learning (Immordino-Yang, 2007; Posner et al., 1982; Regehr & Norman, 1996; Semb & Ellis, 1994; Uljens, 1997). Moreover, according to several views in psychology and neuroscience, it is impossible to learn without transfer of previously formed memories (Alexandrov, 2006; Haskell, 2001; Shvyrkov, 1986). There is evidence that the basement of the assembly of memories is a structure of motivation (Shvyrkov, 1986) with the principal dichotomy of approach and withdrawal domains of memory (see in Alexandrov, 1999; Alexandrov & Sams, 2005). We employ this framework to study the learning process in two well-established memory domains – those of approach and

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withdrawal (Alexopoulos & Ric, 2007; Cacioppo & Gardner, 1994; Hansell, 1989; Schneirla, 1959), and hypothesize that learning is influenced by what domain of individual experience becomes a basis for emergence of a new experience.

There is evidence for correspondence between negative affect and withdrawal, as well as for positive affect and approach (Cacioppo & Gardner, 1994; Czajak & Cipora, 2012; Damasio, 2000; Davidson et al., 1990; Hansell, 1989). "Positive" and "negative" contexts are considered divergent with respect to complexity, cognitive load, differentiation etc. (Alexandrov, 1999; Claeys & Timmers, 1993; Damasio, 1994; Lewica, 1988; Ohira et al., 1998; Peeters & Czapinski, 1990; Robinson-Riegler & Winton, 1996; Schwarz, 1990). Consequently, the two domains are not symmetric. The "negative" (withdrawal) domain of experience is argued to contain more elements (i.e. units of individual experience), than the "positive" (approach) domain (Alexandrov & Sams, 2005; Alexandrov et al., 2007).

Performance goals of approach and withdrawal are among the most influential dispositions that produce divergent processes and outcomes (Elliot & Church, 1997; Harackiewicz et al., 2002). They differ as a function of valence (Elliot, 1999). It has been shown that subjects with diverse goal orientations have different rates of performance improvement (Yeo et al., 2008) and transfer of learning (see Dweck, 1986).

As proposed earlier (Elliot, 1999; Pintrich et al., 1993), one of the sources of students' motivation is environmental emphases. Indeed, an educational setting represents a strong motivational *context* that may depend on teachers' evaluation strategy. Experimental demonstration of the valence dimension within the performance goal concept (Elliot & Harackiewicz, 1996) has utilized success- and failure-oriented instructions to perform the same task. It was shown that the performance differed in relation to the valence (achievement or avoidance) specified in the instruction. Accordingly, the positive or negative incentive value of the same stimulus has an impact on performance measures (Alexandrov et al., 2007; Derryberry, 1993). In sum, performance is displayed in contrasting behavioral parameters when revealed in positive or negative achievement contexts.

It was suggested earlier that motivational processes affect learning and transfer (Dweck, 1986; Ellis, 1965; Pintrich et al., 1993), and that transfer of learning implies emotion (Immordino-Yang & Damasio, 2007). However, the scope of the experimental evidence was limited to the acquisition of knowledge or complex interpersonal skills (reviewed in Helfenstein, 2005). A general approach to learning, developed by us (Alexandrov, 2006, 2008), predicts that motivation and emotions have a strong impact even on the learning of relatively simple tasks.

There is evidence that transfer of skills is similar in aversive and rewarding conditions (Prather et al., 1972). However, in this particular study the motivational context of the first and the second tasks differed. Moreover, the study was aimed at investigation of stress resistance in students of the Air Force Academy. Therefore, the 'rewarding' (verbal reward) and 'aversive' (60-volt electric shock) conditions were not of symmetrical value, and both could actually be withdrawal-oriented. To our knowledge, we present the first attempt to contrast approach and withdrawal contexts via transfer of learning within a simple visual-discrimination setup that requires skill acquisition.

The research questions behind this study are the following. Is there a difference of transfer effect between approach and withdrawal contexts in the learning of simple tasks? If there is, which of the motivations is more beneficial for utilization of prior experience in learning of a new similar task? Predictions concerning our specific setup and performance measures are based on the idea of dissimilar complexity of approach and withdrawal domains of experience. Since the approach domain is proposed to be less discriminative, we expected less evident negative transfer in the approach context.

