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Helplessness Experience and Intentional (Un-)Binding: Control Deprivation Disrupts the Implicit Sense of Agency

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Prolonged deprivation of personal control induces cognitive, motivational, and affective impairments that can lead to learned helplessness syndrome. Research on cognitive mechanisms involved in responding to uncontrollable events reveals a critical role of lack of contingency between one's action and outcomes. However, the impact of experienced uncontrollability on individuals' sense of self-agency has not been explored yet. This research examined how prolonged control deprivation affects implicit sense of agency. We exposed participants to action–outcome noncontingency of varying lengths and measured implicit sense of self-agency manifested in intentional binding. In 2 studies (N = 133 and N = 354, respectively), we found that control deprivation decreased the intentional binding effect, and that the relationship appeared to be monotonic: the longer the control deprivation, the smaller the intentional binding effect. Moreover, in the condition of prolonged control deprivation, no intentional binding was observed at all: Participants evaluated the time elapsing between the action and the effect as if both occurred separately. Our finding suggests that long-term exposure to uncontrollability has detrimental effects on the ability to detect consequences of one's actions, the basis of implicit self-agency. The implications of our results for the theory of control deprivation and sense of agency are thoroughly discussed.

Keywords: learned helplessness, control deprivation, sense of agency, intentional binding

Goal-directed behavior is mediated by contingency learning: by computing contingency between one's actions and outcomes, humans are able to exert a controlling influence on their environment (Balleine & Dickinson, 1998). Therefore, lack of contingency between behavior and outcomes poses a critical challenge to goal-directed behavior and threatens one's agency. More than 40 years ago, Martin Seligman and his colleagues (see, e.g., Maier & Seligman, 1976; Seligman, 1975) proposed that enduring loss of control—understood as a lack of action–outcome contingency—results in learned helplessness (LH) syndrome, including impaired detection of new action–outcome contingencies (*cognitive deficit*), slow-down of activity (*motivational deficit*), and a generalized increase of negative emotions (*affective deficit*). Seligman hypothesized that this syndrome is due to a generalized expectation of control absence learned during contact with uncontrollable events. In other words, he assumed that the core aspect of LH syndrome is loss of human agency, understood as the ability to initiate new behaviors that allow one to effectively cope with environmental challenges. Although this assumption is widespread, empirical evidence is scarce and incomplete. The aim of this article is to contribute to understanding the links between uncontrollability and sense of agency. Based on evidence that sense of agency is malleable and sensitive to situational factors (Caspar, Christensen, Cleeremans, & Haggard, 2016; Obhi, Swiderski, & Brubacher, 2012) and that uncontrollability increases uncertainty (Kofta & Sędek, 1999), we hypothesize that exposure to uncontrollable events triggers uncertainty regarding one's courses of action, decreasing sense of agency.

For a long time, students of the LH phenomenon were focused on demonstrating that loss of control leads to performance deficits on a variety of tasks (e.g., Hiroto & Seligman, 1975; Kofta & Sędek, 1989; Maier & Seligman, 1976) and on identifying boundary conditions for the effects to emerge (see, e.g., Abramson, Seligman, & Teasdale, 1978). Relatively less attention was devoted to the subjective experience resulting from control deprivation, that is, to understanding how the loss of control affects one's sense of agency (mental representation of oneself as an origin of an action). The subjective experience instigated by objective uncontrollability may act as a mediating or moderating variable between lack of control and performance deficits. It may change the way the objective amount of control deprivation affects cognitive functioning (e.g., executive functions) and motivation to initiate new

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action strategies and pursue goals (see, e.g., Pittman & Pittman, 1979; Ric & Scharnitzky, 2003). However, the literature on how subjective representation of one's own agency is related to objective loss of control provided rather mixed evidence. Whereas some research has shown that control judgments correspond to action–outcome contingencies (see, e.g., Allan & Jenkins, 1980; Neunaber & Wasserman, 1986; Sędek & Kofta, 1990; Wasserman, Chatlosh, & Neunaber, 1983), there has also been compelling evidence that—under some conditions—control judgments diverge significantly from objective action–outcome covariation resulting in an illusion of control (see, e.g., Alloy & Abramson, 1979, 1982; for an extensive discussion of this issue, see Alloy, Clements, & Koenig, 1993). Moreover, previous research has focused on the relationship between objective control deprivation and explicit control judgments only.

In the last 2 decades, research on the implicit sense of agency evolved rapidly allowing a better understanding of what sense of agency as a psychological construct really is (Haggard, Clark, & Kalogeras, 2002; Moore & Obhi, 2012). The development of these conceptual frameworks was accompanied by construing new measures of implicit sense of agency, allowing for an empirical examination of how loss of control also interferes with sense of agency on a preconceptual level. Particularly suitable for this purpose seems to be the phenomenon of intentional binding (IB) studied within a research paradigm that uses perceived time elapsing between intentional actions and their subsequent outcomes (Haggard et al., 2002).

This research focuses on the effects of uncontrollability on people's implicit feelings that they exercise impact on the environment and can change their fate via self-initiated activity. In particular, we examine how different lengths of exposure to lack of action–outcome contingency affect IB. Mechanisms underlying the negative effects of control deprivation on cognitive performance are still not sufficiently well identified, but do have important implications for clinical, social and educational psychology (Bukowski, Fritsche, Guinote, & Kofta, 2017; Rydzewska, Rusanowska, Krejtz, & Sędek, 2017; Skinner & Greene, 2008). Thus, in this research, we focus on how control deprivation affects basic processes related to experienced sense of agency, presumably contributing to the discussed effects.

A study by Moore, Lagnado, Deal, and Haggard (2009) revealed that instantaneous action–outcome contingency may determine the magnitude of IB. In our research, we would like to further explore this topic, and investigate whether prolonged lack of action–outcome contingency may affect IB also in subsequent tasks. We hypothesize that experiencing prolonged exposure to lack of covariation between response and outcome—induced via LH training—will lead to reduction of IB. There is ample evidence that prolonged experience of loss of control brings about an altered state of mind called cognitive exhaustion (Kofta & Sędek, 1998; Sędek & Kofta, 1990; Sędek, Kofta, & Tyszka, 1993). This mental state emerges due to long-term investment of mental effort without visible cognitive gain, for example, without progress in understanding the problem at hand and finding its solution. The described process is fundamentally due to an increased level of irreducible behavioral uncertainty (understood as the entropy of the set of hypotheses on how to solve the problem, see Kofta & Sędek, 1999; see also Bukowski & Kofta, 2017; McIntosh, Sędek, Fojas, Brzezicka-Rotkiewicz, & Kofta, 2005). In this article we assume that action–outcome noncontingency—via induction of irreducible behavioral uncertainty—results in inhibition of IB (see further discussion of this hypothesis in the following text).

Control Deprivation, Cognitive Exhaustion, and Behavioral Uncertainty

A wide variety of research has examined why control deprivation produces general deficits in cognitive processing. For example, research showed that control deprivation reduces accuracy of performance but not effort expenditure, and these cognitive deficits appear only after a prolonged experience of control deprivation (Ric & Scharnitzky, 2003). According to the present theoretical perspective, these deficits are assumed to arise mainly due to prolonged, inefficient investment of cognitive effort resulting in a state of cognitive exhaustion (Sędek & Kofta, 1990; see also Kofta & Sędek, 1998). This hypothetical mental state manifests in cognitive deficits on avoidance learning, inductive reasoning, problem solving, and mental model formation (Kofta, 1993; Kofta & Sędek, 1998; McIntosh et al., 2005; Sędek et al., 1993; von Hecker & Sędek, 1999).

More importantly, on an attentional level of cognitive functioning, long-term control deprivation was shown to decrease the efficiency of executive attention, resulting in a less selective response strategy (Bukowski, Asanowicz, Marzecová, & Lupiáñez, 2015). These findings imply that lengthy exposure to uncontrollability adversely affects the goal-driven attentional system, resulting in a decreased ability to filter out unimportant information as a major disturbance (Bukowski & Kofta, 2017). Presumably, this disfunction emerges because exposure to uncontrollable events increases behavioral uncertainty, that is, uncertainty regarding "how-to-act." Uncertainty of this kind is experienced when a person strives toward a goal but is unable to reach it despite repeated attempts. It arises because, in the uncontrollable situation, each hypothesis of problem solution is paired with inconsistent feedback, which prevents a promising hypothesis from being endorsed as an action plan. Importantly, under uncontrollability, behavioral uncertainty cannot be reduced despite trying and tends to gradually increase over time. In consequence, people disengage from an action (see McIntosh et al., 2005).

