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ORIGINAL PAPER

Mental contrasting and energization transfer to low-expectancy tasks

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Abstract

Mentally contrasting future with reality is a self-regulation strategy that triggers expectancy-dependent energization for tasks instrumental to attaining the desired future. Energization by mental contrasting even transfers to tasks unrelated to the desired future at hand. Would such energization transfer by mental contrasting even energize people to perform unrelated tasks for which they have low success expectations? In Laboratory Experiment 1, mentally contrasting (vs. indulging) about performing well in a *creativity task* triggered physiological energization and better performance in an unrelated low-expectancy *cognitive task* that participants received in place of the creativity task. In Field Experiment 2, mentally contrasting an *interpersonal wish* helped schoolchildren invest more effort and perform better in a low-expectancy *academic task*—finding typos. Online Experiment 3 replicated Experiment 2 with adults. Mental contrasting participants' effort and performance in the low-expectancy academic task did not differ from their effort and performance in a high-expectancy task. We discuss implications for designing interventions to foster energization for low-expectancy tasks.

Keywords Mental contrasting · Effort · Energization · Field experiment · School performance

Introduction

A student new in town wants to make new friends. Visualizing the desired future of getting to know someone—having good company—and then identifying crucial inner obstacles that may prevent them from making new friends—being reluctant to approach people—will help them mobilize energy and overcome the obstacle given they have confidence (high success expectations) to attain the desired future.

Indeed, such mental contrasting of a desired future with obstacles in the reality triggers energization and performance in pursuing the desired future (Oettingen et al., 2009). Moreover, because energization can be understood as a generalized activation state, energization triggered by mental contrasting even predicted performance in a task unrelated to the visualized future (Sevincer et al., 2014). We go beyond this research by investigating whether this energization transfer effect by mental contrasting a specific high-expectancy wish can energize people during a task unrelated to the initial wish, even though people have low success expectations for that task. Energizing people during low-expectancy tasks is a long-standing challenge, for example, in educational practice (Hidi & Harackiewicz, 2000).

Mental contrasting

When people use mental contrasting, they first generate an important wish they like to fulfil ("writing an excellent essay"). They then identify and imagine the best outcome of having fulfilled their wish ("relief") and the critical obstacle that may prevent them from fulfilling their wish ("being distracted"). If people have high expectations to fulfil the wish by surmounting the obstacle, visualizing the wished-for future followed by the obstacle mobilizes energy to overcome the obstacle. If they have low expectations, mental contrasting leads them to withhold their energy. In short, mental contrasting produces selective goal pursuit; people will passionately pursue their wish when they have high success expectations but will refrain from doing so when they have low expectations.

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Mental contrasting is typically tested against indulging, imagining the desired future only, and dwelling, imagining the present reality only. These one-sided elaborations fail to make people perceive the reality as an obstacle to their desired future and therefore do not produce selective goal pursuit. Similarly, in reverse contrasting, imagining the reality before the future, the reality is not elaborated in the context of the desired future and thus is not perceived as an obstacle to the desired future. Therefore, reverse contrasting also does not produce selective goal pursuit. The pattern that mental contrasting (vs. the other modes of thought) produces selective (expectancy-dependent) goal pursuit has been observed in numerous studies (summaries by Oettingen & Sevincer, 2018; Sevincer & Oettingen, 2020).

Energization

Researchers also investigated energization as a mechanism that mediates mental contrasting effects on expectancy-dependent goal pursuit (summary by Sevincer & Oettingen, 2015). Energization has been defined as a resource necessary to perform a task (Richter et al., 2016) and can be assessed by indicators of cardiovascular activity. When people perform a task, the body has an increased metabolic demand of energy and consequently the cardiovascular system displays greater activity as it needs to transport more blood containing oxygen and nutrients (Brownley et al., 2000).[1]

One reliable cardiovascular indicator of energization is systolic blood pressure (SBP), the maximum blood pressure. SBP is a reliable indicator because it is systematically linked to the force with which the heart contracts to pump blood through the body. The heart's contraction force is also an indicator of energization. It is measured by the heart's pre-ejection period (PEP), which is the period between the beginning of the electronic stimulation of the left ventricular and the opening of the aortic valve. The PEP in turn directly depends on sympathetic (beta-adrenergic) discharge to the heart ().

Using SBP as an indicator of energization, Oettingen et al. (2009) examined whether changes in energization mediate the effects of mental contrasting on pursuing the desired future targeted by mental contrasting. The researchers found that participants who mentally contrasted (vs. indulged) about fulfilling an important interpersonal wish evinced changes in energization (SBP) that corresponded to their expectations of successfully fulfilling that specific wish. The changes in energization then predicted commitment to fulfilling the wish. That is, when participants had high expectations of fulfilling their wish, mental contrasting produced high (increased) energization and commitment to fulfilling their wish; when participants had low expectations of fulling their wish mental contrasting produced low (decreased) energization and commitment. Energization mediated the effect of mental contrasting on commitment. The indulging participants' energization and commitment did not change and did not depend on their expectations of fulfilling the specific wish.

Energization transfer

Building on the above findings by Oettingen et al. (2009) that mental contrasting a high-expectancy wish triggers energization as a resource to pursue that specific wish, Sevincer et al. (2014) extended these results by proposing that the energization triggered by mental contrasting a specific wish could also transfer to predict performance in a task unrelated to the initial wish, if participants were confronted with such a task directly after the mental contrasting exercise rather than with an opportunity to pursue the initial wish. Thus, by denying participants the opportunity to pursue their wish and presenting them with an unrelated task instead, the elicited energization would be redirected and transferred toward the unrelated task.

