Chapter 2
Neurophysiological Correlates of the Self-Regulation of Goal Pursuit

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People often struggle with their goals and become very frustrated when they fail to reach them. Sometimes, the underlying problem is that people fail to frame their goals adequately. People may set themselves a prevention goal (i.e., focus is on negative outcomes) where a promotion goal (i.e., focus is on positive outcomes) would have been more suitable (Higgins 1997), or a performance goal (i.e., focus is on one's standing) where setting a learning goal (i.e., focus is on one's progress) would have been the right thing to do (Dweck and Elliott 1983). Most importantly, the chosen goal (e.g., achieving a certain weight loss) should specify an outcome that is perceived as highly desirable (i.e., the estimated attractiveness of the likely short- and long-term consequences of attaining the goal is high) but also feasible (i.e., the perceived probability of success is high; Gollwitzer 1990; Oettingen and Gollwitzer 2001).

Still, selecting and committing to desirable and feasible goals as well as framing these goals appropriately is only a first step to successful goal attainment, as there is always the issue of keeping up one's goal striving in the face of obstacles (Gollwitzer and Oettingen 2012). Here it helps when people anticipate the difficulties or problems they may run into when trying to meet their goals. The obstacles that can challenge successful goal attainment are manifold. They may relate to failing to get started (e.g., procrastination of goal striving), failing to stay on track

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(e.g., falling prey to distractive temptations), failing to call a halt to futile goal striving (e.g., escalation of commitment to a faulty means), and failing to prevent overextension (e.g., getting depleted too quickly). Thus, successful goal attainment not only requires that people choose wisely between possible goals (i.e., select goals that are both desirable and feasible and then frame them appropriately) but also cope effectively with challenges on the way to goal attainment.

The Self-Regulation of Goal Selection

A self-regulation strategy that has been shown to help people to best select and commit to new goals is mental contrasting of future and reality (Oettingen 1997, 2012). This strategy allows people to strongly commit to achieving desired and feasible future outcomes. It implies to first imagine the attainment of a desired future (e.g., do more exercise) and then to reflect on the personal obstacles of present reality that impede attaining the desired future. This juxtaposing of future and reality makes people realize that they have not reached their desired futures yet and therefore need to take action if they want to attain them. As a consequence, people start thinking on whether or not they have a good chance to overcome the personal obstacles that stand in the way. Only when people have high expectations of success will they then strongly commit to the goal to attain the desired, and thus goal realization is promoted; if expectations of success are low, however, people will desist. Thus, mental contrasting helps to discriminate between feasible and unfeasible attractive goals and committing to goals in an expectancy-dependent manner.

Mental contrasting has to be differentiated from another form of thinking about the future known as indulging (Oettingen 2000). Whereas in mental contrasting the present reality is juxtaposed to the desired future, when people engage in indulging they only envision the wished for future; they do not identify obstacles and a necessity of acting to actually achieve the desired future is not experienced. As a consequence, indulging fails to create strong goal commitments; goal commitments stay moderate no matter whether expectations of success are high or low. In contrast, mental contrasting produces selective, expectancy-dependent goal commitment, which in turn produces better goal attainment when expectancies of success are high rather than low (Oettingen 2012). Thus, only mental contrasting produces wise behavior change efforts on the side of the individual (high engagement for change in the face of high expectations of success, and reduced engagement for change when expectations of success are low).

Mental Contrasting Effects and Processes

The differences between mental contrasting and indulging have been analyzed focusing on various indicators of goal commitment. More specifically, research using self-report measures, assessing the behavioral intensity of moving towards

the goal as well as the rate of goal attainment, and taking physiological measures, all have shown that mental contrasting and indulging differ in their underlying cognitive and motivational components and processes. In a series of experiments testing underlying cognitive processes, Oettingen and colleagues showed that goal attainment by mental contrasting is produced by changes in both implicit cognition and energization (overview by Oettingen 2012). Recent research, for example, has revealed that mental contrasting strengthens the associative link between the desired future and reality, as well as between present reality and instrumental behavior; it also leads people to identify negative aspects of reality as obstacles to reaching the desired future. Moreover, mental contrasting effects on goal striving and attainment have also been found to be mediated by motivational processes: mental contrasting increases feelings of energization as well as physiological arousal in high-expectancy participants, whereas it lowers them in low-expectancy participants. Importantly, no such changes are observed in indulging participants.