The preceding analysis suggests why response-outcome noncontingency might interfere with individuals' implicit sense of agency. In contrast to controllable situations, in uncontrollable situations the level of uncertainty regarding "how-to-act" is consistently high and growing. In consequence, the link between an intention (hypothesis) and action is very weak. This factor should interfere with psychological linking of intention to subsequent behavior.

IB as an Implicit Measure of the Sense of Agency

Over the last 2 decades, researchers have paid increasing attention to understanding the mechanisms of awareness of intentional action. This mounting interest can be linked to the finding that the awareness of intentional actions arises not in a single stage (e.g., from specification of motor commands), but due to integration of representations from multiple stages (originating from the very first intention to take an action, through intermediary steps, to the action's subsequent effect). The central nervous system (CNS) binds the representations from these different stages to produce a coherent experience of our own actions (Haggard & Clark, 2003; Haggard et al., 2002; Moore & Haggard, 2008; see also Moore & Obhi, 2012 for review). This binding is reflected in the temporal attraction of actions and their effects in conscious awareness: Awareness of the voluntary action is shifted to later in time, whereas awareness of the effect is shifted to earlier in time, toward the action. This phenomenon is specific to voluntary action and is canceled or reversed with nonvoluntary actions such as those induced by transcranial magnetic stimulation of the motor cortex (Haggard et al., 2002; but see Buehner & Humphreys, 2010, for a contradictory evidence). Moreover, IB is stronger when an individual believes that he or she triggered the sensory effect compared with when he or she believes that the effect was triggered by someone else (Desantis, Roussel, & Waszak, 2011). Therefore, these shifts—IB—can be linked to volitional activity and treated as implicit cues that individuals use to infer responsibility over the outcome (see, e.g., Synofzik, Vosgerau, & Lindner, 2009).

Various situational factors influence the magnitude of IB. Importantly, these various situational factors that decrease the magnitude of IB are also well known to interfere with the human sense of agency. In studies that resembled the seminal Milgram (1963) experiments on obedience, Caspar et al. (2016) showed that when participants were coerced to make a key-press causing harm to a coparticipant, the perceived interval between action and outcome was significantly increased (i.e., indicating less agency) compared with conditions in which participants were free to choose their actions. Similar to Milgram's experiments, these studies suggest that social coercion may undermine mechanisms of human agency. In a similar vein, Obhi et al. (2012) demonstrated that priming of low power (via asking to write about an episode when someone had power over an individual) increases the estimated time between action and outcomes (thus decreasing IB) compared with no priming and high-power conditions. Power has frequently been linked to personal control (Fast, Gruenfeld, Sivanathan, & Galinsky, 2009; Inesi, Botti, Dubois, Rucker, & Galinsky, 2011). Thus, it is possible that, in the studies by Obhi et al. (2012), the effects of power priming on the implicit sense of agency were mediated by feelings of lack of control. This reasoning was corroborated in recent studies by Beck, Di Costa, and Haggard (2017), where the authors found that having control over the external world (here operationalized as control over the probability of obtaining a painful heat stimulus) increased IB. Also, directly relevant to our research, a study by Moore et al. (2009), revealed that temporal shifts in action awareness (toward the outcome) increase when the occurrence of the outcome is contingent on one's action (i.e., a situation that we would define as a high control condition). Additionally, in a different line of research, it was shown that priming determinist beliefs (i.e., disbelief in free will) diminishes individuals' implicit sense of agency (Lynn, Muhle-Karbe, Aarts, & Brass, 2014). Overall, converging evidence suggests that IB can be treated as part of agentic experience, and that factors undermining the sense of agency lead to a decrease in the temporal attraction between actions and their outcomes.

Control Deprivation and IB

The experience of agency involves a process of causal learning based on statistical contingency of actions and their outcomes (Moore et al., 2009). Taking this into account, learning that there is no relation between actions and their outcomes should therefore reduce the sense of agency. Thus, one could reasonably expect that prolonged exposure to loss of control conditions—defined by Seligman (1975) as *action–outcome noncontingency*—should impair mechanisms responsible for a subjective sense of agency and decrease the magnitude of IB (i.e., temporal attraction between actions and their outcomes).

However, some findings suggest that the relationship between experience of action–outcome noncontingency and the objective performance as well as the sense of agency may not be as straightforward as it seems. Previous research has revealed that (relatively brief) exposure to loss of control may result in performance boosts rather than deficits (Mikulincer, 1994; Pittman & Pittman, 1979). For example, Pittman and Pittman (1979) exposed participants to brief control deprivation and then asked them to solve anagrams. They observed that participants, particularly those with an internal locus of control, performed better than a group exposed to a longer duration of control deprivation, but more importantly, even better than participants in the control group (with no control deprivation). Pittman and Pittman (1979) interpreted their findings in line with Wortman and Brehm's (1975) integrated reactance–helplessness theory suggesting that, when personal control is threatened, people are motivationally aroused to restore control, at least at the early phase of confrontation with an uncontrollable situation.

Some other findings indirectly imply that (short-termed) loss-of-control experience might result in similar boosts observed with measures of the implicit sense of agency. For instance, it was found that lack of control promotes identification of coherent interrelationships among a set of different stimuli, and thus might provide support for inferring causal relationships (Whitson & Galinsky, 2008). In the research more directly related to the IB literature, Di Costa, Théro, Chambon, and Haggard (2018) examined the magnitude of IB in a reinforcement-learning environment, where participants received feedback on their decisions. The authors observed an increase in participants' implicit sense of agency (i.e., IB) after erroneous decisions compared with good decisions. Such a boost can play a crucial functional role in adaptive behavior and coping with failure (and, possibly, action–outcome noncontingency). In a different study, Demanet, Muhle-Karbe, Lynn, Blotenberg, and Brass (2013) measured IB while asking participants to pull stretch bands of varying resistance levels. In this study, an increase in IB was observed in conditions of high physical effort compared with low physical effort. Possibly then, (short) experience of control deprivation would serve as motivation to restore control and lead to an increase in IB similar to those observed under high physical effort (i.e., assuming that strivings for control restoration resemble physical effort and wrestling, one could expect similar outcomes in both cases).

To conclude, the existing literature suggests that prolonged exposure to loss of control would reduce the implicit sense of agency. However, no specific predictions could be made with respect to short episodes of loss of control. On the one hand, it is possible that such conditions would provoke boosts in the implicit sense of agency. On the other hand, brief exposure to loss of control might already result in a reduction of the implicit sense of agency (possibly due to growing behavioral uncertainty; Bukowski & Kofta, 2017).

Overview of the Research

In two experimental studies, we examined the relationship between the experience of control deprivation and the magnitude of IB, a measure of implicit sense of agency. We hypothesized that, following prolonged exposure to response–outcome noncontingency, the magnitude of the implicit sense of agency will decrease. However, we made no specific prediction regarding the outcomes of a brief loss of control experience (i.e., hypotheses of decrease vs. increase in the implicit sense of agency, or no effect at all after brief control deprivation seemed equally valid).

In both studies, we used a classical concept-formation task to induce action–outcome noncontingency (patterned on tasks introduced by Hiroto & Seligman, 1975; we refer to this task as *behavioral helplessness training* [BHT]). In this task, participants are asked to identify the correct feature of a figure based on the feedback received after each trial. However, in the lack of control condition, the feedback is randomly predetermined and incongruent with the participant's behavior, making the task unsolvable. We believe that such training induces growing levels of irreducible behavioral uncertainty, where all predictions regarding how-to-act seem equally valid or nonvalid. To measure IB, we used a procedure based on the original task developed by Haggard et al. (2002), where participants made temporal judgments on the occurrence of an action and its outcome. Following other authors, we interpreted perceptual delay between occurrence of an action and outcome as a measure of implicit sense of agency. Thus, the more an action and outcome were temporarily attracted to each other, the greater the agentic experience. Stimuli, data, and the analytical code can be accessed through OSF repository (https://osf.io/zwdx9/).

Study 1

The aim of Study 1 was to examine whether exposure to BHT would reduce the magnitude of IB, that is, whether learning response–outcome noncontingency will reduce a temporal attraction between one's action and its sensory consequences. We designed an experimental study, where short versus long experiences of control deprivation (action–outcome covariation) were induced and their effects on IB were compared with a baseline condition. We expected to observe a significant decrease of IB after a long experience of control deprivation in comparison to a baseline condition. We have not spelled out specific predictions regarding a short experience of control deprivation.