Sevincer et al. (2014) reasoned that such a transfer could occur because energization can not only be understood as a resource necessary for pursuing a specific goal but also as a general activation state. Indeed, one influential definition of energization is "the extent to which the organism as a whole is activated or aroused" (Duffy, 1934, p. 194). Thus, rather than fueling goal-directed behavior for a specific task, energization can fuel any behavior. This idea is brought forward in drive theory (Hull, 1952). According to the theory, behavior is a function of energy and direction. The energy is provided by drive, which is an undifferentiated, universal energizer that is fueled by the sum of all current bodily deficits (hunger, thirst, pain, among others). The direction is provided by habit, which is determined by whether an organism had learned that a specific behavior would reduce the drive in a particular situation. Thus, according to drive theory, there is no one-to-one linkage between drive and an associated behavior, rather drive can energize any behavior. This principle, that a drive that had not yet fully spurred a particular behavior to reduce the drive potentially could spur any behavior was coined "irrelevant drive". Following up on Hull's ideas, Zillmann, proposed that physiological energization should function analogously to the psychological drive in that it "indiscriminately 'energizes' and thus facilitates enacted behavior" (Zillmann, 1971, p. 422). Support for this idea comes from Zillmann's (1971) findings on "excitation-transfer", suggesting that residual arousal from one stimulus (watching an erotic movie) may potentiate

[1] This function of the cardiovascular system is particularly relevant for physical tasks, the role of the cardiovascular system for cognitive tasks is less clear. We will elaborate on this point below and in Footnote 2.

participants' responses to a second, unrelated stimulus (a hostile provocation).

In line with the idea, that energization by mental contrasting could transfer to a task unrelated to the initial wish targeted by mental contrasting, Sevincer et al. (2014) found that, students who mentally contrasted (vs. control) their initial wish of writing an excellent essay evinced energization (measured by change in SBP) that dependent on their expectations of writing an excellent essay. However, rather than giving participants the opportunity to write the essay, the experimenters presented participants with a task unrelated to their initial wish, squeezing a handgrip exerciser (Muraven et al., 1998). As hypothesized, the energization triggered by mental contrasting about writing the essay mediated participants' performance in the handgrip task. This pattern was conceptually replicated in a second study. Students who mentally contrasted (vs. control) about excelling in an intelligence test displayed expectancy-dependent changes in SBP which then mediated their performance in an unrelated task, writing a get-well letter, that they received in place of the intelligence test.

The present research: energization transfer to low-expectancy tasks

We go beyond the studies by Sevincer et al. (2014) in the following ways. First, Sevincer and colleagues never tested the role of expectations of successfully solving the unrelated task. One may assume that such energy transfer only occurs if people have high success expectations not only for their initial wish but also for the unrelated task. If, however, the energy transfer also occurred when success expectations for the unrelated task are low, it would have important implications: a person with high expectations of fulfilling one wish, through mental contrasting, could be brought to become energized and well-performing on a task unrelated to their wish even though they have low confidence in successfully solving that task. For example, someone who has high success expectations of making new friends, and is mentally contrasting about making new friends, would become energized to solve a given academic task, even though their success expectations for that particular academic task are low.

Therefore, we tested whether mental contrasting a high-expectancy wish elicits energization that then predicts performance in a task unrelated to the initial wish even though participants' success expectations for that task are low. We suspected that such an energization transfer to low-expectancy tasks should occur because we prompted participants to perform the unrelated task when they were in a state of high energization immediately after the mental contrasting exercise. Thus, their residual energization from the mental exercise should be channeled toward the subsequent, unrelated task. This channeled energization should focus people on the immediate task irrespective of whether their expectations of successfully that task are high or low.

Second, research on energization transfer by mental contrasting used SBP as a physiological indicator for energization. However, researchers have emphasized PEP as a more direct indicator of energization. PEP measures the contraction force of the heart (myocardial contractility; Richter & Gendolla, 2009). Myocardial contractility is determined by beta-adrenergic sympathetic discharge to the heart, which is a relatively direct indicator of energization (Obrist, 1981). Thus, while PEP is determined by beta-adrenergic sympathetic discharge, SBP is also influenced by other cardiovascular parameters such as peripheral resistance (diameter of the vessels), which depends on alpha-adrenergic sympathetic discharge. Therefore, "PEP is a much purer index of beta-adrenergic impact" than SBP (Silvestrini & Gendolla, 2013, p. 2) and is "probably the most reliable noninvasive indicator of sympathetic impact on the heart that is currently available" (Richter et al., 2016, p. 156). In Experiment 1, we therefore assessed energization by PEP.

Third, research on energization transfer was conducted in the laboratory. Psychological phenomena should also be studied in naturalistic settings (Paluck & Cialdini, 2014). In Experiment 2, we tested in the classroom whether energization transfer by mental contrasting can help schoolchildren perform an academic task, finding typos. And in Experiment 3, we aimed to replicate the findings online with adults. Moreover, in Experiments 2 and 3, we measured energization transfer by effort rather than physiological energization. Physiological energization has sometimes been used synonymously with effort (Massin, 2017), and both terms indicated resource investment, energization as the physiological underpinning and effort as a behavioral manifestation of resource investment.

Experiment 1: physiological energization in the laboratory

Participants mentally contrasted or indulged about successfully performing a creativity test, for which we induced high success expectations by giving bogus feedback. We measured physiological energization by PEP. Thereafter, rather than administering the announced creativity test, we presented participants with a cognitive task.

Performance in cognitive tasks is influenced by several factors—ability, strategies, and exerted energization or effort (Locke & Latham, 1990). Two research domains suggest that higher energization or effort are related to performing cognitive tasks. First, in psycho-physiological research, a stronger cardiovascular response is associated with performance in cognitive tasks. For example, participants evinced a stronger cardiovascular response (e.g. PEP, SBP, heartrate) while performing cognitive tasks such as mental arithmetic tasks (Allen et al., 1978; Obrist, 1963), visual–verbal tests (Manuck et al., 1978), memory tasks (Gendolla et al., 2001; Houston, 1973), attention tasks (Gendolla & Krüsken, 2001; Gendolla & Richter, 2005), and reaction-time tasks (Light & Obrist, 1983).[2] Second, in research on educational psychology, higher self-reported effort is related to better performance in cognitive tests (e.g., math tests; meta-analysis by Duckworth et al., 2011). Further, when stressed, people allocate resources (i.e., invest more energy/effort) to uphold their cognitive performance (Hockey, 1997). We induced low expectations for the cognitive task by informing participants that the task was designed for intellectually gifted people. We hypothesized that mental contrasting (vs. indulging) participants would evince higher energization and better performance in the cognitive task.