Neural Correlates of Mental Contrasting

Across studies, mental contrasting and indulging have been found to be two distinct self-regulatory strategies with characteristic effects on goal commitment and attainment. To test whether the postulated differential underlying mechanisms are also reflected at neural basis, Achtziger et al. (2009) focused on the brain activity associated with the strategies of mental contrasting versus indulging. For this purpose, Achtziger et al. (2009) recorded continuous magnetoencephalographic data while participants engaged in either mental contrasting or indulging. Whereas mental contrasting is cognitively very demanding and involves a purpose that one intends to fulfill (i.e., it serves to resolve the issue of whether or not to commit to realizing a certain desired future outcome), indulging has an end in itself. Moreover, in contrast to indulging, mental contrasting requires juxtaposing the present negative reality to the desired future (i.e., working memory) as well as detecting relevant obstacles and answering the question of how one dealt with these obstacles in the past (i.e., episodic memory); all of this should benefit much from vividly imagining the future and relevant present and past events. Thus, a greater activity in brain regions associated with working memory and episodic memory processes, but also with strong intention formation, action preparation, and imagery were expected for mental contrasting as compared to indulging, as the latter only implies free daydreaming.

In the Achtziger et al. study, participants were pre-selected based on how well they did in both mental contrasting and indulging. In this pretest, they were asked to name their two most desired interpersonal future outcomes and their two most desired academic future outcomes. The experimenter then handed out detailed written instructions on how to engage in the two different modes of thought with respect to their desired interpersonal outcomes (i.e., mentally contrasting one and indulging in the other; see Oettingen 2000, Study 1; Oettingen et al. 2001).

Mental contrasting instructions requested participants to list two positive aspects they associated with having the targeted desired interpersonal outcomes and two aspects of present reality that stand in the way of reaching this desired outcome. Thereafter, participants were asked to elaborate these aspects in the following order. First, they were told to imagine events and scenarios related to one of the positive future aspects. Specifically, participants were instructed: "Think about this aspect and depict the respective events or experiences in your thoughts as intensively as possible! Let the mental images pass by in your thoughts and do not hesitate to give your thoughts and images free reign. Take as much time and space as you need to describe the scenario. If you need more space to write, please use the back of the page." Using the same instructions, participants were then asked to imagine events and scenarios related to one of the listed aspects of negative reality. Finally, participants were asked to turn to the other listed positive future aspect, and subsequently to the other listed negative reality aspect.

Indulging instructions were equally detailed. Participants first had to list four positive aspects they associated with having attained the targeted interpersonal outcomes. Participants were then requested to mentally elaborate all four positive future aspects using the instructions cited above. Thus, mental contrasting and indulging instructions differed only in terms of which aspects of the targeted desired interpersonal outcome needed to be elaborated. Each participant had to follow mental contrasting instructions for one, and indulging instructions for the other of the two named most desired interpersonal outcomes; order of instructions was counterbalanced.

For the next day, only those pretested participants were invited to take part in the MEG study who had been judged by independent raters as both effective mental contrasters and effective indulgers with respect to their interpersonal outcomes, and who in addition had indicated high expectations of success with respect to their two named desired academic outcomes. In the MEG study, participants' electromagnetic activity was recorded while they rested for 5 min before being asked to engage for 10 min in mental contrasting of one of the desired academic outcomes listed the day before, and for 10 min of indulging in the other. The order of strategy application was counterbalanced, and a break of 1.5 h duration was placed in between.