Method

Participants and design. A total of 133 participants took part in an online study in exchange for a small compensation. Participants were asked to complete the study on their personal computers. A special plugin prevented them from opening other applications or web windows during the study. A group of 34 participants who obtained IB scores (see the definition to follow) higher than 500 ms or lower than −500 ms (an indication of misunderstanding the task) were excluded from the analyses. The remaining sample was composed of 52 females and 47 males, with an average age of $M_{age} = 24.90$, $SD_{age} = 3.15$. Participants were randomly assigned to one of three conditions, where they took part in long BHT ($n = 25$), short BHT ($n = 40$), or no training at all ($n = 34$).[1] A sensitivity analysis (with $\alpha = .05$ and power $= .80$) indicated a minimum detectable effect size equal to $d = 0.64$ (i.e., medium effect size, which was justifiable given repeatedly reported medium or large effect sizes in similarly designed IB studies, e.g., Obhi et al., 2012). Ethical approval for this study was obtained from the Faculty of Psychology, University of Warsaw Ethical Committee (Decision 27/10/2015).

Procedure and measures. After following the instruction screens and signing the consent form, participants were redirected to a study consisting of two parts: training and test. During the training part, participants received BHT (short or long), or no training at all (baseline condition). Immediately after, the test part took place where the magnitude of IB was assessed. Both parts lasted up to 18 min (the training part lasted on average from 2 min to 9 min depending on the condition, as described in the next section, whereas the test part lasted on average 9 min), see the overview of the procedure in Figure 1. Finally, participants were asked to complete the manipulation check measures. At the end, they were informed that the experiment was over, thanked, and fully debriefed.

BHT. A computerized concept-formation task was used as a way of inducing uncontrollability experiences (see, Kofta & Sędek, 1989), based on an idea that the main source of helplessness is a lack of perceived coherence between required actions and behavioral outcomes (Hiroto & Seligman, 1975; Seligman, 1975). The task consisted of six (long condition) or two (short condition) concept-formation problems. In each problem, participants were sequentially presented with a series of 12 screens with two patterns on each, that is, figures containing features from five dimensions, for example, large figure versus small figure, square versus triangle, plain or patterned background (see Figure 2). After each screen, participants were asked to select the pattern of each pair that had the feature they believed was the solution and were informed whether they had made the right or wrong decision. Importantly, participants were informed that the task was solvable and based on the feedback they should be able to determine the diagnostic feature of the figure. In fact, the feedback to each screen was given in a predetermined random order, so that each participant was given 50% "yes" and 50% "no" feedback on each trial. This made the task unsolvable and assured the objective response–outcome noncontingency. Additionally, after completing each problem, participants were presented with a list of 10 possible solutions and were asked to indicate the correct one. Irrespective of their choice, they were always informed that their guess was wrong.

Participants in the baseline condition did not take part in the BHT. Instead, they were presented with two problems. During each, they were shown a screen containing 12 figures taken from the BHT. They were asked to drag the figures on the screen, sort them, and make groups (each containing at least two figures) at will, depending on perceived similarities. No feedback was pro-

[1] Inequality of *n*s is due to random dropout from conditions, as some participants did not finish the procedure.

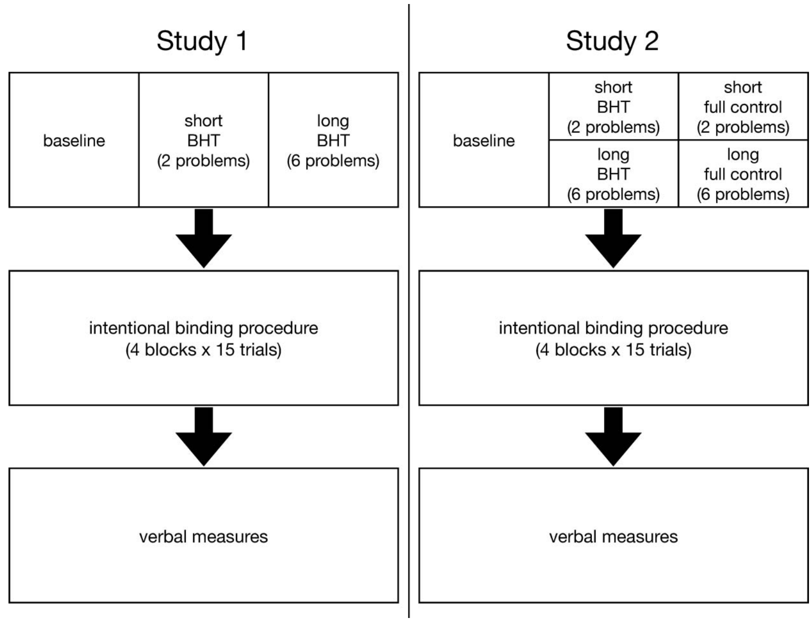

Figure 1. The overview of the procedures in Studies 1 and 2. BHT = behavioral helplessness training.

vided to either of the problems.[2] Participants spent, on average, 2 min in the baseline condition, 3 min in the short BHT condition, and 9 min in the long BHT condition.

IB assessment. IB was assessed using a method introduced by Haggard et al. (2002) and slightly modified by Demanet et al. (2013). The task consisted of 4 blocks, each containing 15 trials, resulting in 60 trials overall, lasting around 9 min. During each trial, participants were attended to the image of a circular clock face consisting of 60 dots (see Figure 3).[3] One of the dots—with a diameter twice the size of the other dots—stood for a clock hand that rotated clockwise at a steady rate of one-third rotation per s. At the beginning of the trial, the clock hand started moving from a random position. Then, the scenario differed depending on the block. In the first block (*agency action*), in each trial participants were asked to push the *F* button at the time of their choice, but no sooner than before the full rotation of the clock hand. The participant's action was followed by a brief tone (frequency = 600 Hz, duration = 75 ms), at a delay of 250 ms. After that, the clock hand rotated for a random amount of time (selected from a uniform distribution from 1 s to 2 s) and disappeared. Then each participant was asked to indicate—using a mouse pointer—on the clock face, when the action (pressing the button) had happened. In the second block (*agency tone*), the scenario was the same, but this time each participant was asked to indicate when the outcome (tone) had happened. In the third block (*baseline action*), there was no tone after the action and the task was to indicate the occurrence of the action. Finally, in the fourth block (*baseline tone*), participants were instructed to wait for a tone that occurred randomly (between 3 s and 5 s after the start of the trial). Here, participants were asked to indicate when the tone had occurred. The order of the blocks was counterbalanced. In each trial, adequate judgment error (i.e., deviation of the judgment time from real time) in ms was recorded.

IB scores for each individual were computed by subtracting average judgment errors in baseline action/tone blocks from average judgment errors in agency action/tone blocks, respectively (see Table A1 in the Appendix). Then, after reversing the sign of the result from tone blocks, the two differences were added to represent the overall IB score. The higher the IB value, the higher the temporal attraction between the action and the tone.

Manipulation check measures. To measure the effectiveness of our manipulation, we asked participants about their experiences during the study. These included measures of cognitive and motivational deficits, as well as affective changes. We measured cognitive difficulties by asking four questions (α = *.81, M* = 3.42, *SD* = 1.43), for example, "Thinking about possible solutions was hard". A decline in intrinsic motivation was measured with five items (α = .87, *M* = 3.7, *SD* = 1.42), for example, "It was hard for me to mobilize to solve the task." The answers to these two measures were coded on a seven-point scale ranging from *definitely disagree* to *definitely agree*. Finally, a list of 11 emotions

[2] In the baseline condition, we attempted to minimize both the lack-of-control as well as the successful control experience, while allowing participants to have contact with the materials used in the experimental groups. However, freedom of choice is an important component of personal control. Therefore, as suggested by one of the anonymous reviewers, the baseline procedure used in Study 1 and Study 2–allowing participants to manipulate the research material (categorize geometric figures) freely–may have in fact primed feelings of control. Thus, this might not serve as an effective baseline condition. In support of this line of reasoning, in both studies the IB scores were the highest in the baseline condition. Future studies should use more effective procedures in the baseline condition.

[3] Majority of previous studies on intentional binding use at least 30 trials per block. However, we deliberately chose a shorter version with 15 trials per block, following studies by Demanet et al. (2013). Prior research (Kofta & Sędek, 1998; Young & Allin, 1986) showed that the effects of the helplessness training are relatively strong, immediately after the treatment, but then tend to gradually dissipate over time. Therefore, an increased number of trials per block of the IB procedure would prolong the time passing from the helplessness training and lead to weaker or null effects.