Method

Participants and design

We recruited 85 students (25 female, 60 male, $M_{age} = 26.05$, $SD = 8.71$) from a German University. Participants were recruited via the online recruitment system and advertisement on campus for a study on physiological reactions. We used the average sample size per condition from previous studies on mental contrasting and physiological energization (Oettingen et al., 2009; Sevincer et al., 2014) as our minimum sample size ($N = 78$). The effect sizes (*d*s) reported in Sevincer et al. (2014) ranged between 0.35 and 1.00, the effect size in Oettingen et al., (2009, Study 1) was 0.76. We also performed power analyses, which yielded that we would need a minimum of 72 participants to detect an intermediate effect (0.70). Participants could choose between receiving course credit or €10. To be eligible, they had to be free from heart disease and hypertension, and had to abstain from caffeine, cigarettes, alcohol, medication, and strenuous exercise for at least 2 h prior to the experiment (Shapiro et al., 1996). There were two conditions: Mental contrasting vs. indulging.

[2] The precise physiological mechanisms for the observed relationship between a stronger cardiovascular response and high cognitive performance are yet unclear (Gendolla & Richter, 2005). In particular, the observed relationship is independent of the metabolic activity of the brain (cardio-somatic uncoupling; Obrist, 1981). That is, a stronger cardiovascular response is not accompanied by an enhanced blood flow, and oxygen and glucose consumption in the brain. Rather, the metabolic activity of the brain remains relatively stable (Raichle & Gusnard, 2002). Thus, the stronger cardiovascular response during cognitive performance excesses the metabolic demand of the brain.

Procedure

Participants were tested individually. They were seated in an experimental cubicle with a computer. The cubicle also contained a blood pressure monitor with a compressing cuff to measure SBP (Carescape Dinamap V100), and an integrated system (Biopac MP150) with amplifiers for impedance cardiography (ICG; NICO100C) and electrocardiography (ECG; ECG100 amplifier) to measure PEP.

To prepare the SBP measurements, the compressing cuff of the blood pressure monitor was placed over the brachial artery of participants' left arm. The apparatus used oscillometry to determine SBP in millimeters of mercury. A single blood pressure measurement lasted approximately 30 s.

To prepare the PEP measurements, two small skin areas on the right side of participants' upper torso and on the left side of their lower torso were cleaned with skin preparation gel. Two pieces of disposable electrode tape were then attached around the cleaned places and another two pieces around participants' neck (Sherwood et al., 1990). The system measures the total electrical conductivity of the torso by sending a high-frequency, low-magnitude electrical current through participants' torso. It continuously records ICG and ECG signals at a rate of 1.000 samples per second. The ICG and ECG signals are used to determine the PEP in milliseconds.

Baseline cardiovascular measurements (T1) To control for individual differences in cardiovascular reactivity, we took baseline measurements of SBP and PEP. Participants rested quietly for 5 min while watching a neutral movie about landscapes. To measure SBP, we took two measurements, which we averaged into one baseline SBP index ($\alpha = .92$).

To measure PEP, we continuously recorded ECG and ICG signals during the 5-min period. PEP scores were calculated for each of the 30 s intervals, using a commercially available software (Mindware HRV 3.0.18 and IMP 3.0.21 modules). The software integrated ECG and ICG signals to determine PEP in milliseconds. Specifically, PEP is the time interval between the Q-point of the ECG wave (initiation of the left ventricle contraction) and the B-point of the ICG wave (opening of the aortic valve). The B-points and Q-points were initially determined by the software using the Max Slope Change algorithm. The ECG signal had a Baseline and Muscle Noise filter applied (0.25–40 Hz band-pass filter). We also visually inspected the ECG and ICG waves and manually adjusted the B-point if necessary (Sherwood et al., 1990). Moreover, we inspected the data for any recording artifacts and only artifact-free cycles were used to construct the ensemble averages for the 30 s intervals (Richter & Gendolla, 2009). Finally, to obtain the PEP baseline score, we averaged all ten 30-s measures obtained during the 5-min baseline period ($\alpha = .98$).

Creativity test: induction of high expectations To induce high success expectations for the creativity test, we followed a procedure by Oettingen et al. (2012). Participants were provided with bogus positive feedback on their creative potential. On the screen appeared 30 adjectives from the Creative Personality Scale ("unconventional", Gough, 1979). Participants rated for each adjective whether it describes them or not. Thereafter, they learned that their answers indicated their creative potential. They also learned that their creative potential is in the top 90th percentile of the population.

To verify that participants had high expectations for the creativity test, we asked: "How likely do you think it is that you will correctly solve more of the items in the creativity test than participants on average?" Moreover, to verify that performing well is important to them we measured their incentive value: "How important is it to you that you will correctly solve more of the items in the creativity test than participants on average?" We used 7-points scales (1 = *not at all*, 7 = *very*).

Pre-manipulation cardiovascular measurements (T2) To test whether the induction of high success expectations affected participants' cardiovascular responses, we took a second SBP and PEP measurement. One measurement of SBP was taken while PEP was assessed continuously for 30 s.

Strategy manipulation: mental contrasting vs. indulging Following the procedure by Krott and Oettingen (2018), all participants first named the best outcome they associated with performing well in the creativity test (e.g., "relief") and elaborated on it in writing for 2 min (see Supplementary Material for verbatim instructions: https://osf.io/v8md6/). Thereafter, in the mental contrasting condition, participants named the main obstacle in the present reality that keeps them from performing well on the creativity test ("e.g., I am feeling tired"). They then elaborated on it in writing for 2 min using analogous instructions. In the indulging condition, participants named and elaborated the second-best outcome they associated with performing well in the creativity test.

Post-manipulation cardiovascular measurements (T3) After the mental exercise, we took the dependent SBP and PEP measurement following the same procedure as in T2.

Rationale for performing the cognitive task To provide participants with a reason why they would not perform the announced creativity test but a cognitive task, the experimented entered the room and told them that a mistake was made in the experimental procedure (see Supplementary Material for verbatim instructions). The experimenter then opened a different program and instructed participants to start working on the opened questionnaire.

Induction of low success expectations for cognitive task Participants read that the upcoming cognitive task was designed for intellectually gifted people. Gifted people have an IQ higher than 130 and only 2.5% of the population are gifted. Therefore, it is likely that they will not be able to answer most of the test items. To verify participants had low expectations, we asked: "How likely do you think it is that you will correctly solve more of the items in the cognitive test than participants on average?" We also measured the incentive value of performing well: "How important is it to you that you will correctly solve more of the items in the cognitive test than participants on average?" We used 7-points scales (1 = *not at all*, 7 = *very*).