In order to assess brain activity, the collected continuous MEG data were analyzed in a rather novel way using the so-called multiple dipole density method (Fehr et al. 2003a, b). Results revealed differential magnetoencephalographic activity for the two strategies of intention formation, thus supporting the assumption that both strategies can be differentiated in terms of their underlying neural correlates. Importantly, the data suggested that mental contrasting is a problem-solving strategy, as higher brain activity was observed in the left prefrontal area as compared to resting and in the right frontal area as compared to resting and indulging. The same pattern of results was observed with regard to both the left and right temporal and the right parietal areas, as more dipoles per second were measured during mental contrasting as compared to resting and indulging. Finally, greater activity was found bilaterally in occipital areas during mental contrasting

compared to resting, as well as the right occipital site for mental contrasting as compared to resting and indulging (see Fig. 2.1). As activity in frontal/prefrontal, temporal, parietal, and occipital areas have been identified as involving working memory, episodic memory, intention formation, and mental imagery, respectively, these results support the assumption that mental contrasting, but not indulging, is a cognitively demanding, problem-solving strategy.

Goal Striving by Implementation Intentions

Holding strong goal commitment is an important determinant of successful goal attainment. However, striving toward one's goals may be hampered by all kinds of challenges on the way to the goal that need to be coped with effectively (Oettingen and Gollwitzer 2010). One powerful strategy that has been shown to help people take control over the implementation of their goals (i.e., effectively cope with common problems and difficulties of goal implementation) is planning

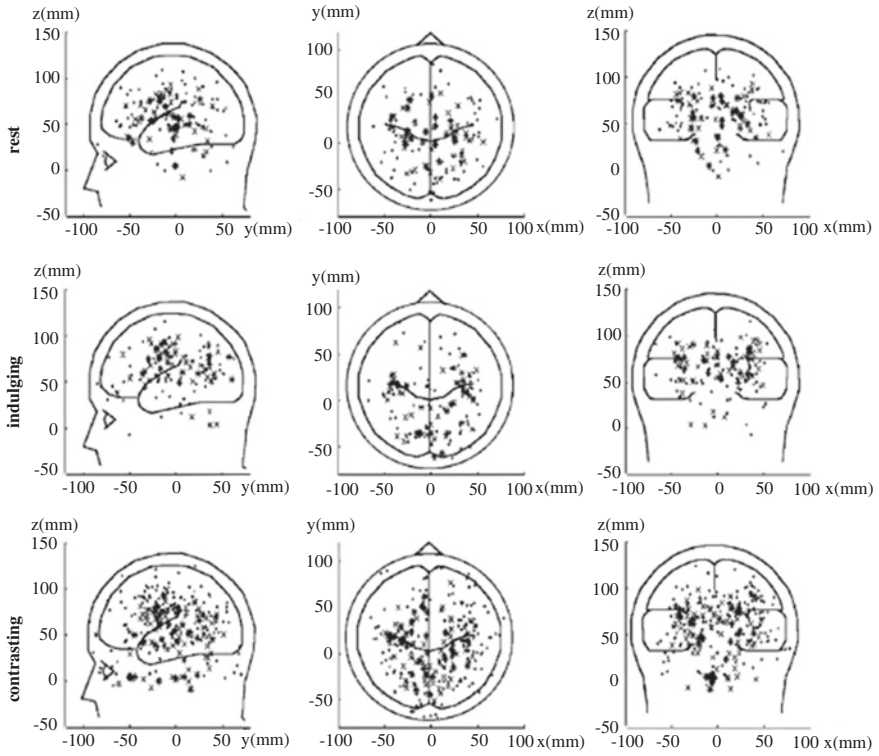

Fig. 2.1 Plotted multiple dipole density (MDD) over all participants for resting, indulging, and mental contrasting

out one's goal striving in advance via if-then plans or implementation intentions. Implementation intentions define when, where, and how one will act on one's goals (or goal intentions). Goal intentions have the structure of "I intend to reach Z!" as they merely specify a desired performance or outcome the individual feels committed to attain. Implementation intentions, on the contrary, have the structure of "If situation X is encountered, then I will perform the goal-directed response Y!", as they spell out how the goal intention will be realized once a goal-relevant situational cue is encountered. By forming implementation intentions, an anticipated critical situation is linked to a goal-directed response, and a commitment to respond to the specified critical situation in a planned, goal-directed manner is created. Whereas goal intentions only specify a desired future behavior or outcome the individual feels committed to attain, implementation intentions specify how this will have to be accomplished.