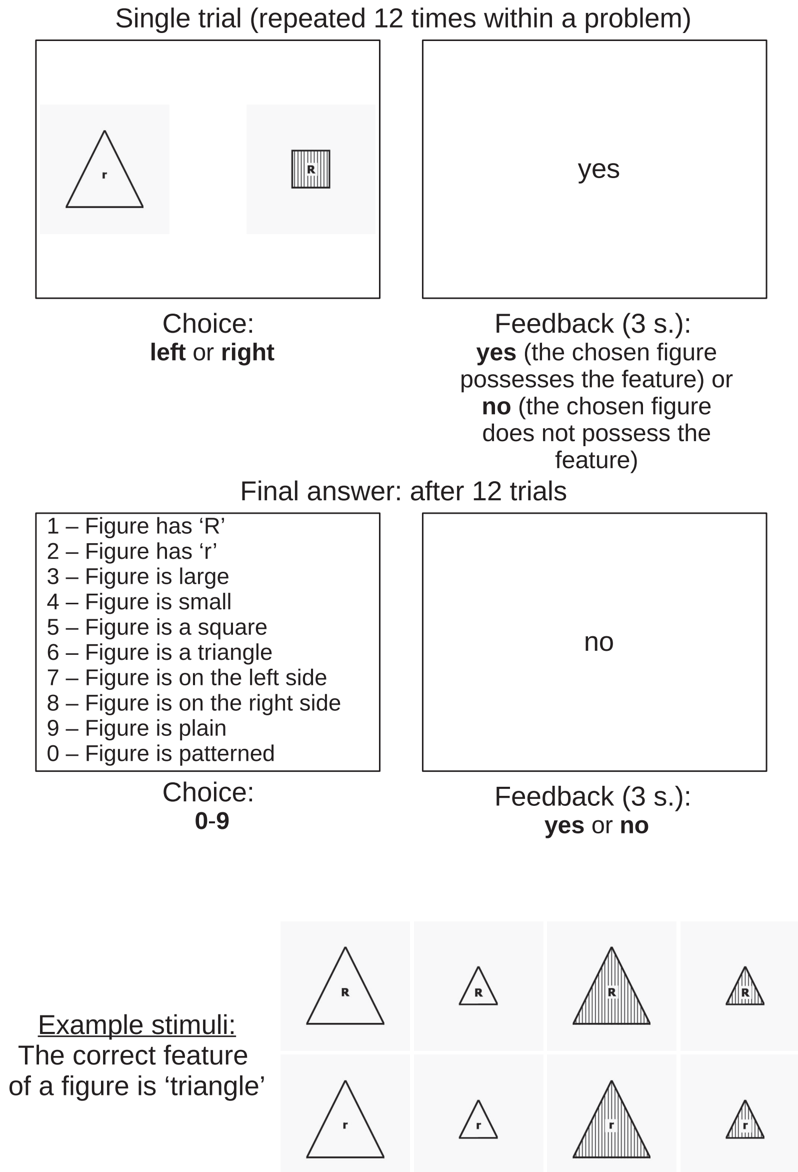

Figure 2. Behavioral helplessness training used in Study 1 and Study 2. Depending on the experimental condition, feedback to the participant's choice was provided at random or congruent with the responses.

was presented and participants were asked, "To what extent you felt . . .". The emotions formed four different factors: four negative emotions (e.g., sadness, anxiety: $\alpha = .87$, $M = 2.51$, $SD = 1.37$), three positive emotions (e.g., joy, pleasure: $\alpha = .87$, $M = 3.03$, $SD = 1.31$), two uncertainty related emotions (uncertainty, confusion: $\alpha = .85$, $M = 3.21$, $SD = 1.69$), and two weariness related emotions (weariness, disaffection: $\alpha = .86$, $M = 3.90$, $SD = 1.82$). The answers were coded on a seven-point scale ranging from *not at all* to *very strong*.

Results

Manipulation checks. To check the effectiveness of the BHT, we conducted a series of one-way analyses of variance (ANOVAs) for two measures associated with helplessness syndrome deficits: cognitive difficulties and low intrinsic motivation, and for four measures of emotions.

The results provided in Table 1 suggested that with the prolongation of the BHT the severity of the two types of deficits increased. All linear contrasts were statistically significant, suggesting a monotonic increase. Participants taking part in subsequent BHT tasks reported increased cognitive difficulties and a decline in intrinsic motivation to take part in the study. We also observed a significant quadratic trend for cognitive difficulties. Participants in both BHT conditions reported significantly more severe cognitive difficulties than participants in the baseline condition. However, the difference between par-

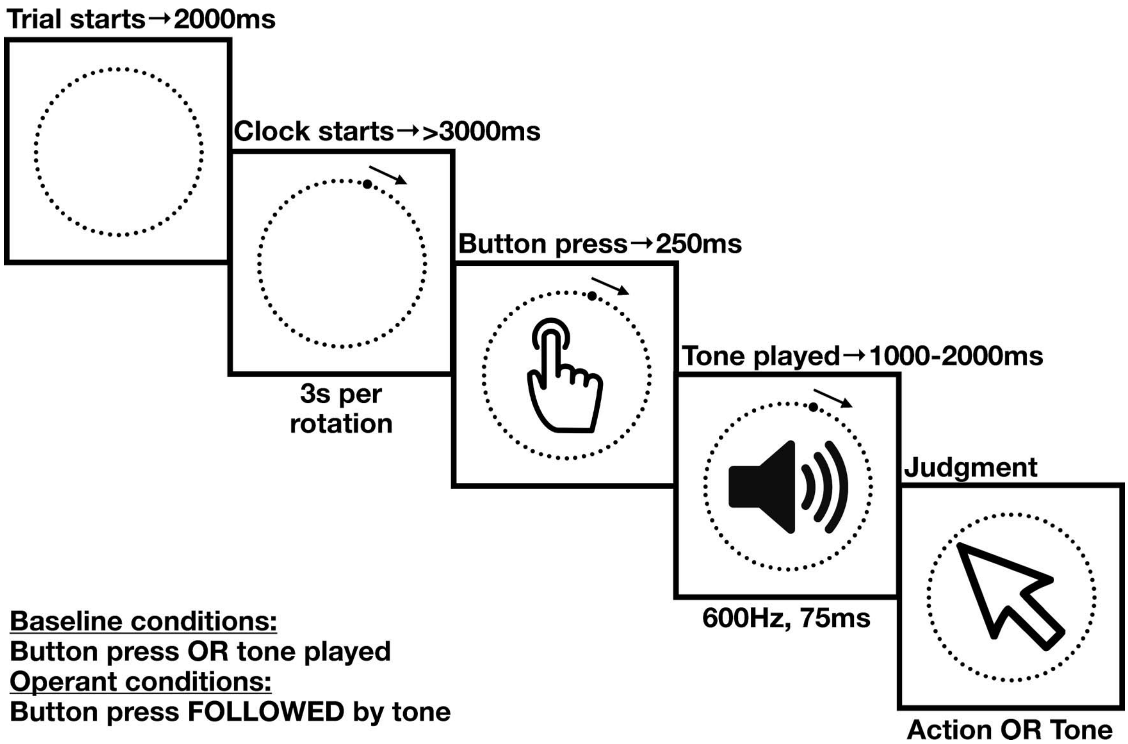

Figure 3. Procedure used to assess the magnitude of intentional binding.

ticipants in short and long BHT conditions was small relative to the difference between either of the former two and participants in the baseline condition. Furthermore, among varying emotional changes, a significant difference was observed only in the case of uncertainty related emotions. Prolonged BHT resulted in increased levels of uncertainty.

The obtained results suggest that the BHT was a successful way of inducing deficits associated with LH syndrome. Thus, we regard our manipulation as effective. Furthermore, the obtained results suggest that the rate of increased helplessness symptoms was monotonic.

Length of helplessness training and IB. We conducted one-way ANOVA to check how the length of experienced action–outcome noncontingency (baseline vs. short BHT vs. long BHT) affects the magnitude of IB. The omnibus test indicated significant differences between experimental conditions, $F(2, 96) = 3.62$, $p = .030$, $\eta^2 = .07$. However, our aim was to examine and contrast two specific predictions. According to the first prediction, prolonged BHT would lead to a gradual decrease in IB score (i.e., implicit sense of agency). According to the second prediction, short BHT would lead to an increase in IB score, but long BHT would lead to a decrease in IB score (relative to short BHT). To test these hypotheses, we compared linear versus quadratic trends. We conducted planned comparisons to examine linear versus quadratic trends as a function of the length of experienced action–outcome noncontingency (baseline, short BHT, long BHT). The analysis yielded a significant linear contrast, $\Psi = 96.05$, $t(96) = 2.63$, $p = .010$, $d = .54$, but the quadratic contrast was not significant, $\Psi = -18.39$, $t(96) = -0.32$, $p = .748$, $d = -.07$.