Transfer of learning represents largely the core of the educational purpose itself, as an instrument and a goal of education (Perkins, Salomon, 1994; but see Posner et al., 1982 for an opposite view). Unfortunately, positive transfer does not always take place where it is expected without intentional teaching for transfer (Anderson et al., 1996; Chambers, 1987; Salomon, Perkins, 1988; Haskell, 2001). Failure to transfer cannot be fully explained without motivational factors (Pintrich et al., 1993). Therefore, investigation of the factors of transfer effect and analysis of the processes that underlie the relationship between motivation and transfer remain important issues in the search for correspondence between teaching and learning.

2. Methods

2.1. Participants.

The participants were 58 students (37 boys and 21 girls) from the 5th and 6th grade of the Teacher Training School of Oulu, Finland (age M = 11.69, SD = 0.6). Written consent was received from the parent(s) of each participant. The participants were informed that they were going to carry out game-like tasks on a computer to receive a prize that depends on speed and accuracy. (After the completion of the experiment they were rewarded equally.) All participants reported normal or corrected to normal vision, and good health.

2.2. Tasks.

A "Number of letters" task (Task N) was to define if there were four or five letters in a presented word, and to press correspondingly "g" or "h" button on the keyboard as quickly as possible. The "Font-size" task (Task S) was to define if the font size of a presented word was "big" or "small", and to press "g" or "h" button correspondingly. In Task N all words were either 4 or 5 letters long, and of the same size (font-size 30). In Task S, the words were also either 4 or 5 letters long, and either "big" (font-size 34) or "small" (font-size 26).

The list of words was randomized once, and the resulting order was the same for all participants. The font-size of the words in Task S was randomized online in each session. Therefore, Task N included variation of one parameter – number of letters; Task S included variation of two parameters – number of letters and font-size. Hence, Task N can be described as univalent and Task S as bivalent (Rogers & Monsell, 1995), i.e. they were of different complexity. Presentation of the univalent task before the bivalent one was expected to reveal positive transfer. The opposite order was expected to reveal negative transfer.

2.3. Procedure.

All participants were asked to sit comfortably in front of the computer monitor. The distance between the eyes and the screen was approximately 60 cm. Sufficient visual angle did not exceed 3.5 degrees. All instructions were presented aurally, accompanied by briefings on the screen.

The approach and withdrawal contexts were shaped by the rule specified in the instructions. The goal of both tasks was to earn as many points as possible. In the approach context, it was specified that a participant had zero points at the start; points were given for correct answers with no penalty for errors. In the withdrawal context, the participants were told that they had maximum points at the start; they lost points after each error, and there was no way to earn more. The context was assigned randomly once, and was kept the same for all tasks of a given participant.

The two tasks were performed individually on a standard computer. Participants were asked to hold the space bar with the index finger of their dominant hand at all time, except when pushing the response key with the same finger. This skill of using the keyboard required a separate block of trials before the discrimination task onset. It had subjects push any button after word presentation ("keyboard skill" block). A one-second intertrial interval (ITI) was introduced at pressing the space bar following the response button release. A brief (appr. 40 ms) presentation of a word, pressing of the response button, pressing (and holding) the space bar, and the ITI constituted one trial.

Time from word onset to pressing the response button (RT) and the accuracy of the participants' performance were recorded in each trial and subjected to further analysis as independent variables (error rate and RT). RT is often reported to be more sensitive to a learning-dependent state of memories (Anderson, 1981; Kubesch et al., 2009; Osgood, 1948). Thus, RT was expected to reveal the transfer effect, and the error rate was intended to compare the difficulty of the tasks.

Each task consisted of two blocks: practice and test. Only in the test block of each task were the points counted, i.e. the approach or withdrawal contexts were introduced. No feedback concerning the current score was provided during the task.

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 evaluation and the new instructions were given before each of these blocks.

2.4. Materials.

The words were 176 Finnish nouns or adjectives, 4 or 5 letters long, presented in Times font, upper-case, white on black background. All words were of general use and familiar to the participants. The list was created by Finnish school-teachers and pedagogical experts from the University of Oulu , taking into account 5-graders' vocabulary and local specificity.

The word presentation and data recording were controlled by "Show" software (in-lab made by S.A. Smirnov and A.K. Krylov). Two computers, equipped with 60 Hz 15-in. color monitors at 640x480 resolution, were used in two regular school classrooms.