Dependent variable: performance in cognitive task We presented participants with the spatial-intelligence subtest of the intelligence-structure-test (Liepmann et al., 2012). The subtest contains 20 items. In each item, participants are given an arrangement of four graphical figures, which are built up following a certain rule. Participants are asked to choose among five figures which of the figures correctly completes the presented arrangement. We used the number of correctly solved items as our performance measure. To examine whether the cognitive task is perceived as being difficult, we conducted a short online survey, reported in the Supplementary Material (https://osf.io/v8md6/). The results suggested that people perceive the task to be moderately difficult. To conclude, participants were fully debriefed.

Results

Descriptives

Table 1 depicts means, standard deviations, and correlations among the measures.

Baseline cardiovascular measurements (T1)

Table 2 depicts the absolute cardiovascular measurement scores between conditions at the three measurement points. Neither baseline PEP nor SBP differed between conditions, $ts < .095$, $ps > .59$.

Creativity test: high expectations

Expectations of solving the announced creativity test were above the midpoint of the 7-point scale (Table 1), indicating that our induction of high expectations was successful. Incentive was also above the midpoint of the 7-point scale, indicating that solving the test was important to participants.

Table 1 Study 1: means and standard deviations (in parentheses) of the cardiovascular measurements in the two conditions

Measurement time	Condition			
	Mental contrasting		Indulging	
	PEP	SBP	PEP	SBP
Baseline (T1)	106.77 (19.62)	115.51 (11.54)	109.30 (20.40)	117.82 (10.71)
Pre-manipulation (T2)	98.68 (22.55)	116.76 (13.85)	103.25 (22.91)	117.55 (12.31)
Post-manipulation (T3)	86.18 (16.72)	124.00 (16.77)	110.56 (57.36)	116.06 (11.34)

Table 2 Study 1: means, standard deviations, and correlations among the measures

Scale	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
Creativity test												
1. Expectations (1–7 scale)	4.66	1.28	–									
2. Incentive (1–7 scale)	4.87	1.52	**.17**	**–**								
Cognitive task												
3. Expectations (1–7 scale)	2.09	1.47	**.43**	.01	–							
4. Incentive (1–7 scale)	4.85	1.57	**.24**	**.39**	**.65**	**–**						
5. Performance	13.69	2.62	.11	.01	**.23**	.14	–					
Energization measurements												
6. Baseline PEP	108.13	19.94	.18	**−.29**	−.08	−.18	.02	**–**				
7. Baseline SBP	116.61	11.14	.05	.20	**.24**	.19	−.14	**−.38**	–			
8. Pre-manipulation PEP	99.53	26.11	−.01	**−.27**	**−.14**	−.19	−.06	**.88**	**−.29**	–		
9. Pre-manipulation SBP	117.13	13.08	.13	.08	**.24**	**.25**	−.06	−.23	**.78**	−.15	–	
10. Post-manipulation PEP	98.55	43.95	−.11	−.00	−.19	**−.29**	−.18	**−36**	−.07	**.40**	.04	**–**
11. Post-manipulation SBP	119.67	14.14	**.26**	.12	**.40**	**.36**	**.25**	**−.24**	**.63**	−.19	**.75**	−.09

Correlation coefficients printed in bold typeface are significant at $p < .05$

Neither expectations, nor incentive differed between conditions, *t*s (83) < 0.79, *p*s > .43.

Change in cardiovascular reactivity from before (T2) to after manipulation (T3)

To examine whether the mental contrasting (vs. indulging) condition displayed increased energization from before to after the mental exercise, we followed the method by Llabre et al. (1991). To control for baseline cardiovascular reactivity, we first calculated change scores from baseline to T2, and from baseline to T3 for PEP and SBP.

We then submitted these scores to a 2 (condition: mental contrasting vs. indulging) × 2 (measurement time: T2 to T3) mixed ANOVA. For PEP, we observed a marginal condition by time interaction effect, $F(1, 62) = 3.79$, $p = .056$, $d = 0.50$. Directly before the mental exercise, the scores did not differ between the mental contrasting condition ($M = 6.66$, $SD = 11.17$) and the indulging condition ($M = 6.23$, $SD = 11.00$), $t(65) = .16$, $p = .88$; directly after the mental exercise, the mental contrasting condition displayed lower scores ($M = -20.59$, $SD = 13.53$) than the indulging condition ($M = 0.65$, $SD = 54.53$), $t(65) = 2.17$, $p = .03$, 95% CI [−40.76, −1.73].

An analogous pattern emerged for SBP. This time, there was a significant condition by time interaction effect, $F(1, 65) = 12.25$, $p = .001$, $d = 0.87$. Before the mental exercise, the scores did not differ (mental contrasting: $M = 1.21$, $SD = 10.04$; indulging: $M = -.26$, $SD = 5.72$), $t(65) = .82$, $p = .42$; after the mental exercise, the mental contrasting condition displayed higher scores ($M = 7.15$, $SD = 12.78$) than the indulging condition ($M = -1.37$, $SD = 9.38$), $t(65) = 3.12$, $p = .003$, 95% CI [3.06, 13.98]. Overall, the pattern indicates that mental contrasting led to increased energization—PEP tended to decrease, SBP increased—compared to indulging.

Cognitive task: low expectations

Expectations of solving the cognitive test were below the midpoint of the 7-point scale (Table 2), indicating that we successfully manipulated low expectations. Incentive was above the midpoint, indicating that solving the test was important to participants. Neither expectations, nor incentive differed between conditions, ts $(83) < 1.38$, ps $> .17$.

Cognitive task: performance

As predicted, mental contrasting participants solved more items ($M = 14.33$, $SD = 2.58$) than indulging participants ($M = 12.97$, $SD = 2.51$), $t(83) = 2.45$, $p = .016$, 95% CI [0.26, 2.46], $d = 0.50$. Cognitive performance correlated positively with SBP (Table 1). The relationship between cognitive performance and PEP was non-significant ($p = .144$) but in the predicted direction. Apparently, the more energized participants were the better they tended to perform.

Relationship physiological energization: cognitive performance

When we calculated z-scores and combined the SBP and reverse-coded PEP z-scores, the resulting index correlated positively with cognitive performance, $r = .26$, $p = .036$.

Discussion

Participants who mentally contrasted (vs. indulged) about excelling in a creativity test for which they were induced high success expectations evinced increased physiological energization. The mentally contrasting participants also solved more items in a subsequent cognitive test they received in place of the creativity test and for which they were induced low success expectations. Apparently, mental contrasting about a high-expectancy creativity wish elicited energization and enhanced performance in an unrelated low-expectancy cognitive task.