Goal intentions (e.g., "I want to reduce my alcohol consumption") have been found in a recent meta-analysis to account only for 28 % of the variance in behavior (which qualifies as a weak effect size; Sheeran 2002). A meta-analysis on the efficacy of implementation intentions (Gollwitzer 1993, 1999) has however revealed a medium to large effect size for implementation intentions with respect to the higher rate of goal attainment in comparison to acting on goal intentions alone (d =0.65; Gollwitzer and Sheeran 2006). Indeed, in domains where simple goal intentions are rather ineffective, implementation intentions are commonly observed to help people achieve their goals: eating a healthy diet (Adriaanse et al. 2011), reducing pregnancy risk (Martin et al. 2011), vaccinating (Milkman et al. 2011), regular taking of pills (Sheeran and Orbell 1999), or performing cervical smear tests (Sheeran and Orbell 2000).

Implementation Intention Effects and Processes

Forming implementation intentions facilitates goal attainment on the basis of psychological processes that relate to both the anticipated critical situation and the specified goal-directed response. More specifically, an increased mental accessibility of the situational cue (e.g., Parks-Stamm et al. 2007; Webb and Sheeran 2007) and the establishment of a strong cue-response link (Webb and Sheeran 2008) mediate implementation intention effects. This heightened mental activation (and thus accessibility) of the situational cue has been shown to allow for easy detection, effective recall, and a readiness to attend to the critical situation even if one is otherwise cognitively busy (e.g., Achtziger et al. 2012). Further, the strong cue-response links which are established when a person forms implementation intentions lead to an automatic initiation of the specified goal-directed response in the presence of the specified situational cue. Consequently, action initiation becomes immediate, efficient, and no longer needs a conscious intent (Bayer et al. 2009; Brandstätter et al. 2001; Gollwitzer and Brandstätter 1997).

Electrocortical Correlates of Implementation Intentions

Although the mechanisms underlying the effectiveness of implementation intentions have been studied for years using various cognitive task paradigms, little was known until recently about their underlying neural correlates. These correlates help to establish a deeper understanding of the temporal dynamics and attention mechanisms, as well as the spatial distribution of brain activity associated with action control by implementation intentions.

The electrocortical correlates underlying action control by implementation intentions have been tested so far with two populations who are known to have action control difficulties: children with attention deficit hyperactivity disorders (ADHD) and individuals with high spider fear. As children with attention deficit hyperactivity disorder are known to be impulsive, Paul et al. (2007) used a stop signal task to assess whether children with ADHD might profit from forming implementation intentions in order to achieve better executive control. Therefore, children diagnosed with ADHD and control children without ADHD received in a first session instructions on how to perform a classification task (i.e., classifying animals vs. vehicles by pressing respective buttons). Then, in the second session where the classification task was modified into a stop signal task, an implementation intention was established on how to deal with the stop signal that was presented for some of the classification trails ("If I see a stop sign, then I will not press any button"). In the second session of the classification task, animals and vehicles were presented and children were asked to respond to them as in the first session by pressing one of two buttons, respectively; however, they were asked to inhibit their responses when a stop signal appeared on the screen. Behavioral data supported the prediction of less inhibition errors to the stop signals in ADHD children after having formed an implementation intention, compared to children with ADHD who were only assigned the goal to refrain from showing a classification response when a stop signal was presented. Importantly, compared to the goal intention participants the implementation intention participants also showed an amplitude increase during the first half of the component known as P300 for the presented stop signals. Thus, children with ADHD in the goal intention condition showed the typically less pronounced amplitude increase in response to stop stimuli, whereas implementation intentions improved response inhibition and increased the P300 to the level of children without ADHD. As the P300 reflects the decision to withhold the execution of a motor response (Jackson et al. 1999), the finding that children with ADHD in the implementation intention condition improved their performance to the level of children without ADHD suggests that forming implementation intentions disencumber executive functions and thus facilitate action control.