2.5. Experimental design and analysis.

We randomly assigned each participant to one of four groups to manipulate two contexts (approach / withdrawal) and two orders of the tasks (Task N – Task S / Task S – Task N). The were 13-17 participants in each group.

We presented two tasks of presumably different difficulty, but both required very simple discrimination. Hence, data from the practice blocks was used to estimate the difficulty of tasks, because the error rates were expected to achieve floor levels in the test blocks. For the same reason, we expected error rates to be similar for Task N and Task S. For this purpose, the error rate was computed for each subject as a frequency of wrong answers in practice blocks and in test blocks.

By the end of the practice blocks, the performance measures achieved levels that were relatively stable throughout the test blocks (see Fig. 2 for median RT in each trial). Therefore, the median of RTs in correct trials and the error rate were computed for each subject through the whole test block. The first two trials were removed from analysis.

Simple crossover design was employed to assess the transfer effect (Ellis, 1965; Tallet et al., 2010; see Krauth, 2000, p. 96). We presented the two tasks in different order for different groups of subjects. If the distribution of RT medians in the same task differed significantly between these groups, we concluded that there was transfer effect. For example, Group 1 performed Task N first, and then Task S. Group 2 had the opposite order: Task S – Task N. If the RTs in Task S of Group 2 exceed the RTs in Task S of Group 1, we concluded that mastery of Task N is beneficial for mastery of Task S, i.e. there is positive transfer effect.

Error rates and RT medians of the test blocks were subjected to comparisons with nonparametric tests. That is, we assessed the presence of the transfer effect in each of the four groups with different order of tasks (N-S or S-N) and valence of context (approach or withdrawal).

The number of participants served as an amount of observations, and a significance level of .05 was adopted in all analyses.

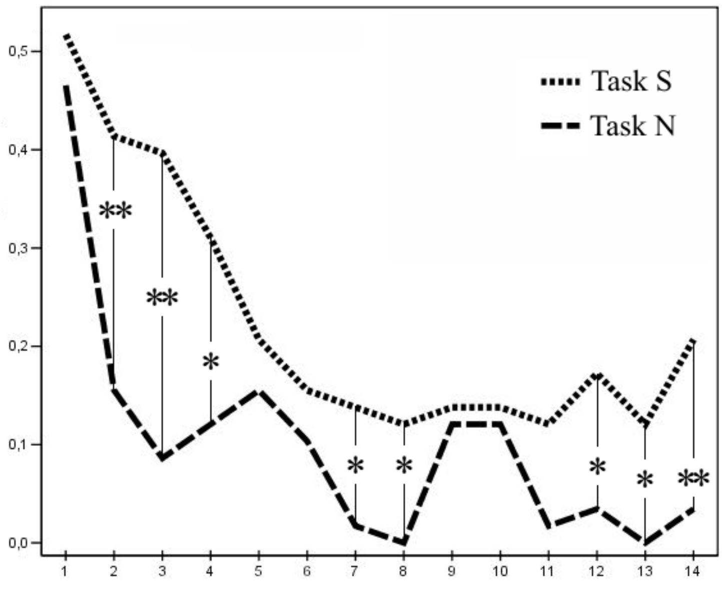

Figure 1. Error rates (vertical axis) of all subjects across 14 trials of the practice sessions of Task N and Task S (see corresponding dotted lines). Steeper learning curve and lower error rates during practice of the Task N are revealed by significant differences (Fisher's exact test, * p<.05; ** p<.01).

3. Results

3.1. Error rate.

Comparison of the error rates of the practice blocks between Task N and Task S revealed significant difference with no relation to either the order of tasks or motivational context (Wilcoxon's T <87; p < .05). The Task N is characterized by a steeper learning curve, and the error rates remain significantly different during several trials of the practice blocks (Fisher's exact test, Fig. 1). Furthermore, error rate differences between practice and test blocks reached significance level in Task S (Wilcoxon's T; p < .05), but not in Task N. Thus, initial mastery of bivalent Task S revealed relatively higher error rates than that of the univalent Task N, which is an indicator of their divergent difficulty. Greater difficulty of Task S was also reported by the majority of the subjects.

Comparison of the error rate between the test blocks of Task N and Task S revealed no significant differences (Mann-Whitney U, p > .20). These comparisons were made separately for each motivational context and order of tasks. That is, by the onset of the test blocks, the two tasks were performed with similar error rates. Accordingly, we have found neither positive, nor negative transfer effect with this performance measure.