Experiment 1 provides evidence from the lab. However, eliciting energization and performance for low-expectancy tasks is a long-standing challenge in many applied contexts, particularly in education. Therefore, Experiment 2 examined whether energization transfer by mental contrasting can also be observed in the classroom. Rather than measuring physiological energization, we measured children's effort in an error-search task. Energization and effort both indicate resource investment, energization as the physiological underpinning and effort as the behavioral manifestation. We also measured performance by the number of correctly detected typos.

Experiment 2: effort at school

Method

Participants and design

We recruited 290 schoolchildren (134 girls, 155 boys, one unidentified, $M_{age} = 10.56$, $SD = 1.46$) from grades three to six from four urban public schools. Because there were no prior studies on energization transfer in the field, we recruited as many children as we could. We also performed power analyses with the average observed effect size from Experiment 1 ($d = 0.74$), yielding we would need 118 participants to detect such an effect with 99% power.

The study was approved by the local ethics ocmmittee and the local authority for education. Children received a small gift, a color pen. Of the 290 children who participated, we excluded 42: 19 because they did not speak German as their best language, 21 because they did not name or elaborate a wish, and 2 because they did not understand the error-search task. The results did not change when we included these children. There were two conditions: Mental contrasting vs. indulging.

Procedure

The experiment was conducted during class time. The experimenters gave the children an overview of the study, handed out the experimental booklets and stressed that participation was voluntary.

Interpersonal wish with high expectations Children named an important current interpersonal wish for which they have high expectations (see Supplementary Material for verbatim instructions). Children named for example: "To get along better with my parents". They indicated their success expectations ("How much do you think that you will fulfill your wish?") and incentive ("How important is it for you to fulfill your wish?"). We used 5-point scales (1 = *not at all*, 5 = *very*).

Strategy manipulation: mental contrasting vs. indulging All children first identified and elaborated the best outcome they associate with having fulfilled their wish. In the mental contrasting condition, they then identified and elaborated the most important obstacle in themselves that stands in the way of fulfilling their wish: in the indulging condition, children elaborated the second-best outcome. See the Supplemental Material for the verbatim instructions.

Error search task: instructions Children were informed they will read a text several pages long. Within the text there will

Table 3 Study 2: means, standard deviations, and correlations among the measures

Scale	N	M	SD	1	2	3	4	5	6
Interpersonal wish									
1. Expectations (1–5 scale)	248	3.59	1.09	–					
2. Incentive (1–5 scale)	248	4.38	0.78	.11	**–**				
Error-search task									
3. Task Expectations (1–5 scale)	248	2.96	0.83	.07	**.13**	**–**			
4. Effort (lines worked on)	248	46.22	17.96	.05	**.23**	.09	**–**		
5. Correct errors found	248	45.24	22.32	.02	**.27**	**.19**	**.76**	–	
Language skills									
6. Grade (reverse coded; 1–6 scale)	179	4.68	0.82	.09	**.19**	**.25**	**.16**	**.33**	–
7. Self-reported skills (1–5 scale)	248	3.43	0.92	**.15**	**.14**	**.32**	.08	**.23**	**.51**

Correlation coefficients printed in bold typeface are significant at $p < .05$

be typos. Their task is to find and underline the errors, but they should not correct the errors. They will have 5 min to work on the task. The experimenter will let them know when time is over.

Error-search task: induction of low expectations The experimenter stressed that in previous sessions only very few children found all errors in the given time. As a manipulation check, we measured children's expectations of performing well by three items (e.g., "How sure are you that you will find all errors?"). We used 5-point scales (1 = *not at all*, 5 = *very*). We combined the three items ($\alpha = .84$) into one index.

Error-search task Children read a story about a cook preparing a dish. The story was from a book for elementary and middle-school children. The story contained 125 relatively easy typos (misspelled words: lanch rather than lunch). All children started at the same time. They highlighted as many typos as they could until the time was up and placed a mark in the text where they had to stop. As an indicator of how much effort children put in the task, we used the length of text (in lines) that they had worked on as indicated by the location of the mark. As an indicator of performance, we used the number of errors highlighted correctly. We calculated the number of correctly detected errors by subtracting the incorrectly highlighted errors from the total highlighted errors. The correctly detected errors correlated with the total errors in Experiments 1 and 2, $r\text{s} > .87$, $p\text{s} < .001$.

Language skills To control for German language skills, we asked children to report their current grade in the subject German language. We also asked them to self-assess their skills: "How good are you in the subject German language". We used a 5-point scale (1 = *not good*, 5 = *very good*). Because grades and language skills correlated positively (Table 3), we z-transformed and combined them into one index. We also asked children which is the language they speak best. They were fully debriefed.[3]

Results

Descriptives

Table 3 depicts means, standard deviations, and correlations among the measures.

Interpersonal wish: high expectations

Expectations of fulfilling the interpersonal wish and incentive were relatively high, that is above the midpoint of the 5-point scale (Table 3). Expectations and incentive did not differ between conditions, $t\text{s} < 0.81$, $p\text{s} > .42$.

Error-search task: low expectations

Expectations for performing well on the error-search task were around the mid-point of the 5-point task: $M = 2.96$, $SD = 0.83$. Given that children are often overly optimistic (naïve optimism) about their school performance (Oettingen et al., 1994), the induction of low expectations appeared credible. Expectations did not differ between conditions, $t(246) = 0.92$, $p = .92$.

Error-search task: effort

Preliminary analyses indicated that mentally contrasting children tended to work on more lines ($M = 48.12$, $SD = 18.76$) than indulging children ($M = 44.19$, $SD = 16.91$), $t(246) = 1.73$, $p = .085$. Because our data was nested, that is children (Level

[3] Because mood influences energization (Gendolla & Krüsken, 2002), we assessed mood using self-assessment manikins for mood (Bradley & Lang, 1994). When we repeated the Linear Mixed Models entering mood as covariate the effect of condition on number of lines remained robust, $p = .04$.