The analysis of marginal means suggested that with an increase in the length of BHT, the average scores of IB decreased: From the highest score in the baseline condition ($M = 118.29$, $SE = 23.79$),

Table 1
A Summary of Verbal Measures Across Experimental Conditions in Study 1

Variable	*M* (*SE*) Baseline	Short BHT	Long BHT	*F*	Linear contrast	Quadratic contrast
Cognitive difficulties	2.38 (0.22)	3.87 (0.20)	4.16 (0.25)	18.11***	1.26***	−0.49*
Low intrinsic motivation	3.24 (0.24)	3.86 (0.22)	4.12 (0.28)	3.22*	0.63*	−0.15
Negative emotions	2.29 (0.24)	2.67 (0.22)	2.72 (0.28)	0.94	0.31	−0.14
Positive emotions	3.44 (0.22)	2.82 (0.21)	2.83 (0.26)	2.51†	−0.44†	0.25
Uncertainty	2.82 (0.29)	3.27 (0.27)	3.86 (0.34)	2.73†	0.73*	0.05
Weariness	3.84 (0.32)	3.86 (0.29)	4.06 (0.37)	0.12	0.16	0.07

Note. For all tests number of the denominator $df = 96$. BHT = behavioral helplessness training.
† $p < .10$. * $p < .05$. *** $p < .001$.

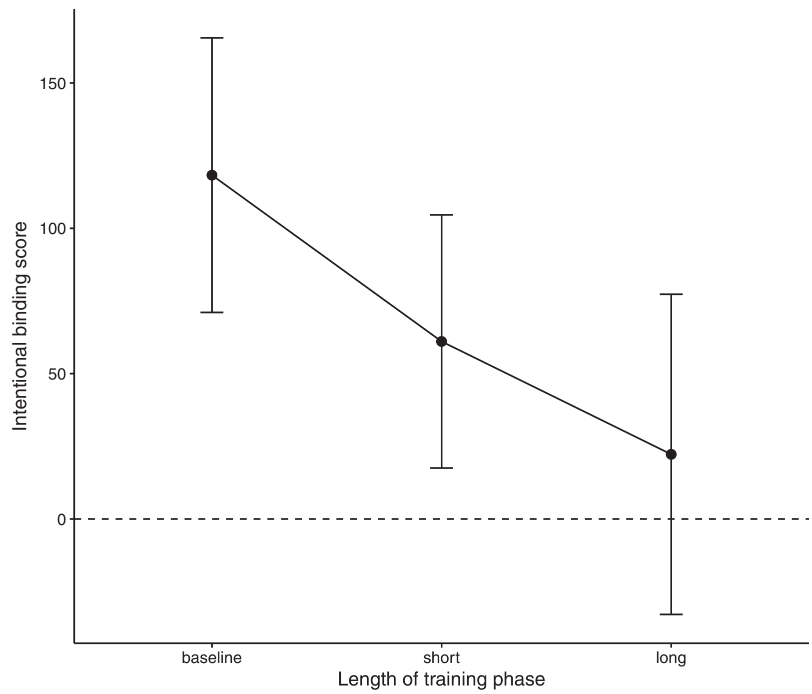

Figure 4. Length of behavioral helplessness training (BHT) and average scores of intentional binding with 95% confidence intervals.

through the medium score in the short BHT condition (M = 61.07, SE = 21.95), to the lowest score in the long BHT condition (M = 22.24, SE = 27.75); see Figure 4.

IB and verbal measures of helplessness. In an additional, exploratory step, we analyzed correlations between scores of IB and different measures associated with helplessness syndrome. The analysis revealed IB to be a relatively separate outcome of BHT. The measures (be it experienced uncertainty, cognitive difficulties, low intrinsic motivation, or various emotions) were not significantly correlated with the IB score. Contrarily, we observed strong and significant correlations between all verbal measures associated with helplessness syndrome (see Table 2).

Discussion

The obtained evidence suggests that an increase in experience of action–outcome noncontingency is accompanied by a decline in the temporal attraction between one's action and its sensory consequences. While in the baseline condition perceived temporal distance between the action and its effect was almost half as short as the true distance of 250 ms, after short-term control deprivation the perceived distance was only a quarter shorter than the true distance, and after long-term control deprivation the perceived distance was nearly the same as the objective temporal distance. Interestingly, no significant correlations between IB and verbal indications of control deprivation were observed.

Study 1 had one obvious limitation: Experimental conditions differed not only in levels of uncontrollability but also in length. Thus, it is plausible that factors other than control deprivation affected the results. Mere exposure to a relatively long series of similar problems, regardless of whether these problems are solvable or unsolvable, might have resulted in inhibition of IB due to growing fatigue and weariness. In Study 1, we did not record data

Table 2
Correlations Between Dependent Variables in Study 1

Variable	1	2	3	4	5	6	7
1. IB score	—						
2. Cognitive difficulties	.02	—					
3. Low intrinsic motivation	.03	$.55^{***}$	—				
4. Negative emotions	.04	$.44^{***}$	$.34^{***}$	—			
5. Positive emotions	.11	$-.36^{***}$	$-.53^{***}$	$-.28^{**}$	—		
6. Uncertainty	.03	$.48^{***}$	$.22^{*}$	$.64^{***}$	−.17	—	
7. Weariness	−.05	$.31^{**}$	$.64^{***}$	$.48^{***}$	$-.60^{***}$	$.31^{**}$	—

Note. IB = intentional binding.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

that would allow the exclusion of such an interpretation. Also, in the reported study, none of our manipulation checks directly measured the magnitude of perceived lack of control.

Study 2

In Study 2, we wanted to replicate and strengthen previous evidence that growing levels of uncontrollability are associated with a decrease in the magnitude of IB. This study was conducted on a larger sample, including two additional conditions. These two additional conditions exactly matched the two BHT conditions (short vs. long), except for inducing experiences of controllability instead of uncontrollability. If mounting fatigue/weariness (presumably caused by the tiring repetition of the same task format during the experimental session) would account for the gradual decline of IB proportional to the duration of the uncontrollable situation, one would note an analogous pattern after exposure to a controllable situation.

Method

Participants and design. A total of $N = 354$ naïve participants took part in an online study in exchange for a small renumeration.[4] The sample was collected with the aim to assign 55 participants to each experimental condition (based on the medium effect size obtained in Study 1, $p = .05$, and power $= .80$). Based on previous studies, a slightly larger sample was collected to account for potential exclusions. Participants were asked to complete the study on their personal computers. A special plugin prevented them from opening other applications or web windows during the study. A group of 49 participants who obtained IB scores higher than 500 ms or lower than -500 ms (an indication of misunderstanding the task) were excluded from the analyses. The remaining sample, $N = 305$, was composed of 243 women and 61 men, with an average age of $M_{\text{age}} = 24.84$, $SD_{\text{age}} = 3.24$. The study had a 2×2 plus one-factorial design with the length of the training phase (two conditions: short vs. long) and control (two conditions: full control vs. BHT) as separate factors, and baseline condition as an additional one. A sensitivity analysis (with $\alpha = .05$ and power $= .80$) indicated a minimum detectable effect size equal to $d = 0.42$ (i.e., small effect size). Ethical approval for this study was obtained from the Faculty of Psychology, University of Warsaw Ethical Committee (Decision 27/10/2015).

Procedure and measures. The procedure in this study was similar to the one in Study 1. After following instructions and signing a consent form, participants were redirected to the training part. There they took part in short or long BHT, in the baseline procedure (all three procedures were identical to those in Study 1), or two full control conditions. Participants in short and long full control conditions were presented with two or six concept-formation problems respectively. These tasks were the same as those in BHT. At variance with BHT conditions, however, here the tasks were solvable, and participants always received feedback ("right" or "wrong") congruent with their guesses. After the training part (which lasted on average 2 min in the baseline condition, 3 min in short conditions, and 9 min in long conditions), participants were redirected to the IB assessment procedure (identical as in Study 1), which lasted 8 min on average (see the overview in Figure 1). We computed IB scores for each participant as in Study 1 (see, Table A2 in Appendix). Finally, participants were asked to complete the manipulation check measure, were thanked and fully debriefed.

Manipulation check measures. To measure the effectiveness of our manipulation, we used a 6-item scale of perceived lack of control during the task ($\alpha = .96$, $M = 3.96$, $SD = 2.00$), for example, "I felt that my effort brought hardly any effect" or "I felt no control over the task." Also, a set of manipulation check measures used in Study 1 was included for an additional inspection. These were measures of cognitive difficulties ($\alpha = .86$, $M = 3.10$, $SD = 1.54$), low intrinsic motivation ($\alpha = .85$, $M = 3.47$, $SD = 1.45$), and 4 emotion indicators: negative ($\alpha = .88$, $M = 2.36$, $SD = 1.38$), positive ($\alpha = .89$, $M = 3.37$, $SD = 1.43$), uncertainty related ($\alpha = .81$, $M = 2.79$, $SD = 1.51$), and weariness related ($\alpha = .86$, $M = 3.56$, $SD = 1.86$). Participants indicated their answers on a seven-point scale from *definitely disagree* to *definitely agree*.