3.2. RT.

No significant differences of the RT medians were revealed in test blocks of the *first* Task N or the *first* Task S between groups with different contexts (Kruskal-Wallis H, p > .10). That is, mastery of the first Task N, as well as the first Task S was accompanied by RT values that had no relation to motivational context. The effect of these variables was evident only upon carryover after switch to the second task.

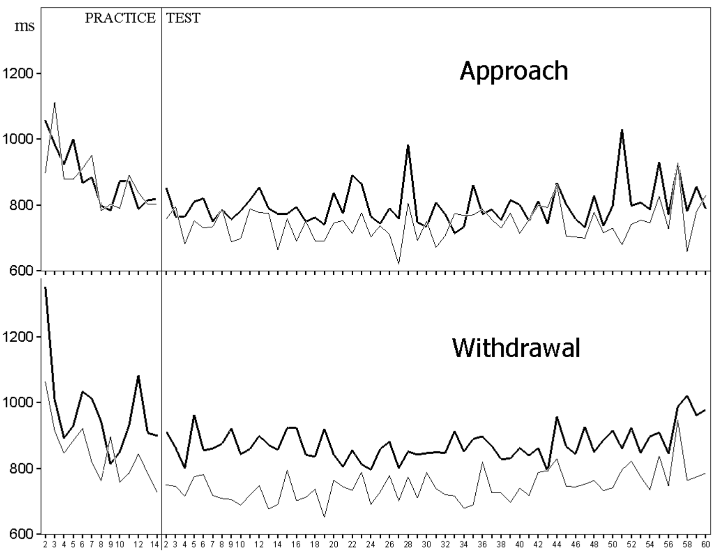

Figure 2 (upper left). Medians of RT (vertical axis) of all four groups in Task N in each trial of practice and test sessions across subjects. Thick lines indicate RTs in Task N preceded by Task S. Thin lines indicate RTs in Task N presented first. A continuous negative transfer effect in the withdrawal context (bottom) is contrasted to no transfer effect in the approach context (top).

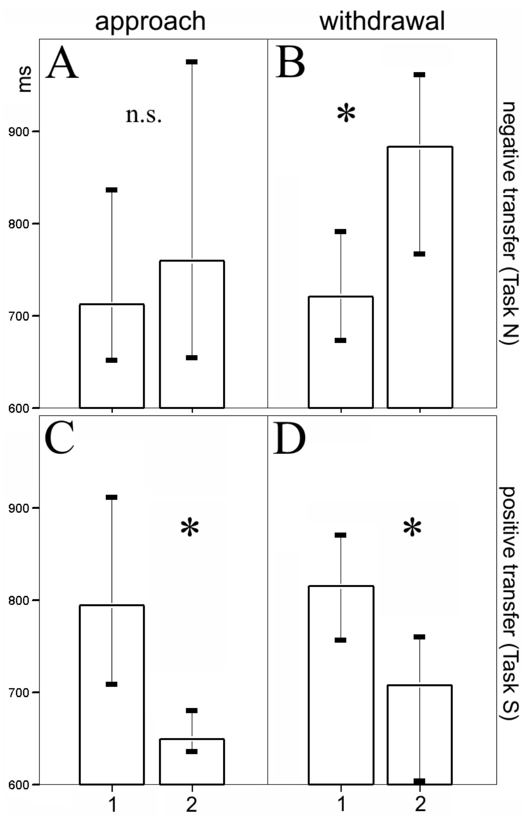

Figure 3 (right). Medians of RT (vertical axis) in the tasks for groups with different order of presentation: each task was introduced either as the first (1), or as the second (2) for different groups. Bars and drop-lines show median and quartiles (of individual RT medians) of the test sessions in each group. Manipulation of the order of presentation has revealed negative transfer effect (Task N) and positive transfer effect (Task S). Significant differences indicating the transfer effect are shown by the asterisk (p<.05). >>

Analysis of RT medians revealed both positive and negative transfer. Negative transfer effect was evident only in the Task S – Task N order, that is, when the bivalent task was followed by the univalent task. RT in Task N preceded by Task S significantly exceeded that when Task N went first. This was true in the *withdrawal* context *only* (U = 40.0, p = .013). A negative transfer effect was not revealed in the approach context (Fig. 2, Fig. 3 A, B).