1) were nested within classes (Level 2), and classes within schools (Level 3), we performed multilevel analyses (Raudenbusch & Bryk, 2002) on the number of lines. We first tested unconditional models to test whether sufficient variance exists on each level. The model showed 81.2% of the variance occurred between children, 1.8% between classes, and 16.9% between schools. Given that only little variance occurred at the class level, we tested a two-level linear mixed model with children on Level 1 and school on Level 2. We entered school as a random effect on Level 2 and condition as predictor (Heck et al., 2013). To control for children's aptitude in German, we entered our language skills index as covariate. We group centered language skills as recommended by Kreft and Leeuw (1998). Language skills predicted number of lines, $F(1, 244.26) = 2.08$, $p = .039$, 95% CI [0.13, 4.71], indicating children with better language skills worked on more text. Condition also predicted number of lines, $F(1, 241.68) = 2.08$, $p = .038$, 95% CI [-8.67, -0.24], $d = 0.26$, indicating that as hypothesized mentally contrasting (vs. indulging) children worked on more lines and this effect was robust over and above differences in language skills.

Error-search task: performance

We performed analogous analyses as above. Mental contrasting children tended to detect more errors ($M = 47.86$, $SD = 22.40$) than indulging children ($M = 42.44$, $SD = 21.98$), $t(246) = 1.92$, $p = .056$. Multilevel analyses testing unconditional models showed 57.9% of the variance occurred between children, 2.3% between classes, and 39.7% between schools. Because only little variance occurred between classes, we tested a two-level linear mixed model with children on Level 1 and school on Level 2 controlling for language skills. Language skills (group-centered) predicted number of correctly detected errors, $F(1, 235.01) = 6.35$, $p < .001$, 95% CI [5.02, 9.54]. Condition also predicted number of correctly detected errors, $F(1, 235.04) = 2.62$, $p = .009$, 95% CI [-9.56, -1.35], $d = 0.33$, indicating that mentally contrasting (vs. indulging) children correctly detected more errors and this effect was robust over and above language skills.

Discussion

Schoolchildren who mentally contrasted (vs. indulged) about an important interpersonal wish for which they had high success expectations invested more effort and performed better on a subsequent error-search task for which they had low expectations.

Experiment 3 aimed to replicate Experiment 2 online with adults. Further, rather than inducing only low expectations for the error-search task, we employed a full design by manipulating low vs. high expectations.

Experiment 3: effort online

Method

Participants and design

We recruited 400 U.S. Americans (299 women, 85 men, 7 diverse, 9 unidentified, $M_{age} = 32.9$, $SD = 12.5$) via Prolific. The study was advertised as a study on personal wishes involving two separate tasks. Because we used the same dependent variables as in Experiment 2, we performed power analyses with the average observed effect size from Experiment 2 ($d = 0.30$). The analyses yielded we would need a minimum of 382 participants to detect such an effect with 90% power. We prescreened participants to include only people who spoke English as first language. We paid participants $1.66.

We excluded 20 participants. Nine because they skipped text in the error-search task, and 11 because they failed the test to check whether they read the instructions. Our final sample consisted of 380 participants. We used a 2 (strategy: mental contrasting vs. indulging) by 2 (expectations for error-search task: low vs. high) design.

Procedure

Interpersonal wish with high expectations

Analogous to Experiment 2, participants named an important interpersonal wish for which they have high success expectations. We used the instructions by Wittleder et al. (2020). Participants also indicated their expectations and incentive using the same items as in Experiment 2. This time, we used 7-point scales (1 = *not at all*, 7 = *very*).

Strategy manipulation: mental contrasting vs. indulging

We used the same instructions as in Experiment 1 tailored to fulfilling the interpersonal wish.

Error-search task: manipulation of low vs. high expectations

Participants were informed that on the following pages, they will read a text multiple lines long. Their task is to write in a field next to each line how many typos the line contained. To complete the task successfully, they should find at least three-quarters of all typos. They will have 3 min to work on the task.

In the low-expectations condition, participants read only 10% of participants have been able to complete the

Table 4 Study 3: means, standard deviations, and correlations among the measures

Scale	N	M	SD	1	2	3	4	5	6
Interpersonal wish									
1. Expectations (1–7 scale)	380	5.54	1.17	–					
2. Incentive (1–7 scale)	380	6.54	0.75	**.27**	**–**				
Error-search task									
3. Task Expectations (1–7 scale)	380	4.61	1.86	.09	− .05	**–**			
4. Task Incentive (1–7 scale)	380	5.37	1.51	.02	.09	**.35**			
5. Effort (lines worked on)	380	14.97	4.78	− .07	− .07	**.20**	.01		
6. Correct errors found	380	22.23	9.77	− .01	− .08	**.28**	.04	**.64**	
Language skills									
7. Self-reported skills (1–7 scale)	379	6.80	0.50	.08	.09	.09	.03	.05	**.12**

Correlation coefficients printed in bold typeface are significant at $p < .05$

task successfully (find three-quarters of all errors). In the high-expectations condition, they read 80% of participants have been able to complete the task successfully. We had pilot tested these instructions to ensure they would yield low expectations and high expectations, respectively. To ensure participants read the instructions, on the next page, we asked them to indicate what percentage of other participants have been able to complete the task. We excluded 11 participants who reported a percentage that was not consistent with their condition. In the low-expectancy condition, we excluded those who reported that *over* 50% of participants have been able to complete the task and in the high-expectancy condition we excluded those who reported that *under* 50% of participants have been able to complete the task. The results remained the same regardless of whether we excluded those participants.[4]

Manipulation check

Participants indicated their success expectations ("How likely do you think it is that you will be successful on this task [find three-quarters of the errors]?"). They also reported their incentive (How important is it to you that you will be successful on this task [find three-quarters of the errors)?"). We used 7-point scales (1 = *not at all*, 7 = *very*).

Error-search task

We used an analogous version from Experiment 2, adapted to adults. Participants read the beginning of the novel "Moby Dick". The story contained 235 relatively easy typos. Participants had 3 min to work on the task. A timer indicated the remaining time. Until the time was up, participants wrote in a field next to each line how many errors they thought the line contained. There were too many lines (83 in total) to complete the entire task. Like in Experiment 2, as an indicator of effort we used the lines of text participants had worked on. As an indicator of performance, we summed up the numbers that equaled the correct number of errors hidden in each line.

Language skills

Participants self-assessed their English skills ("How would you rate your English proficiency?"; 7-point scale, 1 = *very low*, 7 = *very high"*). Participants were fully debriefed.

Results

Descriptives

Table 4 depicts means, standard deviations, and correlations among the measures.

