Examining the Moderating Impact of Plys and Tracks on the Insensitivity Effect: A Preliminary Investigation

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Abstract

This experiment examined whether the tendency for people to adhere to rules or instructions that no longer occasion effective action, depends on the: 1) source (self- versus socially-generated) and/or 2) nature (plys or tracks) of the rule. This was done by providing participants with either instructions (i.e., a ply or track) or no-instructions about the contingencies operating in a Matching To Sample (MTS) task. During the first phase of this task instructed and non-instructed contingencies overlapped. However, halfway through the task, the non-instructed contingencies reversed so that now instructed and non-instructed contingencies conflicted. Overall, the results indicated that after the non-instructed contingency reversal participants adhered more to 1) socially- as opposed to self-generated rules and 2) plys compared to tracks. Keywords: pliance, tracking, rule-governed behavior, insensitivity effect

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A defining feature of human behavior is the ability to generate and follow a variety of verbal rules or instructions, such as “I should stop at a red traffic light in order to avoid an accident,” “Do not cheat on your partner if you want to maintain a healthy relationship,” and “If you do well in school, you’ll find a good job.” What these rules or instructions have in common is that they enable us to adapt to the physical, social, and verbal environment (i.e., they enable us to contact or avoid certain consequences more quickly and accurately relative to when such information is not available).

Despite their advantages, rules and instructions can also undermine our contact with other contingencies in the environment. Indeed, research has repeatedly shown that once behavior is controlled by a rule, individuals may persistently follow that rule, even when doing so no longer produces the most beneficial outcome (e.g., Donadeli & Strapasson, 2015; Harte, Barnes-Holmes, Barnes-Holmes, & McEnteggart, 2017; Hayes, Brownstein, Haas, & Greenway, 1986; Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Joyce & Chase, 1990; Kudadjie-Gyamfi & Rachlin, 2001; Miller, Hirst, Kaplan, DiGennaro Reed, & Reed, 2014; Ninnes & Ninnes, 1998; Otto, Torgrud, & Holborn, 1999). We refer to this insensitivity of behavior to the consequences of other (non-instructed) contingencies, as the instruction or rule-based “insensitivity effect (IE)” [1].

The tendency for humans to adhere to rules, even when following those rules comes at a short– or long-term cost, plays a role in many different phenomena, from superstitions (e.g., “If I pick the same numbers every week, I have a greater chance of winning the lottery”), to

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[1] Note that terms such as (verbal) rules and instructions broadly refer to a set of (verbal) antecedent stimuli and are not technical terms that emerged from an inductive functional analysis (see O’Hora, Barnes-Holmes, & Stewart, 2014, for recent work in that vein). As such, we will use these terms interchangeably as a means to orient the reader towards a particular class of behavior.

problem solving (Bilalić, McLeod, & Gobet, 2008), and human suffering (Hayes, 1993). Over the past decades, researchers have identified a number of factors that moderate this instruction or rule-based IE. Such factors include the physical presence or absence of the rule-giver (e.g., Donadeli & Strapasson, 2015; Kroger-Costa & Abreu-Rodrigues, 2012), prior experience with rule-following (e.g., Martinez-Sanchez & Ribes-Iñesta, 1996), individual differences (e.g., Monestès, Villatte, Stewart, & Loas, 2014), as well as instruction accuracy (e.g., Hojo, 2002).

Another moderator of the IE that has received much attention is *the type of instruction or rule* that individuals are provided with (see Hughes & Barnes-Holmes, 2016; Törneke, 2010; Törneke, Luciano, & Validivia-Salas, 2008; Villas-Bôas, Meyer, Kanter, & Callaghan, 2015). So far, work on this topic has focused on two different types of rules: plys and tracks, which are said to govern two different classes of behavior: pliance and tracking, respectively. To illustrate, consider the following examples. Imagine you are in your final year of college and your parents tell you that "if you pass all your exams, we will give you a new smartphone." Assume that you have followed their rule (i.e., studied hard and passed all of your exams). In this case, your behavior could be defined as an instance of pliance. Pliance has traditionally been conceptualized as *"rule-governed behavior under the control of apparent speaker-mediated consequences for a correspondence between the rule and relevant behavior"* (Zettle & Hayes, 1982, p.80). A rule that functions to evoke pliance is typically termed a ply. Now imagine that you are told "if you do not want to become sick then avoid eating mushrooms that have red-and-white spots." Let us assume you have followed that rule and have not eaten any such mushrooms. In this case your behavior could be considered an instance of tracking (Hayes, Barnes-Holmes, & Roche, 2001; Hayes, Zettle, & Rosenfarb, 2004; Zettle & Hayes, 1982). Tracking has been defined as *"rule-governed behavior under the control of the apparent correspondence between the rule and the way the* *world is arranged"* (Hayes et al., 2004, p. 206). A rule that serves to evoke tracking is usually labeled a track. The key difference between tracking and pliance lies in the fact that for tracking reinforcement is a natural consequence of behavior, whereas for pliance it is contingent upon the actions of the speaker (i.e., the rule-giver) (see Hayes et al., 1986c).