Positive transfer effect was evident only in the Task N – Task S order, that is, when the univalent task was followed by the bivalent task. RT in Task S was significantly lower if it was preceded by Task N, than in the case where Task S was presented first. This was true in both approach (Mann-Whitney U = 60.5; p = .019) and withdrawal (U = 34.0; p = .006) contexts (Fig. 3 C, D).

4. Discussion

In the present study, approach and withdrawal contexts of learning were contrasted via assessment of the transfer effect between simple tasks. The direction of transfer was guided by manipulating the sequence of similar tasks (for similar design and results, see Tallet et al., 2010). It was found that the occurrence of transfer is related to the valence of motivational instruction.

Mastery of the tasks employed in this setup included both using the keyboard and visual discrimination. In view of the difficulty of the tasks, our results resemble those on acquisition of skills. The error rates in the practice blocks of Task S exceeded those of Task N, as well as those of the test session of Task S. In a simpler Task N the difference of error rates between practice and test blocks did not achieve significance. This is in correspondence with movement sequence learning data in that the mastery of simpler task did not reveal an error rate decline, because the initial level of this measure was low; for a harder task, this drop was significant due to the high error rate at the start of task execution (Müller et al., 2002).

The difficulty of the tasks is considered a factor of transfer effect (Postman, 1971). Here we used this variable to induce positive and negative transfer effects. One of the ways to vary difficulty is to change the number of dimensions, included in the stimuli (e.g. Rogers & Monsell, 1995). We presented one univalent and one bivalent task to each subject, varying the order of tasks for different groups. In the univalent task (Task N), only the number of letters was varied in the presented words, and it was the only dimension necessary for correct performance. In the bivalent task (Task S), the words varied in two dimensions – font-size and number of letters – one of them being useless. Moreover, Task N could be completely clear before its onset, because the number of letters is an obvious parameter; whereas in Task S the font-size could not be presumed in advance – it had to be fully acquired after task onset. Therefore, the shift of task difficulty from harder Task S to more simple Task N has lead to negative transfer effect. Accordingly, the opposite order had resulted in a positive transfer effect.

The transfer effect can be assessed with learning curves (Lewis & Shephard, 1951). Besides, the shape of the learning curves is related to performance goals (Yeo et al., 2008). In our study, we have not revealed any differences between approach and withdrawal contexts through comparison of error rates. Presumably, this result reflects the ease of the tasks and may be due to the floor effect. Therefore, RT analysis was our main concern, as it appears to be a more informative measure in similar setups (Anderson, 1981; Kubesch et al., 2009; Osgood, 1948).

No transfer effect was found between the approach and withdrawal contexts in *practice* sessions. Apparently, this is due to the high variation of measurements. However, the difference was found for *test* blocks, where the performance measures were relatively stable. Notably, the context-related transfer effect was not transient, it remained stable until the end of the test block (Fig. 2).

There is multiple evidence that outwardly similar behavioral acts providing different goals have different brain bases (see Alexandrov, 2008 for review). Discrimination of the two domains of individual experience (see Introduction) implies that identical behaviors, one aimed at success and another – at avoidance of failure, correspond to emotions of different valence (Hansell, 1989; Alexopoulos & Ric, 2007; Gable & Harmon-Jones, 2008). There is growing evidence that they are accompanied by distinct neuronal processes (Alexandrov et al., 2007; Davidson et al., 1990; Gray, 1990; O'Doherty et al., 2001; Perlstein et al., 2002; Rolls et al., 2003; Seymour et al., 2007; Viinikainen et al., 2009; but see Matsumoto & Hikosaka, 2009). Therefore, there is a ground in the neuroscience to propose that the new units of experience emerge within the existing structure based on the motivational dichotomy.

Interference effect has been used as evidence for memory domains (e.g. Cocchini et al., 2002). We employed the transfer effect as an indicator of systemic processes within the approach and withdrawal domains. In general, our main result – simple-task transfer asymmetry in withdrawal and approach contexts – is in correspondence with the united concept of emotions and consciousness (Alexandrov, 1999; Alexandrov & Sams, 2005) in that the approach and withdrawal memory domains provide different organism-environment interactions.