Another study by Schweiger Gallo et al. (2009, Study 3) targeted a different population: people with high spider fear. Though participants with spider fear have been previously shown to be able to down-regulate their fear when they formed implementation intentions to keep calm and relaxed (Schweiger Gallo and

Gollwitzer 2007), it remained unclear what was responsible for these effects. In order to gain insights into the neurocortical correlates underlying the effectiveness of implementation intentions in emotion regulation, Schweiger Gallo et al. (2009) complemented self-report data with electrophysiological recordings in a study where the selected implementation intention focused on ignoring the spiders. Participants were assigned to a control (watch only) condition, a goal intention condition ("I will not get frightened!") or goal intention plus implementation intention condition ("And if I see a spider, then I will ignore it!"). All participants were then presented pleasant (for example, appetizing food) and neutral (for example, household objects) pictures, as well as spider pictures. In line with other studies on emotion regulation by implementation intentions (e.g., Schweiger Gallo et al. 2009, Studies 1 and 2), self-report data revealed that participants with an ignore-implementation intention were able to down-regulate their fear when looking at spiders. Importantly, no such differences were found for the experience of the pleasant and neutral pictures (i.e., implementation intention effects were only found for the specific fear-eliciting stimuli, which were discriminated from the pleasant and neutral stimuli). Electrophysiological recordings corroborated these results, as a differential activity in response to the spider slides was found in terms of a smaller P1 at right parietal and right occipital sites in implementation intention participants only. In contrast, both control and goal intention condition participants showed the typical positivity of the P1 after processing the unpleasant pictures. As the P1 is known to discriminate between affective stimulus content and larger P1 amplitudes are observed with unpleasant than pleasant or neutral pictures (see review by Olofsson et al. 2008), this finding suggests that implementation intentions produce their effects through cortical control that appears very early (i.e., at around 120 ms) in stimulus processing. Thus, ignore-implementation intentions do not appear to down-regulate an already experienced negative emotion, but rather block the emergence of negative emotions at their onset. In a later time segment, the slow wave at 550–750 ms, both self-regulatory conditions (i.e., goal intention and implementation intention participants) differed at right frontal sensors from the control condition. As the frontal slow wave has been related to prospective remembering (e.g., West et al. 2000), and as goal intentions and implementation intentions have been shown to rely on prospective memory processes (Gollwitzer and Cohen 2008), the results by Schweiger Gallo et al. (2009) imply that during this time window of 550–750 ms instructions are kept in mind and realized.

Neural Correlates of Implementation Intentions

Prospective memory focuses on the memory aspect of carrying out intentions: it is the ability to encode an intention and then successfully remember to execute it at the appropriate future moment (Einstein and McDaniel 1990). Einstein et al. (2005) have suggested that in some situations, prospective remembering can occur relatively

automatically, as a result of direct triggering by environmental stimuli. In other situations, prospective remembering may depend more heavily on deliberate monitoring of one's environment for target events (Smith, 2003). Einstein et al. (2005) suggested that the extent to which these different types of processes are engaged can depend on whether a good link was formed between an anticipated cue and the intended action. Parallel to this distinction, implementation intentions are thought to facilitate goal attainment because they specify a mandatory action when a particular cue is encountered. In contrast, a goal intention is more reliant on self-initiated behavior.

In recent years, neuroimaging studies have adopted prospective memory paradigms in order to specifically assess the spatial distribution of brain activity underlying the formation of implementation intentions. Previous cognitive neuroscience studies have highlighted the rostral prefrontal cortex (PFC), approximating Brodmann area 10 (BA 10), as an important region in prospective memory (Burgess et al. 2008). Neuroimaging studies typically show that performance of prospective memory tasks, compared with performance of ongoing tasks alone, elicit increased activity in lateral BA 10 and decreased activity in medial BA 10. Burgess and colleagues have accounted for these results by suggesting that lateral BA 10 plays a role in attending to internally represented information such as intentions for future action; hence the signal in this region is increased during prospective memory performance. In contrast, medial BA 10 is thought to play a role in attention toward perceptual information in tasks that can be performed on the basis of well-learned stimulus–response links (Burgess et al. 2007).