The idea that plys and tracks occasion different levels of the IE has permeated both the Relational Frame Theory (RFT) and Acceptance and Commitment Therapy (ACT) literatures (see Törneke, 2010; Törneke et al., 2008). Within these literatures it has been generally assumed that plys occasion larger levels of the IE compared to tracks. This hypothesis is based on the idea that most individuals have a long history of receiving speaker-mediated consequences for compliance with instructions or rules (see Baruch et al., 2007; McAuliffe et al., 2014). Yet, the actual empirical support for this hypothesis is scarce. Indeed, to the best of our knowledge only four studies (i.e., Baruch, Kanter, Busch, Richardson, & Barnes-Holmes, 2007; Henley, Hirst, DiGennaro Reed, Becirevic, & Reed, 2017; McAuliffe, Hughes, & Barnes-Holmes, 2014 [Experiment 2]; Miller et al., 2014) have investigated this hypothesis in a single experiment (see Kissi et al., 2017).

The basic paradigm that was generally used to examine the moderating impact of plys and tracks on the IE can be described as follows: before being presented with the experimental task, participants were given instructions that were assumed to function as either a ply or track. The experimental task was then programmed in such a way that adherence to those instructions was initially reinforced. After a certain number of trials, the programmed contingencies were altered so that the instructions no longer corresponded with the task contingencies. As such, now following the initial ply or track was no longer reinforced. The extent to which participants continued following the initial instructions (i.e., plys or tracks) despite the fact that doing so was no longer reinforced was considered a measure of the IE.

The results of Baruch et al. (2007), Henley et al. (2017), McAuliffe et al. (2014; Experiment 2), and Miller et al. (2014) are largely inconsistent and can be summarized as follows. Baruch et al. (2007) and McAuliffe et al. (2014) examined whether plys and tracks occasioned different levels of the IE in dysphoric and non-dysphoric students. Both studies established plys and tracks by either asking participants to read instructions (randomly selected from a container) aloud to the experimenter (plys), or silently to themselves (tracks). To strengthen the effects of the plys, participants from the ply group were informed that the experimenter would monitor their performances throughout the task. The authors of both studies expected an interaction between levels of dysphoria and the type of rule, such that the dysphoric groups would show a larger IE compared to the non-dysphoric groups, and that this difference would be greater in the ply compared to the track groups. However, the results were not as expected, and also differed between the two studies. Baruch et al. found no difference between the ply and track groups. They did, nevertheless, observe an IE in the low dysphoric groups, whereas the high dysphoric groups actually became more sensitive to the task contingencies. In contrast, McAuliffe et al. did observe a difference between the ply and track groups. The high dysphoric participants who were provided with a ply, showed an IE. This was not the case when high dysphoric participants were provided with a track (these participants were more likely to behave in-line with the changed contingencies). The latter pattern of results was also observed in the low dysphoric group irrespective of the type of rule (ply or track) provided. Finally, Miller et al. (2014) and Henley et al. (2017) examined the moderating effects of instructions phrased as “you must …” (plys) and “you might consider …” (tracks) on the IE in a student population. In both studies plys occasioned a larger IE compared to tracks.

Although all four studies provide valuable information about the extent to which plys and tracks moderate the IE, only Henley et al. (2017) included a no-instructions group (i.e., a control group). As such, no conclusions can be drawn concerning the extent to which the instructions (plys and tracks) used in Baruch et al., 2007, McAuliffe et al., 2014 and Miller et al., 2014 undermined participants' adaptation to the contingency change.

The current paper represents a response to the limited and inconsistent empirical work in this area. We sought to extend the aforementioned findings by designing an experiment wherein participants were randomly allocated to one of three groups: a ply, track, or no-instructions group. In each group, participants were required to complete an experimental task in which behavior consistent with the programmed contingencies was initially reinforced. Halfway through the task these contingencies were reversed so that previous response patterns (i.e., those emitted prior to the contingency reversal) were no longer reinforced. Prior to this task, participants in the ply and track groups were provided with accurate instructions about the programmed contingencies. Those in the no-instructions group received no such instructions and instead had to learn via trial-and-error.