We have revealed qualitatively similar positive transfer effects in both approach and withdrawal contexts. The motivational context modified the negative transfer effect only. We explain this by the important difference of accommodative reconsolidation processes (Alexandrov et al., 2001; see Introduction) concomitant with positive and negative transfer. When the tasks were presented with increasing difficulty, every parameter of words that was introduced was the one the subject had to exercise. In this case, no exclusive (inhibitory) relations between systems were required. Consequently, both approach and withdrawal domains served as equally good bases for new learning. Given the opposite order of the tasks, a formerly excessive parameter became critical. In this case, accommodative reconsolidation involved more radical modifications of prior experience, because it could not fully support new learning. Thus, a bigger withdrawal domain served the same learning with longer RTs for as long as 60 trials of the test sessions. The stable context-dependent transfer effect, shown in Fig. 2, may therefore reflect on-going accommodative reconsolidation processes.

Detrimental response latency does not necessarily signify deficit of encoding (Anderson, 1981). Moreover, as in the contextual interference paradigm, movement time decline may result in subsequent performance improvement (e.g. Cross et al., 2007). Therefore, no practical suggestions can be derived *straight* from our experimental data. Nevertheless, we believe that further applied research in educational psychology – especially in the domains of perceptual learning and acquisition of skills – would be encouraged by the following speculation. Our finding suggests that the extent of transfer may depend on the incentive context of the normative evaluation. That is, the use prior experience during learning is related to the achievement goal immersed into the instructional context – whether the evaluative statements serve as a signal for approval or disapproval. This result highlights the salience of motivational context for the proactive effect of learning: emphasizing success as an object of assessment is a more fruitful strategy for transfer-oriented teaching than to mark failures, at least in the cultural context of the given sample.

5. Conclusion

Motivational context – approach or withdrawal is a predictor of the learning transfer even in simple-task settings. We based our predictions on the proposition that approach and withdrawal behaviors are associated with positive and negative emotions, correspondingly, and are provided by two different domains of individual experience. The withdrawal domain provides superior differentiation ("resolution") of organism-environment interaction compared to the approach domain. Consequently, the negative transfer effect in the withdrawal context exceeds that in the approach context.

Transfer of learning is a basic instrument and principal ambition of education. Positive motivational context of learning may be one of the principles in teaching for transfer.

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References

Alexandrov, Yu. I. (1999). Comparative description of consciousness and emotions in the framework of systemic understanding of behavioral continuum and individual development. In: C. Teddei-Ferretti, C. Musio (Eds.), Neuronal Bases and Psychological Aspects of Consciousness (pp. 220-235). Singapore: World Scientific.

Alexandrov, Yu. I. (2006). Learning and memory: traditional and systems approaches. Neuroscience and Behavioral Physiology, 36, 969-985.

Alexandrov, Yu. I. (2008). How we fragment the world: The view from inside versus the view from outside. Social Science Information, 47, 419–457.

Alexandrov, Yu. I., Grinchenko Yu. V., Shevchenko D. G., Averkin R. G., Matz V. N., Laukka S., & Korpusova A. V. (2001). A subset of cingulate cortical neurons is specifically activated during alcohol-acquisition behaviour. Acta Physiologica Scandinavica, 171, 87-97.

Alexandrov, Yu. I., & Sams, M. E. (2005). Emotion and consciousness: Ends of a continuum. Cognitive Brain Research, 25, 387-405.

Alexandrov, Yu. I., Klucharev, V., & Sams, M. (2007). Effect of emotional context in auditory-cortex processing. International Journal of Psychophysiology, 65, 261-271.

Alexopoulos, T., & Ric, F. (2007). The evaluation-behavior link: Direct and beyond valence. Journal of Experimental Social Psychology, 43, 1010-1016.

Anderson, J. R. (1981). Interference: The relationship between response latency and response accuracy. Journal of Experimental Psychology: Human Learning and Memory, 7, 326-343.

Anderson, J. R., Reder, L. M., & Simon, H. A. (1996). Situated learning and education. Educational Researcher, 25, 5-11.

Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. Annual Review of Psychology, 50, 191-214.

Chambers, D. W. (1987). Issues in transferring preclinical skill learning to the clinical context. Journal of Dental Education, 51, 238-243.

Claeys, W., & Timmers, L. (1993). Some instantiations of the informational negativity effect: Positive–negative asymmetry in category breadth and in estimated meaning similarity of trait adjectives. European Journal of Social Psychology, 23, 111-129.