Interpersonal wish: high expectations

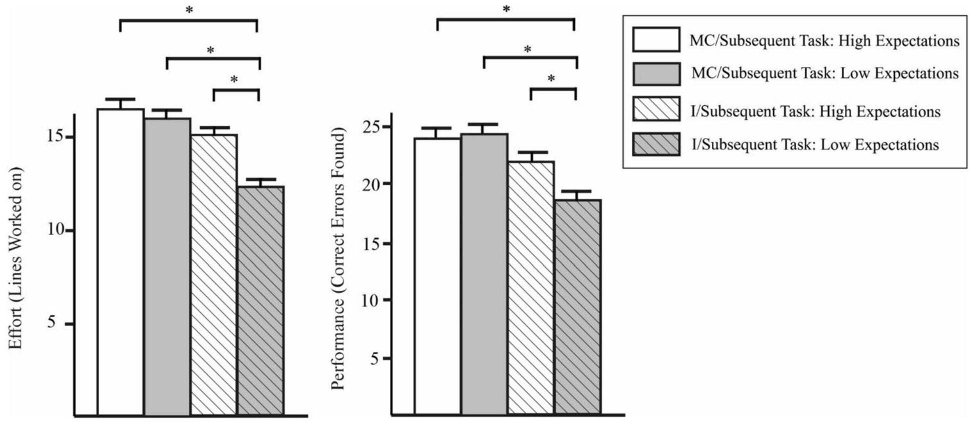
Expectations and incentive were relatively high, that is above the midpoint of the 7-point scale (Table 4). Expectations and incentive did not differ between conditions, Fs < 2.05, ps > .106.

Error-search task: manipulation check for low vs. high expectations

Participants in the low-expectations conditions (mental-contrasting–low-expectations and indulging–low-expectations combined) reported lower expectations for the error-search task ($M = 3.02$, $SD = 1.22$), than those in the high-expectations conditions (mental-contrasting–high-expectations and indulging–high-expectations combined; $M = 5.95$, $SD = 1.08$), $t(378) = 24.84$, $p < .001$, 95% CI [− 3.16, − 2.70], indicating that our manipulation was

[4] The strategy by expectation interaction effects remained significant for effort and performance, ps < .043.

Fig. 1 Study 3: means for effort (left) and performance (right) in the four conditions. *Note* error bars show standard errors. * $p < .05$



successful. Expectations did not differ between the mental contrasting and the indulging conditions, $t(398) = 0.64$, $p = .52$.

Error-search task: effort

We conducted a 2 (strategy: mental contrasting vs. indulging) by 2 (expectations: low vs. high) ANOVA on the number of lines. There were no main effects of strategy or expectations, $F\text{s} < 4.06$, $p\text{s} > .29$. However, we observed a strategy by expectations interaction effect, $F(1, 376) = 6.28$, $p = .013$, $d = 0.26$, indicating mental contrasting vs. indulging differentially affected effort for the low-expectancy vs. high-expectancy task. As in Experiment 2, to control for language skills, we repeated the analyses adding language skills as covariate. The observed interaction effect remained significant, $p = .011$. To illuminate the nature of the interaction, we conducted planned contrasts (Fig. 1).

First, as in Experiment 2, the mental-contrasting–low-expectations condition worked on more lines ($M = 15.97$, $SD = 5.39$) than the indulging–low-expectations condition ($M = 12.43$, $SD = 3.76$), $t(135.74) = 4.93$, $p < .001$, 95% CI [2.17, 4.93], $d = .78$, suggesting that mental contrasting instigated effort for the low-expectancy task.

Second, the mental-contrasting–low-expectations condition did not differ from neither the mental-contrasting–high-expectations condition ($M = 16.35$, $SD = 5.29$) nor the indulging–high-expectations condition ($M = 15.15$, $SD = 3.65$), $t\text{s} < 1.24$, $p\text{s} > .21$, suggesting that there is no evidence that the amount of effort mental contrasting participants invested in the low-expectancy task was different from that in the high-expectancy task.

Third, the indulging–low-expectations condition worked on fewer lines than the mental-contrasting–high-expectations condition, $t(180{,}67) = 5.93$, $p < .001$, 95% CI [−5.23, −2.62], $d = 0.85$, and the indulging–high-expectations condition $t(198) = 5.20$, $p < .001$, 95% CI [−3.76, −1.69], $d = 0.74$. This pattern suggests that unlike after mental contrasting, after indulging the effort participants invested in the low-expectancy task is lower than that they invested in the high-expectancy tasks.

Fourth, participants in the mental-contrasting–high-expectations condition tended to work on more lines than those in the indulging–high-expectations condition, $t(176{,}66) = 1.88$, $p = .059$, 95% CI [−0.05, 2.44] $d = 0.26$. We will return to this finding in the Discussion.

Error-search task: performance

We conducted analogous analyses as above. The pattern generally mirrored the pattern above. A 2 by 2 ANOVA on the number of correct typos revealed no main effects of strategy or expectations, $F\text{s} < 1.55$, $p\text{s} > .43$. There was a strategy by expectation interaction effect, $F(1, 376) = 5.74$, $p = .017$, $d = 0.25$, which remained significant when we added language skills as covariate, $p = .011$ (Fig. 1).

Planned contrasts revealed that, first, the mental-contrasting–low-expectations condition found more correct errors ($M = 24.06$, $SD = 11.16$) than the indulging–low-expectations condition ($M = 18.74$, $SD = 8.90$), $t(171) = 3.49$, $p < .001$, 95% CI [2.31, 8.33], $d = 0.53$. Second, the mental-contrasting–low-expectations condition did not differ from neither the mental-contrasting–high-expectations condition ($M = 23.41$, $SD = 10.15$) nor the indulging–high-expectations condition ($M = 22.83$, $SD = 8.27$), $t\text{s} < 0.87$, $p\text{s} > .38$. Third, the indulging–low-expectations condition found fewer correct errors than the mental-contrasting–high-expectations condition, $t(193) = 3.40$, $p < .001$, 95% CI [−7.37, −1.96], $d = 0.49$, and the indulging–high-expectations condition $t(198) = 3.37$, $p < .001$, 95% CI [−6.48, −1.69], $d = 0.48$. Finally, unlike the pattern for effort, there was no difference between the mental-contrasting–high-expectations condition and the indulging–high-expectations condition, $t(205)=0.45$, $p=.65$.