In-line with the aforementioned work in this area, we assumed that participants who were given a ply would be more insensitive to subsequent changes in the programmed contingencies relative to their counterparts who received a track (i.e., the type of rule provided would moderate the IE). Furthermore, based on the work of Henley et al. (2017), Matthews, Shimoff, Catania, & Sagvolden (1977), and Shimoff, Catania & Matthews (1981) we expected participants in the no-instructions groups to demonstrate greater sensitivity to the contingency reversal than those who received a ply or track. In other words, we predicted that if participants did not receive instructions their behavior would be better controlled by those contingencies operating in the task.

Method

Participants and Design

Forty-five Dutch-speaking participants (37 women) were recruited via an online system at Ghent University, and reimbursed with €7 or a course credit for participating in the experiment. Their age ranged from 18 to 60 years (M = 24.29, SD = 7.71). Participants provided written consent prior to testing and were told that they could terminate the experiment at any time (no participant opted to do so). Participants were randomly assigned (i.e., by drawing pieces of paper with subjects numbers from a bag) to one of the three experimental groups: the ply (N = 15), track (N = 17), or no-instructions group (N = 13)[2]. The study was approved by the Ethics Committee of the Faculty of Psychology and Educational Sciences of Ghent University, Belgium. Note that the study designs and data-analysis plans are available on the Open Science Framework website (osf.io/mmj2j). All data were collected without intermittent data analysis. The data analytic plan, experimental scripts, and data are available via the above link.

Procedure

Before signing up for the experiment, participants were briefly informed (via the online scheduling system) about the nature of the task (i.e., about the Matching-to-Sample [MTS] task) as well as how they would be compensated (i.e., that they would receive €7 or a course credit). Upon arrival each participant was welcomed by the researcher, seated in front of a computer (alone) and provided with a brief description of the experimental agenda (i.e., that they would first have to complete an MTS task and thereafter answer exploratory questions). Once they had provided their (written) informed consent, the experimenter left the room and

[2] In the current experiment we also manipulated the initial accuracy of the rules or instructions (i.e., ply and track). A total of 75 participants were initially recruited (54 women; mean age = 23.68 years, SD = 6.73, age range 18 - 60). All participants were randomly allocated (i.e., by drawing a piece of paper with participant numbers from a bag) to one of the five experimental groups: the initially-accurate ply (N = 15), initially-accurate track (N = 17), initially-inaccurate ply (N = 15), initially-inaccurate track (N = 15) or no-instructions group (N = 13). In this paper we will only discuss the procedure used and the results obtained from the initially accurate instructions and the no-instructions groups. An outline of the procedure that was used in the initially-inaccurate instruction groups as well as the results obtained from those groups can be obtained upon request from the first author (AK).

instructed participants to initiate the MTS task and answer the exploratory questions. After completing the experiment, participants were compensated, debriefed, and dismissed.

Materials

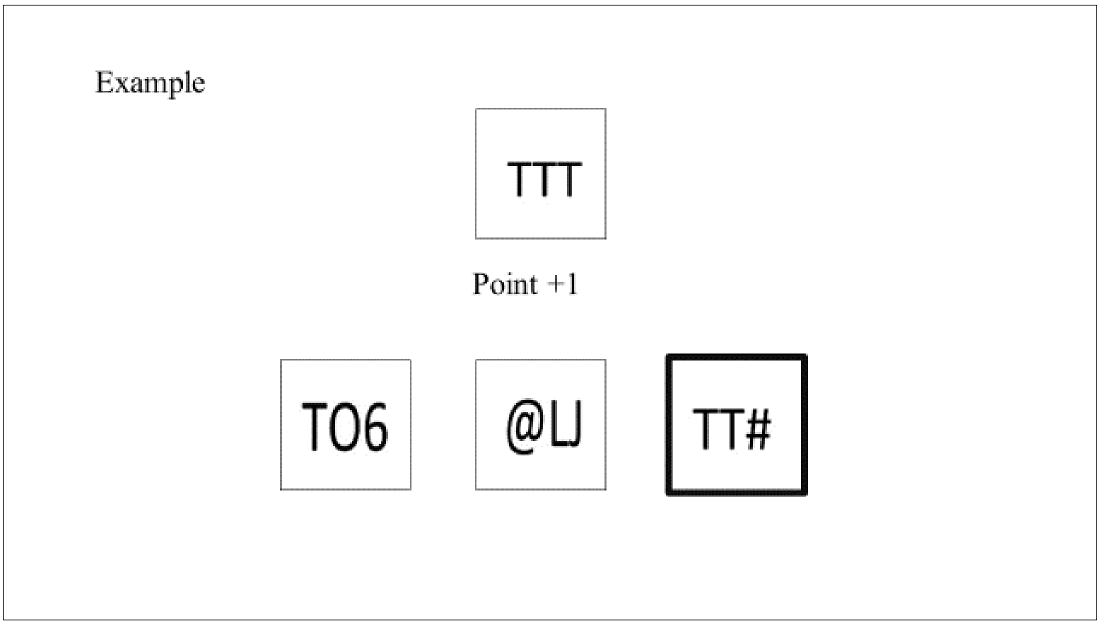
MTS Task. All participants completed a computerized MTS task (i.e., a conditional discrimination task wherein they had to match stimuli based on their physical similarities or dissimilarities) consisting of six blocks of 20 trials (inter-trial interval; ITI = 500ms). The entire MTS task took 15-20 minutes to complete. During each trial, a sample stimulus and three comparison stimuli were randomly selected (via the computer program) to be presented onscreen. Each sample stimulus consisted of a triplet of symbols or letters that were physically identical to one another (e.g., TTT, ***, <<<) and was always presented at the top of the screen. The three comparison stimuli were always presented at the bottom left, middle, and right of the screen and took the following format: one stimulus had two of the letters or symbols (most-like comparison stimulus, e.g., TT#), the second stimulus only one letter or symbol (moderate-like comparison stimulus, e.g., T06), while the third stimulus did not have any letters or symbols in common with the sample stimulus (least-like comparison stimulus, e.g., @L@). A total of 30 sample and 90 comparison stimuli were used during the MTS task.