Experimental studies in cognitive neuroscience and psychology often fail to describe in precise detail the manner in which participants were instructed about the demands of a task. Subtle differences in the wording of task instructions can have significant consequences for task performance, however. In a study conducted by Gilbert et al. (2009), the authors used a modified prospective memory paradigm to examine the effects of task instructions on behavioral performance as well as the underlying brain activity. Participants were assigned to one of two conditions with different sets of instructions in each. In the goal intention condition participants acted on the following instructions: "In this part of the experiment, you must try to score as many points as possible." They were told that they would score 1 point for every ongoing trial (i.e., two letters were presented, one capitalized, and the participants had to indicate on which side the capitalized letter appeared) and 5 points if they pressed a prospective memory response key (the middle button on the keypad) when a prospective memory target was presented (i.e., the two presented letters were of the same kind, e.g., one was an "F" and the other an "f"). They were then asked to silently read an instruction phrase that extended the goal intention of making as many points as possible by using an if-then phrase that simply reminded of the reward contingencies relevant to the goal of making as many points as possible (e.g., in the letters task, "IF the same letter is on both sides, THEN I can score 5 points!"). In the implementation intention condition, however, participants were told to furnish the goal intention of making as many points as possible with an implementation intention that if a prospective memory target was presented, they will press the prospective memory

response key. The instruction phrase used in this condition was "IF the same letter is on both sides, THEN I will press the middle button!" The goal and implementation intention conditions were thus identical except that they differed in terms of what they focused on. In the goal intention condition, a link was made between the prospective memory cue and the rewards linked to successful responding, whereas in the IMP condition, a link was made between the prospective memory cue and the to be executed goal-directed response, as in previous investigations of implementation intentions (Gollwitzer and Sheeran 2006).

Participants were then presented with the same stimuli in both conditions, and the same responses were appropriate to both conditions. The reward structure in the goal intention condition made it clear that participants should respond to prospective memory targets, without stating it explicitly as in the implementation intention condition. Thus, participants in the goal intention condition had to establish a more self-initiated strategy for responding to the prospective memory targets relative to the implementation intention condition. The objective was to examine whether behavioral performance and underlying brain activity is affected if participants are presented with the option to act, compared to an instruction to act when cued. Although the conditions differed only in the wording of instructions, the two conditions were associated with differential patterns of activity in rostral PFC (BA 10). That is, responding to prospective memory targets in the goal intention condition was associated with greater bilateral activity in the lateral BA 10, whereas responding to prospective memory targets in the implementation intention condition was associated with greater bilateral activity in the medial BA 10. The difference in target-related activity between these two conditions in lateral BA 10 mirrored the behavioral difference between the conditions, with greater activity associated with poorer performance. The authors suggested that these results reflect differing demands for self-initiated versus externally cued behavior following different types of instruction, in line with the distinction between goal intentions and implementation intentions proposed by Gollwitzer (1999; recent review of implementation intentions research by Gollwitzer and Oettingen 2011).

In a recent study, Gilbert et al. (2012) showed that successful prospective memory performance was associated with greater similarity between patterns of activity at encoding and retrieval. That is, pattern similarity between encoding and retrieval was greater for prospective memory hits than baseline but not significantly different between prospective memory misses and baseline. These results are consistent with the possibility that similar brain activity between encoding and retrieval may be responsible for boosting recall of delayed intentions. Gilbert et al. (2012) suggest that forming an implementation intention involves thinking about a specific future cue that facilitates retrieval of an intention (e.g., "When I sit down in the restaurant tonight, then I will order a salad!"). By contrast, goal intentions are formed in the absence of such specific cues (e.g., "I intend to eat more healthily"). Given that imagining a particular situation can produce similar brain activity to actually being in that situation (e.g., Stokes et al. 2009), Gilbert et al. (2012) suggest that thinking about a specific cue when forming an intention tends to increase the similarity

between brain activity at encoding and retrieval and this could underlie at least part of the benefits of implementation intentions over goal intentions.