Results

Manipulation checks. To check the effectiveness of our manipulation, we analyzed differences in self-assessed perceptions of lack of control, cognitive and motivational deficits, as well as emotional changes across experimental conditions. Results of omnibus tests indicated significant differences across all variables used as manipulation checks (see Table 3). We conducted a series of planned comparisons to verify our predictions regarding changes in the perceived lack of control across experimental conditions. First, we checked whether prolonged exposure to BHT increased perceptions of lack of control. Thus, we ordered groups in accordance with growing control deprivation (i.e., baseline, short BHT, long BHT), and tested linear versus quadratic contrasts. We observed monotonically growing levels of reported lack of control; the linear contrast was statistically significant, $\Psi = 2.47$, $t(300) = 9.26$, $p < .001$, $d = 1.07$, but the quadratic contrast was not significant, $\Psi = 0.49$, $t(300) = 1.06$, $p = .289$, $d = .12$. In the same vein, we tested whether exposure to a controllable situation increased the perception of control. We ordered groups in accordance with growing levels of control (baseline, short control experience, long control experience), and tested linear and quadratic contrasts. Here, we observed a monotonic decrease in perceptions of lack of control (i.e., an increase in perceptions of control); the linear contrast was statistically significant, $\Psi = -0.97$, $t(300) = -3.47$, $p < .001$, $d = -0.40$, but the quadratic contrast was not significant, $\Psi = -0.56$, $t(300) = -1.22$, $p = .223$, $d = -.14$.

Based on these results, we regard our manipulation as effective. Moreover, we find the rate of inducing lack of control versus control experiences as monotonically increasing. It should be noted, however, that the rates of increase versus decrease in perceptions of (un-)controllability were not the same.

Length of BHT (vs. full control) and IB. Before testing our predictions, we conducted a one-way ANOVA to check whether

[4] Participants in both studies were recruited through an online panel company, from a database of over 100,000 registered users. Moreover, participants were randomly drawn from the user database rather than volunteered. This makes the probability of drawing the same participant twice extremely small.

Table 3
A Summary of Verbal Measures Across Experimental Conditions in Study 2

Variable	Baseline (n = 51)	Full control		BHT		$F(4, 300)$
		Short (n = 64)	Long (n = 59)	Short (n = 59)	Long (n = 72)	
Perceived lack of control	3.43 (0.20)	2.67 (0.18)	2.47 (0.19)	4.92 (0.19)	5.90 (0.17)	67.95***
Cognitive difficulties	2.60 (0.19)	2.38 (0.17)	2.52 (0.18)	3.91 (0.18)	3.93 (0.16)	20.44***
Low intrinsic motivation	3.46 (0.19)	2.76 (0.17)	2.84 (0.17)	3.98 (0.17)	4.19 (0.16)	15.33***
Negative emotions	2.22 (0.19)	2.17 (0.17)	2.06 (0.18)	2.69 (0.18)	2.60 (0.16)	2.54*
Positive emotions	3.41 (0.19)	3.77 (0.17)	3.79 (0.18)	3.26 (0.18)	2.75 (0.16)	6.40***
Uncertainty	2.73 (0.21)	2.50 (0.19)	2.42 (0.19)	3.09 (0.19)	3.15 (0.18)	3.19*
Weariness	3.75 (0.25)	3.07 (0.23)	3.07 (0.24)	3.68 (0.24)	4.18 (0.21)	4.55**

Note. Summary statistics are means and standard errors in parentheses. BHT = behavioral helplessness training.
* $p < .05$. ** $p < .01$. *** $p < .001$.

there were any differences in IB between conditions. An omnibus test indicated significant differences in IB scores, $F(4, 300) = 2.51$, $p = .042$, $\eta^2 = .03$. We wanted to examine and compare predictions of gradual decrease of IB scores following the length of BHT versus the prediction of an increase in IB scores after short BHT, and a decrease in IB scores after long BHT. Therefore, we arranged the baseline ($M = 107.99$, $SE = 23.74$), short BHT ($M = 71.58$, $SE = 22.07$), and long BHT ($M = 16.56$, $SE = 19.98$) conditions in the order of growing uncontrollability experience and tested linear and quadratic trends (in the same way as in Study 1). We obtained a significant linear trend, $\Psi = 91.43$, $t(300) = 2.95$, $p = .004$, $d = .34$, and nonsignificant quadratic trend, $\Psi = 18.60$, $t(300) = 0.35$, $p = .731$, $d = .04$. Thus, with growing levels of uncontrollability the magnitude of IB diminished. Furthermore, the rate of decrease seemed to be monotonic (see Figure 5).

The question arises as to whether one would observe a similar pattern of results in full control conditions. We arranged the baseline, short full control ($M = 66.71$, $SE = 21.19$), and long full control ($M = 84.68$, $SE = 22.07$) conditions in the order of the length of full control experience, and once again tested linear and quadratic trends. However, we found neither linear, $\Psi = 23.31$, $t(300) = 0.47$, $p = .473$, $d = .08$, nor quadratic trends, $\Psi = -59.26$, $t(300) = -1.11$, $p = .268$, $d = .13$. Furthermore, the difference between linear contrasts in uncontrollable versus full control conditions was statistically significant, $\Psi = 68.12$, $t(300) = 2.29$, $p = .023$, $d = .26$, which indicated that the magnitude of decrease in IB was credibly higher in the former than in the latter conditions. The difference between quadratic contrasts in uncontrollable versus control conditions was not statistically significant, $\Psi = 77.86$, $t(300) = 1.14$, $p = .254$, $d = .13$.

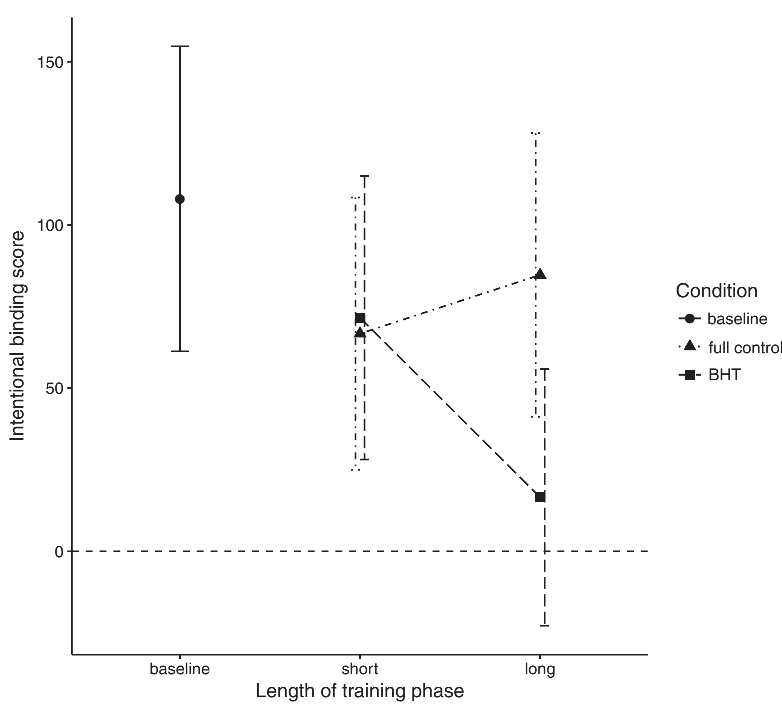

Figure 5. Length of behavioral helplessness training (BHT; vs. full control) and average scores of intentional binding with 95% confidence intervals.

Table 4
Correlations Between Dependent Variables in Study 2

Variable	1	2	3	4	5	6	7	8
1. IB score	—							
2. Perceived lack of control	−.06	—						
3. Cognitive difficulties	−.03	.69***	—					
4. Low intrinsic motivation	−.08	.59***	.60***	—				
5. Negative emotions	−.09	.27***	.34***	.42***	—			
6. Positive emotions	−.01	−.45***	−.36***	−.59***	−.37***	—		
7. Uncertainty	−.03	.38***	.44***	.33***	.64***	−.23***	—	
8. Weariness	−.07	.38***	.36***	.64***	.62***	−.55***	.44***	—

Note. IB = intentional binding.
*** $p < .001$.

IB and verbal measures of helplessness. Similar to Study 1, we conducted additional analyses to examine correlations between IB scores and verbal measures of helplessness (see Table 4). We found none of the previously used verbal measures of helplessness to be significantly correlated with IB scores. Furthermore, we also found that the direct measure of perceived lack of control was not significantly correlated with the IB scores.

Discussion

Study 2 successfully replicated previous findings: Growing levels of uncontrollability were accompanied by a decline in temporal binding. After prolonged exposure to lack of action–outcome contingency, the perceived temporal distance between one's actions and their sensory consequences was increased (thus IB was diminished). Importantly, such a change seemed to be directly related to an increased objective lack of control over the outcomes and could not be explained by other factors. Specifically, prolonged exposure to controllable conditions—likely to cause weariness and fatigue—did not result in a similar reduction of the IB magnitude. Similar to Study 1, no significant correlations between IB and several explicit measures related to control deprivation were found.