Cocchini, G., Logie, R. H., Della Sala, S., MacPherson, S. E., & Baddeley, A. D. (2002). Concurrent performance of two memory tasks: Evidence for domain-specific working memory systems. Memory & Cognition, 30, 1086-1095.

Cross, E. S., Schmitt, P.J., & Grafton, S.T. (2007). Neural substrates of contextual interference during motor learning support a model of active preparation. Journal of Cognitive Neuroscience, 19, 1854-1871.

Czajak, D., & Cipora, K. (2012). Cognitive inhibition under conditions of high/low avoidance-motivated negative affect. In The Fifth International Conference on Cognitive Science. Abstracts (V.1, P. 49-50). Kaliningrad.

Damasio, A. R. (1994). Descartes' Error: Emotion, Reason, and the Human Brain. New York: Grosset/Putnam Book.

Damasio, A. R. (2000). The Feeling of What Happens. Vintage, London.

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-Withdrawal and Cerebral Asymmetry: Emotional Expression and Brain Physiology I. Journal of Personality and Social Psychology, 58, 330-341.

Derryberry, D. (1993). Attentional consequences of outcome-related motivational states: Congruent, incongruent, and focusing effects. Motivation and Emotion, 17, 65-89.

Dweck, C. S. (1986). Motivational processes affecting learning. American Psychologist, 41, 1040-1048.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. Educational Psychologist, 34, 169-189.

Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. Journal of Personality and Social Psychology, 72, 218-232.

Elliot, A. J., & Harackiewicz, J. M. (1996). Approach and avoidance achievement goals as and intrinsic motivation: A mediational analysis. Journal of Personality and Social Psychology, 70, 461-475.

Ellis, H. C. (1965). The transfer of learning. New York: MacMillan.

Gable, P. A., & Harmon-Jones, E. (2008). Approach-motivated positive affect reduces breadth of attention. Psychological Science, 19, 476-482.

Gray, J. A. (1990). Brain systems that mediate both emotion and cognition. Cognition and Emotion, 4, 269-288.

Harackiewicz, J. M., Barron, K. E., Pintrich, P. R., Elliot, A. J., & Thrash, T. M. (2002). Revision of achievement goal theory: Necessary and illuminating. Journal of Educational Psychology, 94, 638-645.

Hansell, J. H. (1989). Theories of emotion and motivation: A historical and conceptual review. Genetic, Social, and General Psychology Monographs, 15, 429-448.

Haskell, R. E. (2001). Transfer of learning: Cognition, instruction, and reasoning. New York: Academic Press.

Helfenstein, S. (2005).Transfer. Review, reconstruction, and resolution. Juväskylä: University of Juväskylä.

Immordino-Yang, M. H., & Damasio, A. (2007). We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education. Mind, Brain, and Education, 1, 3-10.

Immordino-Yang, M. H. (2007). A tale of two cases: Lessons for education from the study of two boys living with half their brains. Mind, Brain, and Education, 1, 66-83.

Krauth, J. (2000). Experimental design. A handbook and dictionary for medical and behavioral research. Amsterdam: Elsevier.

Kubesch, S., Walk, L., Spitzer, M., Kammer, M., Lainburg, A., Heim, R., & Hille, K. (2009). A 30-minute physical education program improves students' executive attention. Mind, Brain, and Education, 3, 235-242.

Lewica, M. (1988). On objective and subjective anchoring of cognitive acts: How behavioural valence modifies reasoning schemata. In: W. Baker, L. Mos, H. V. Rappard, H. J. Stam (Eds.), Recent Trends in Theoretical Psychology (pp. 285-301). New York: Springer Verlag.

Lewis, D., & Shephard, A. H. (1951). Prior learning as a factor in shaping performance curves. Proceedings of the National Academy of Sciences, 37, 124-131.

Matsumoto, M. & Hikosaka O. (2009). Two types of dopamine neuron distinctly convey positive and negative motivational signals. Nature, 459, 837-842.

Müller, R.-A., Kleinhans, N., Pierce, K., Kemmotsu, N., & Courchesne, E. (2002). Functional MRI of motor sequence acquisition: effects of learning stage and performance. Cognitive Brain Research, 14, 277-293.

O'Doherty, J., Kringelbach, M. L., Rolls, E. T., Hornak, J., & Andrews, C. (2001). Abstract reward and punishment representations in the human orbitofrontal cortex. Nature Neuroscience, 4, 95-102.