Future Prospects

Intention Formation in the Health Domain

In recent years, the strategies of mental contrasting (MC) and implementation intentions (II) have been combined in interventions (MCII) in order to improve people's daily lives by helping them in achieving their desired behavior change goals (Oettingen 2012; Oettingen and Gollwitzer 2010). Such desired behavior changes in the health domain include heightening one's physical activity, eating a healthy diet, or reducing the intake of unhealthy snacks—behaviors that have been shown to be difficult to change. By combining both strategies, the benefits of mental contrasting (fostering of strong goal commitments and energization) and implementation intentions (instigation of automatic action control) are united via a single self-regulation strategy.

In this vein, MCII has been shown to produce lasting behavior change effects. The temporal stability of MCII effects has been demonstrated in two studies by Stadler et al. (2009, 2010). In a first study, Stadler et al. (2009) analyzed the effects of two groups (a health information intervention only group and an information plus MCII intervention group) on the physical activity of a group of middle-aged women. Whereas women in the information-only control condition learned about the benefits of regular exercise, those in the MCII group received the same information and learned the mental contrasting with implementation intentions technique. Results across 4 months showed that the information plus MCII group was twice as physically active as the information-only group.

Integrating mental contrasting and implementation intentions, Stadler et al. (2010) also tested the effects of two interventions (i.e., information only vs. information plus MCII) on eating a healthy diet in women. Compared to the baseline, both groups ate more fruits and vegetables in the first month. However, two years later only information and self-regulation group participants ate healthier than participants in the information only group, who returned to their baseline level. The effects of a combined intervention have also been replicated for unhealthy snacking habits (Adriaanse et al. 2010): as in the previous studies, participants in the combined intervention group reported a greater reduction of their unhealthy snacking habit than control participants. Importantly, MCII also produced a greater reduction than both mental contrasting and implementation intentions alone.

MCII has also shown to be a powerful time- and cost-effective self-regulatory tool in a study involving chronic back pain patients (Christiansen et al. 2010). Results showed that the MCII intervention group increased physical strength and mobility at 10 days and 3 months after the intervention, as assessed by subjective and objective measures. Importantly, the intervention consisted only of two sessions for a total of 1 h; this certainly qualifies the MCII intervention as very time- and cost-effective.

Future Research on the Neurophysiological Correlates of the Self-Regulation of Goal Pursuit

Although the first steps have been taken so as to better understand the neurophysiological correlates of forming implementation intentions and engaging in mental contrasting as well as their consequences on action control, further studies are needed to arrive at a better understanding of these strategies. This includes, for example, complementing the existing studies on mental contrasting with electrophysiological and imaging data. Foremost, however, future research might especially benefit from analyzing the neurophysiological correlates underlying MCII effects. Despite being a powerful intervention tool that produces long-lasting changes, no studies have focused so far on the temporal and spatial brain correlates underlying the effectiveness of this self-regulatory tool. Thus, assessing which brain activity is associated with going through the mental exercise of MCII, as well as the brain activity implicated in acting on the basis of MCIIs, is intriguing, as is the question of whether people who adopt MCII as a general metacognitive strategy show different neurophysiological patterns when selecting and acting on goals as compared to people who do not habitually select and implement their goals on the basis of MCII reasoning. In all, we expect in the years to come a growing interest into the neurophysiological foundations of various self-regulatory strategies, including mental contrasting, implementation intentions, and MCII.

Highlights

- Successful goal striving requires that people choose adequate goals and cope effectively with challenges on the way to goal attainment. This can be facilitated by using the self-regulation strategies referred to as mental contrasting and forming implementation intentions.
- Continuous magnetoencephalography (MEG) data corroborate that mental contrasting is a purposeful problem-solving strategy that differs from merely indulging in a desired positive future.
- Electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) data support the assumption that by forming implementation intentions people switch from top-down control of their actions via goals to bottom-up control via specified situational stimuli, and thus confirm the postulate that action control by implementation intentions is based on strategic automaticity.
- The mental contrasting and forming implementation intentions have recently been integrated into one single, cost- and time-effective behavior change intervention called MCII that enhances healthy and prevents unhealthy behaviors.
- Self-regulation strategies of successful goal pursuit qualify as an important determinant of public health when they are used to reach one's health goals.

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