General Discussion

In two experimental studies, we investigated the link between experience of control deprivation and the magnitude of IB, a marker of the implicit sense of agency. We expected that prolonged conditions of response–outcome noncontingency, induced by BHT, would damage the tendency to perceive voluntary actions and their outcomes as close in time. In both studies, we found significant evidence for the existence of such changes. After long BHT, the magnitude of IB decreased to almost nil. This novel finding suggests that BHT severely affects people's sense of agency at the implicit level.

What Is New in Our Findings?

The idea that a sense of control over action is important for IB to emerge is supported by mounting evidence. Merely providing participants with clear information about outcome attainment—presumably increasing their sense of personal control—resulted in stronger IB (Eitam, Kennedy, & Higgins, 2013). In addition, experimental induction of feelings of probabilistic control over the onset of aversive stimuli was shown to increase IB (Beck et al., 2017). Moreover, a heightened level of perceptual-motor control, as well as goal control, was found to intensify it (Kumar & Srinivasan, 2017). Freedom of choice is an important ingredient of personal control. Therefore, the fact that allowing participants to press a key freely (in comparison to instructed key presses) makes the IB effect stronger, supports the role of perceived control in this phenomenon (Barlas, Hockley, & Obhi, 2018).

So, in view of a firmly established connection between sense of control and IB, what is at all new about our findings? We believe that the present approach makes two distinctive contributions to the current literature. First, we demonstrate the consequences of personal control being taken away, not primed. Note that—in contrast to our research—in none of the hitherto reviewed studies were the effects of losing control examined. To our knowledge, only one study addressed an analogous problem, in which the authors found that priming lack of power inhibited subsequently measured IB, whereas priming power did not affect this phenomenon (Obhi et al., 2012). Because perceived control is an essential component of power experience (e.g., Deng, Zheng, & Guinote, 2018; Dépret & Fiske, 1993; Fast et al., 2009), this finding indirectly supports our results showing the importance of loss-of-control for IB. Note that the whole pattern obtained in the study by Obhi et al. (2012) additionally suggests that losing control might even be more important for IB than extending control.

The second distinctive contribution of our research is the following: in contrast to the above reviewed studies, in which momentary feelings of control in the course of IB measurement were manipulated, we showed that induction of control deprivation on a problem-solving task inhibits IB on a subsequently performed, different task[5], and that the impact of control deprivation on this effect increases with the duration of the uncontrollable experience. Thus, in our studies we first produced an altered mental state of LH and then examined how this state of mind affects the IB effect.[6] By doing so, we learned more about the psychological prerequisites of

[5] Obviously with an exception of the study on power and IB (Obhi et al., 2012).

[6] Earlier research confirmed that performance deterioration after exposure to the learned helplessness training (response–outcome noncontingency) shows some inertia, i.e., lasts for some time, disappearing totally only after about 2 hr (Young & Allin, 1986). These findings support the idea that prolonged exposure to noncontingency indeed induces an altered state of mind.

IB, that is to say, human experiences that modulate the IB phenomenon.

What Is the Shape of the Relationship Between Length of Control Deprivation and Subsequent Psychological Functioning?

An enduring controversy exists as to the effects of lack-of-control's duration on subsequent psychological functioning. Early LH theorists predicted increased disengagement and development of a depression-like state of mind in response to an accumulating lack of control (e.g., Abramson et al., 1978; Seligman, 1975). Alternatively, Wortman and Brehm (1975) proposed that, when confronted with control deprivation, people are first mobilized to regain control, and only after that, when their efforts appear futile, develop LH symptoms. Much in the same vein, the theory of control motivation proposed that threat to control stimulates efforts to restore control. This motivation manifests, among other things, in intensified attributional activity and a shift from heuristic to systematic, more accurate processing style after the threat-to-control experience (see, e.g., Pittman, 1993; Pittman & Pittman, 1980). The research reviewed in the introductory paragraphs seemed to partly support this view. The idea that mobilization of personal resources (motivational and cognitive) is a fundamental human response to a threat to control is nowadays widely shared (e.g., Fritsche et al., 2013; Greenaway et al., 2015; see also Bukowski, Fritsche, Guinote, & Kofta, 2017). To give an example, in a recent integrative article, Swann and Jetten (2017) argued that stressing the power of situation and passivity of an individual—an enduring theme of social psychological research for decades—results in an ". . . unbalanced and misleading portrait of human agency" (p. 382). After reviewing several lines of studies, these authors conclude that strong situational forces not only do not interfere with but, on the contrary, often encourage expressions of human agency.

However, in our studies, we found that even relatively short experiences of no control led to the deterioration of individuals' implicit sense of agency, albeit to a smaller degree. In fact, the obtained pattern of results suggests that mounting uncontrollability is accompanied by a steady decrease in the magnitude of IB: no nonlinear tendencies, suggesting stronger IB after short uncontrollability, were observed.

Of considerable interest, past research, that examined cognitive performance after exposure to noncontingency of varying lengths, revealed patterns analogous to those obtained in our studies. In one of them, an impairment of task performance on avoidance learning appeared to be linearly related to the length of noncontingent preexposure (Kofta & Sędek, 1993). Ric and Scharnitzky (2003) found that the longer the exposure to noncontingent outcomes, the worse the performance on measures of sustained attention. Finally, in the most recent studies showing decreased cognitive flexibility after long-term uncontrollability, no improvement effects after relatively brief uncontrollability were noted (Bukowski, de Lemus, Marzecová, Lupiáñez, & Gocłowska, 2019).

All this suggests that even a relatively short experience of control deprivation tends to impair human readiness to engage in goal-oriented behavior. Our guess is that increased engagement (direct or indirect) in coping after threats to control—sometimes reported—might stem from compensatory motivational processes. In response to threatened personal control, our psychological system might react with a heightened level of arousal.

Why Control Deprivation Inhibits IB?

Seeking to discover the possible neural mechanisms that would explain why, after prolonged exposure to uncontrollability, IB is drastically reduced, one should go back to works that attribute this effect to forward action models (e.g., Haggard et al., 2002). These models were first applied to describe the effects of sensory attenuation, for example, the impossibility of tickling yourself (Blakemore, Wolpert, & Frith, 1998). As has been suggested, when one performs an action, the motor command in the CNS is accompanied by its efference copy used to predict possible sensory feedback. This prediction is then compared with the actual sensory feedback of an action, and when both matches, the predicted effect is "canceled" from the experience, resulting in sensory attenuation (Blakemore et al., 1998) or IB (Haggard et al., 2002). As noted by Hughes, Desantis, and Waszak (2013), both sensory attenuation and IB should be apparent when the feedback stimulus is consistent with a specific prediction compared with when it is inconsistent.

The previous findings on cognitive consequences of lack-of control provide a suggestion as to why this experience might disrupt individuals' implicit sense of agency. It was shown that prolonged lack-of-control leads to a general impairment in organizing related input information into coherent mental models (von Hecker & Sędek, 1999). Mental models are cognitive devices (theories of situation constructed online during contact with the task environment) that allow an observer to predict and control future events (Johnson-Laird, 1983; Kofta, 1993). Thus, deep impairments in construing mental models should impede any prediction—also of the effects of one's own actions. In consequence, the IB, probably requiring a comparison between the prediction of a sensory event and what happened (see Hughes et al., 2013), might disappear.

In both our experiments no evidence was found for significant correlations between measures of perceived control, as well as experienced uncertainty, or intensity of self-reported cognitive difficulties (an indication of cognitive exhaustion), and IB (see Table 2 and 4). It should be noted that the relationship between IB and explicit judgments of agency is still subject to debate. Several previous studies (Braun, Thorne, Hildebrandt, & Debener, 2014; Dewey & Knoblich, 2014; Saito, Takahata, Murai, & Takahashi, 2015) revealed that IB and explicit measures of agency does not correlate. Still, some studies suggest that they may coincide (Imaizumi & Tanno, 2019). It seems that the relationship between implicit and explicit measures of agency may not be straightforward. For example, Imaizumi and Tanno (2019) hypothesize that IB may not be a simple marker of sense of agency, but also a behavioral signature of time perception that is modulated by sense of agency. Thus, it is perhaps not surprising that in our studies, we did not observe any correlations between IB and verbal measures, even if both were similarly affected by our experimental procedure.