Ohira, H., Winton, W. M., & Oyama, M. (1998). Effects of stimulus valence on recognition memory and endogenous eyeblinks: Further evidence for positive–negative asymmetry. Personality and Social Psychology Bulletin, 24, 986-993.

Osgood, C. E. (1948). An investigation into the causes of retroactive interference. Journal of Experimental Psychology, 38, 132-154.

Peeters, G., & Czapinski, J. (1990). Positive–negative asymmetry in evaluations: the distinction between affective and informational negativity effects. In: W. Stroebe, M. Hewstone (Eds.), European Review of Social Psychology, vol. 1 (pp. 34-60). New York: Wiley.

Perkins, D. N., & Salomon, G. (1994). Transfer of learning. In International Encyclopedia of Education (Vol. 11, 2nd ed., pp. 6452-6457). Oxford, UK: Pergamon Press.

Perlstein, W. M., Elbert, T., & Stenger, A. (2002). Dissociation in human prefrontal cortex of affective influences on working memory-related activity. Proceedings of the National Academy of Sciences, 99, 1736-1741.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993) Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. Review of Educational Research, 63, 167-199.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. Science Education, 66, 211-227.

Postman, L. (1971). Transfer, interference and forgetting. In J. W. Kling & L. A. Riggs (Eds.), Woodworth and Schlosberg's experimental psychology (3rd ed., pp. 1019–1132). New York: Holt, Rinehart & Winston.

Prather, D. C., Berry, G. A., & Jones, G. L. (1972). The training of a perceptual skill by either rewarding or aversive feedback compared on efficiency, transfer, and stress. Journal of Applied Psychology, 56, 514-516.

Regehr, G., & Norman, G. R. (1996). Issues in cognitive psychology: implications for professional education. Academic Medicine, 71, 988-1001.

Robinson-Riegler, G. L., & Winton, W. M. (1996). The role of conscious recollection in recognition of affective material: Evidence for positive–negative asymmetry. Journal of General Psychology, 123, 93-104.

Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. Journal of Experimental Psychology: General, 124, 207-231.

Rolls, E. T., O'Doherty, J., Kringelbach, M. L., Francis, S., Bowtell, R., & McGlone, F. (2003). Representations of pleasant and painful touch in the human orbitofrontal and cingulate cortices. Cerebral Cortex, 13, 308-317.

Salomon, G., & Perkins, D. N. (1988). Teaching for transfer. Educational Leadership, 46, 22-32.

Schneirla, T. C. (1959). An evolutionary and developmental theory of biphasic processes underlying approach and withdrawal. In M.R. Jones (Ed.) Nebraska symposium on motivation, vol. 7. (pp. 1-42). Lincoln: University of Nebraska Press.

Schwarz, N. (1990). Feelings as information. Informational and motivational functions of affective states. In: E. T. Higgins, R. M. Sorrentino (Eds.), The Handbook of Motivation and Cognition: Foundations of Social Behavior, vol. 2 (pp. 527-561). New York: Guilford Press.

Semb, G. B., & Ellis, J. A. (1994). Knowledge taught in school: what is remembered? Review of Educational Research, 64, 253-286.

Seymour, B., Daw, N., Dayan, P., Singer, T., & Dolan, R. (2007). Differential encoding of losses and gains in the human striatum. Journal of Neuroscience, 27, 4826-4831.

Shvyrkov, V. B. (1986). Behavioral specialization of neurons and the system-selection hypothesis of learning. In F. Klix & H. Hagendorf (Eds.), Human memory and cognitive capabilities: mechanisms and performances (pp. 599-611). North-Holland: Elsevier.

Tallet J., Kostrubiec V., Zanone P.-G. (2010). Proactive transfer of learning depends on the evolution of prior learned task in memory. Human Movement Science, 29, 349-368.

Uljens, M. (1997). School didactics and learning. Hove, East Sussex: Psychology Press.

Viinikainen, M., Jääskeläinen, I. P., Alexandrov, Yu. I., Balk, M. H., Autti, T., & Sams, M. (2009). Nonlinear relationship between emotional valence and brain activity: Evidence of separate negative and positive valence dimensions. Human Brain Mapping (published online).

Yeo, G. B., Sorbello, T., Koy, A., & Smillie, L. D. (2008). Goal orientation profiles and task performance growth trajectories. Motivation and Emotion, 32, 296-309.