Discussion

Participants who mentally contrasted an important interpersonal wish for which they had high expectations invested more effort and showed better performance in a subsequent low-expectancy error-search task than those who indulged. Moreover, the effort and performance of the mental contrasting participants for the low-expectancy task did not differ from that of the mental contrasting and indulging participants for the respective high-expectancy task.

As for the comparison between the two conditions who had high-expectations for the error-search task (mental contrasting vs. indulging) an inconsistent pattern emerged: The mental contrasting participants tended to invest more effort, but their performance did not differ from indulging participants. Because the difference in invested effort between mental contrasting and indulging participants was only marginally significant and there was no corresponding performance difference, we do not interpret this finding.

General discussion

We examined whether mentally contrasting a wish for which people have high expectations fuels energization, effort, and performance in a subsequent task unrelated to the initial wish for which people have low expectations. Participants who mentally contrasted (vs. indulged) successfully solving a creativity test displayed increased physiological energization, and better performance in a low-expectancy cognitive task (Experiment 1). Schoolchildren who mentally contrasted fulfilling a high-expectancy interpersonal wish invested more effort and performed better in an academic task of low expectancy (Experiment 2). Experiment 3 replicated Experiment 2 with adults online: mentally contrasting high-expectancy interpersonal wishes fostered effort and performance in a low-expectancy academic task, and the elicited effort and performance was no different from that in a respective high-expectancy task.

The pattern emerged in the lab, field, and online. It emerged in university students, schoolchildren, and the general population. It also emerged in different cultures, Germany and the U.S. We found the effects when participants applied mental contrasting in the creativity domain and interpersonal domain, when measuring physiological energization and behavioral effort and when measuring performance in a visual–spatial cognitive test and a proofreading task.

Theoretical implications

There exist at least three conceptualizations of energization in the literature (Massin, 2017): (a) energization as a resource necessary for a specific goal pursuit, (b) energization as general activation (or arousal), and (c) energization resulting from a multitude of drives. These three conceptions share that they all conceive of energization as a motor for behavior. They differ in the following ways: energization (or effort) for goal pursuit is a resource necessary to perform a task and is tied one-to-one to the demands of the task (Wright, 1996). Energization as general activation or arousal may stem from various sources (exercising, drinking coffee, among others; Revelle et al., 1976; Thayer, 1967) and may fuel a wide range of behaviors. Energization as held by drive theories originates from deprived needs (Hull, 1952). Such needs also stem from a variety of sources (hunger, thirst, loneliness) and fuel a wide range of behaviors (looking for food, water, friends).

Our research integrates these three conceptualizations by stating that mental contrasting a high-expectancy wish elicits high energization as a resource necessary to pursue that wish. However, because participants have no opportunity to pursue the wish but are presented with an unrelated task instead, the elicited energization should act like a general activation state or an "irrelevant drive" (Hull, 1952) that may fuel any behavior. It therefore should predict performance in the unrelated task. In this view, energization by mental contrasting should work much like a universal energizer such as caffein or stimulating drugs, which have been found to increase performance (Revelle et al., 1976). Unlike these energizers, however, energization by mental contrasting does not require consuming substances and can be applied flexibly and easily whenever needed.

Applied implications

Our finding that mentally contrasting a high-expectancy interpersonal wish helped schoolchildren spend more effort and perform better in a low-expectancy academic task has implications for education. Helping children with low success expectations mobilize effort is a long-standing challenge. Children with low expectations give up earlier (Schunk & Di Benedetto, 2018), have higher fear of failure (Pintrich & De Groot, 1990), need more support (Hidi & Harackiewicz, 2000), and risk losing interest in academic achievement (Oettingen et al., 1994). Research may test whether mental contrasting of high-expectancy wishes in one domain would energize children not only perform better but also approach low-expectancy tasks. Approaching and better performing in low-expectancy tasks may lift their sense of achievement which may raise their success expectations for future tasks.

Motivational intensity theory

Our finding that mental contrasting triggers energization for unrelated tasks relates to motivational intensity theory (MIT; Brehm & Self, 1989). The theory posits that energy or effort mobilization is governed by a resource conservation principle: The amount of resources mobilized for a task is determined by the subjective task demand as long as people perceive completing the task possible (success expectations) and justified (incentive; Richter et al., 2016). As for the relationship between energization transfer by mental contrasting and MIT, even though participants may have low success expectations for the unrelated task, as long as they consider the task to be possible, energization transfer may augment the overall energy with which participants start working on the task.

Field theory

According to Lewin's field theory (1946), if a specific need is not satisfied (a specific wish is not fulfilled), a force (energy) leading to satisfying the need (fulfilling the wish) emerges. In our studies, however, we prohibited participants from satisfying their need (fulfilling their wish). Therefore, the energy tuned toward fulfilling the specific need remained unchanneled. We subsequently presented participants with a task unrelated to their initial wish, hypothesizing that the unchanneled energy can now flow into solving the unrelated task.

Limitations and future directions

Several limitations provide directions for future work. First, in Experiment 1, we measured energization *directly before* the subsequent unrelated task by physiological measures, in Experiments 2 and 3, we measured effort *during* the unrelated task by the number of lines worked on in the error-search task. Future studies should assess energization *directly before and during* the unrelated task to examine whether energization is sustained from before to during the task. Second, we induced mental contrasting. Future work should test whether energization transfer also occurs when mental contrasting is spontaneously applied (Sevincer et al., 2017, 2018, 2020). Third, research may examine whether energization transfer by mental contrasting may help people mobilize energy when they feel threatened by the upcoming unrelated task (when the demand exceeds their resources; Blascovich & Tomaka, 1996). Fourth, because energization effects decay relatively quickly (Wright et al., 1990), research should investigate for how long after mental contrasting energization transfer effects persist. Finally, future research may also investigate boundary conditions of energization transfer. In our studies, the energization from mental contrasting was channeled toward the unrelated task. That is, participants were confronted with the unrelated task after not being given the opportunity to pursue their initial task. Research should test whether energization transfer to low-expectancy tasks also occurs when participants have a choice whether to pursue their initial task or perform the unrelated task.

Conclusion

Going back to the example of the student who is new in town trying to make friends, contrasting one's images of desired future friendships with the obstacle of being reluctant to approach people may have energized our student, and in this way have helped them to do both—make new friends and prepare for their exam. This energization transfer effect might be used to help students mobilize energy during academic tasks, and in particular help those who need help the most: Students with low success expectations.

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