The discussed pattern suggests that the relationship between lack of action–outcome covariation and IB might be due to the functioning of a more basic process than in the case of the relationship between action–outcome covariation and verbal measures. In this context, it is worth noting that the LH phenomenon has been demonstrated not only in humans, but also—even earlier—in animals, including mammals (e.g., Minor, Jackson, & Maier, 1984; Overmier & Seligman, 1967), birds (e.g., Rodd, Rosselini, Stock, & Gallup, 1997), fish (e.g., Nash, Martinez, Dudeck, & Davis, 1983), and even insects (e.g., Brown & Stroup, 1988; Dinges, Varnon, Cota, Slykerman, & Abramson, 2017).[7] This implies that a connection between noncontingent outcomes and behavioral disengagement might be an evolutionarily old, automatically triggered mechanism, its basic function being conservation of energy: withdrawal from useless, inefficient behavior may allow energy to be saved and—after the rest period—different, possibly more effective actions to be tried (see, e.g., Kofta & Sędek, 1998; for positive adaptive value of goal disengagement, see Ghassemi, Bernecker, Herrmann, & Brandstätter, 2017).

Perhaps, then, once a lack of action–outcome contingency is automatically calculated, a "stop" signal is directly sent to centers responsible for generation of goal-oriented motivation (intention). If this is the case, the existence of such a direct connection would account for the lack of correlation between IB and uncertainty/cognitive exhaustion measures in the present studies.

Supportive to the above reasoning, recent research suggests that—in the course of evaluative conditioning as well as in the color-word contingency learning paradigm—human participants learned conditional probabilities of events (contingencies) without awareness (see, e.g., Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012; Schmidt, Crump, Cheesman, & Besner, 2007; Schmidt & De Houwer, 2012; Walther & Nagengast, 2006). However, even if it is true that people detect existing contingencies quite easily, they might nevertheless appear less motivated to detect a lack of contingency. In studies by Alloy and Abramson (1979; for a review, see Alloy et al., 1993), nondepressive participants were shown to demonstrate a gross illusion of control in the conditions of objective lack of action–outcome covariation. As a reminder, however, in these studies participants had to make explicit (not implicit) contingency judgments. Explicit judgments about personal control might be much more prone to self-enhancement motivational bias leading to the illusion of control.

IB and Translating Intention Into Action

Recently burgeoning literature on IB circles around two major themes: the nature of IB itself (the psychological and neural mechanisms of its emergence) and the relationship between IB and a conscious experience of agency (e.g., Haggard & Eitam, 2015; Moore & Obhi, 2012). What might be lacking, however, is a deeper understanding of links between the IB phenomenon and the broader experiential context of human activity. We need to know more about psychological prerequisites of implicit agency (experiences and states of mind that induce or hamper IB) as well as its more distant consequences (e.g., how it affects the course of subsequent goal-oriented activity).

Taking into account broader literature from action control and personal control areas (e.g., Bukowski & Kofta, 2017; Gollwitzer, 2012; Kuhl, 1984; Kuhl & Beckmann, 1985), one may make a working assumption that subjective compression of time intervals between an intended action and outcome signifies that our psychological system is ready to move "from thinking to doing": we are impatient and want to initiate action now, and this is perhaps the reason for the fact that the gap between an intended action and its effect is shortened. Thus, the IB effect might indicate that the process of action initiation has already begun: Mere intention is going to be translated into a real goal-oriented activity.

Assuming the delineated perspective, one may ask why a prolonged exposure to lack of action–outcome contingency results in IB's inhibition, and what function might this process play? Without a doubt, a transition from intending to doing is a milestone in action development. Sometimes, however—instead of initiating and continuing activity—it is better to withdraw from it, particularly when one expects future behavior to be meaningless and unlikely to help in obtaining the desired goal. Presumably, long-term noncontingency is a strong signal for the psychological system that future behavioral engagement is futile, and this is why noncontingency suppresses IB (the action-triggering mechanism is set in the "off" position). Possibly, such a signal would interfere with a predictive (rather than inferential) mechanism of IB emergence (see Moore & Haggard, 2008, for the discussion of this distinction). Previous research also revealed that noncontingency learning can be explained by associative mechanisms, which seem to influence the expression of IB (Moore, Dickinson, & Fletcher, 2011). Those findings provide additional evidence for the hypothesis that noncontingency training may influence the strength of IB, highlighting also the role of error-dependent associative learning processes as a potential underlying mechanism that might account for the diminished implicit sense of agency after prolonged experience of uncontrollability.

Implications for Future Research

If it is indeed so that IB signifies a state of readiness to initiate goal-directed activity, it should play a considerable role in action control promoting a transition from deliberative to implemental mindsets (Gollwitzer, 2012) or from state to action orientation (Kuhl & Beckmann, 1985), with all its regulatory consequences (e.g., increased resistance to temptations; activation of if-then reasoning strategies). According to the same logic, suppressed IB—meaning that the stop mechanism for action initiation is activated—should be associated with various signs of action disengagement such as lowered perseverance in goal pursuit, decreased resistance to temptations or distractors, and heightened accessibility of alternative action tendencies (see, e.g., Beckmann, 1998; Gollwitzer, 2012; Kuhl & Beckmann, 1985).

Another promising line of future research could address the effects of IB's inhibition after noncontingency on information processing. As already stated, research proved that lengthy exposure to action–outcome noncontingency leads to various signs of cognitive deterioration, including impaired inductive reasoning (Kofta & Sędek, 1998), inhibited generation of mental models in the social domain (von Hecker & Sędek, 1999), worsened attentional processing and cognitive control (Bukowski et al., 2015; Kofta & Sędek, 1998; Ric & Scharnitzky, 2003), and decreased

[7] In this research area, the LH effect consists of showing that exposure to unescapable shocks (in comparison to escapable shocks of the same intensity and duration) results in disruption of instrumental behavior (e.g., leads to behavior retardation or freezing, deterioration of learning new action–outcome contingencies, worsened performance in a forced swimming test as well as in the shuttle box escape performance, and so on).

cognitive flexibility (Bukowski et al., 2019). Moreover, some analogous malfunctions are also vivid in reactive depression (e.g., Hertel, 1997; Hertel & Rude, 1991; McIntosh et al., 2005; von Hecker & Sędek, 1999). It would be of utmost interest to examine whether enumerated cognitive dysfunctions, produced by a prolonged experience of noncontingency, are actually mediated by loss of implicit agency (as indexed by IB effect).

Conclusion

To conclude, the present studies allowed us to place the IB phenomenon in a broader experiential context of human goal-oriented activity. We found that, when people are confronted with an enduring lack of contingency between behavior and outcome, this results in the inhibition of IB. Moreover, the relationship between length of noncontingent experience and inhibition of IB appears to be monotonic. An extremely interesting question for future research is why the effect emerges, and how does IB suppression affect the way in which people approach future goal-oriented activity (e.g., goal setting, action control, cognitive control processes).

Context

For 30 years, we have attempted to understand the cognitive mechanisms of LH. We have felt, however, that a purely cognitive explanation might not be sufficient to explain the long-term effects of control deprivation. Learning about IB effect, as a measure of implicit sense of agency, we realized that crossing the domains of LH and IB might be fruitful for both areas of research. The basic finding reported here (control deprivation results in a decrease of IB) allowed us to identify the critical process that may account for the emergence of LH.

The current article is a continuation of our earlier works on the consequences of control deprivation for human information processing (attention, cognitive control and flexibility, cognitive resources) and social cognition (e.g., conspiracy theorizing). It is a part of a broader program of research on the interplay between cognitive and motivational mechanisms of human response to control deprivation. Within this broader program, we focus on the role of the reduction of IB (after loss of control) in action control (e.g., in executive functions, perseverance, resistance to temptations, etc.).

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Appendix

Average Judgment Errors as a Function of Block Type and Experimental Condition

Table A1

Judgment Errors (in ms) for Press and Tone in Operant Blocks Adjusted for the Respective Errors in Baseline Blocks Across Experimental Conditions in Study 1

Condition	Press	Tone
Baseline	90.92 (99.31)	−27.36 (103.53)
Short BHT	36.17 (126.80)	−24.91 (112.98)
Long BHT	4.61 (75.53)	−17.58 (81.67)

Note. Values are means and standard deviations in parentheses. BHT = behavioral helplessness training.

Table A2

Judgment Errors (ms) for Press and Tone in Operant Blocks Adjusted for the Respective Errors in Baseline Blocks Across Experimental Conditions in Study 2

Condition	Press	Tone
Long full control	76.40 (131.99)	−8.28 (149.66)
Short full control	70.85 (150.80)	4.15 (122.21)
Baseline	66.89 (113.69)	−41.10 (132.24)
Short BHT	50.39 (190.65)	−21.19 (156.18)
Long BHT	35.31 (154.07)	18.75 (148.03)

Note. Values are means and standard deviations in parentheses. BHT = behavioral helplessness training.

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