During Blocks 1-3, selecting the comparison stimulus that resembled the sample stimulus the *most* was rewarded with one point. If participants selected one of the other two comparison stimuli (i.e., the least- or moderate-like comparison stimulus) then they lost a point. During Blocks 4-6, the programmed contingencies were reversed without informing participants about this change. Now, participants gained a point if they selected the *least-like* comparison stimulus (i.e., LLCS), while they lost a point if they chose the most- or moderate-like comparison stimulus. Note that points were not exchangeable for monetary rewards, and that all comparison stimulus selections were emitted by single-clicks on the mouse button.

Instructions. First, all participants received written information (via the computer) about how the MTS stimuli and consequences would be presented during the task, and how they could emit responses. Specifically, all participants first received the following *general information*:

"In a moment, several symbols will appear on the screen. One of these symbols will appear in the top center of the screen, and three other symbols will appear along the bottom of the screen (to the left, middle and right of the top symbol). Your task is to select one symbol from the three bottom symbols using the mouse.

If you select the correct symbol, then you will receive a point. If you select an incorrect symbol, then a point will be taken away. Your total score will be displayed as you move through the experiment.



The experiment takes about 15-20 minutes. After each session there will be a 1-minute break. There will be no talking to the researcher during or between sessions. If you have any questions, please ask them now or wait to have them answered at the end of the experiment. Do you have any questions?".

Following this information, participants in the ply and track groups received additional information about the programmed contingencies (via the computer screen). The ply group was told:

> "I (the researcher) want you to follow my instructions in this experiment at AT ALL TIMES. To ensure that you are following my EXACT instructions, I will be constantly checking your performance. Your computer is connected to mine via Wi-Fi so I will be monitoring your responses at the end of each and every session. I will also examine your overall performance at the end of the experiment."

The track group read the following:

> "In this experiment you can earn points if you select the correct symbol out of the three comparison stimuli that will be presented on the screen."

The no-instructions group, however, did not receive additional information about the programmed contingencies and as such had to learn about them through trial-and-error. Prior to each block, participants in both the ply and track groups received further instructions via the computer screen. In the ply group these instructions were:

> "I want you to select the symbol that is *most-like* the symbol at the top of the screen. Remember: I (the researcher) will monitor your performance at the end of each session."

The track group read the following:

> "In order to gain points, select the symbol that is *most-like* the symbol at the top of the screen."

To ensure that participants read and understood the instructions, they were asked to report the instructions (ply or track) to the researcher (via the computer) before they could start with the actual MTS task. Note that the instructions participants received in the ply and track groups were consistent with the programmed contingencies operating during Blocks 1-3 but contradicted those operating during Blocks 4-6.

Exploratory questions. Before initiating Block 1, participants from the ply and track groups were asked *"What leads to earning points?"* In the no-instructions group this question was asked after Blocks 3 and 6. After completion of the MTS task (i.e., after Block 6), all participants were asked three short questions: "*What do you think the experiment was about?*", "*What were the instructions that you received?*", and "*Why did you choose the alternative that was most-like the one presented at the top of the screen?*".

Apparatus. The experiment (MTS task and exploratory questions) was programmed in Visual Basic 2010 and completed on a Dell Latitude E5530 Notebook.

Data Analyses

Based upon our definition of the instruction or rule-based IE, the following analytic strategy was used. First, we conducted a one-tailed exact binomial test to determine on how many trials participants had to select the most-like comparison stimulus (MLCS) in Block 3, before it could be argued that they behaved in-line with the programmed contingencies. We conducted this test only on the data of Block 3, because we reasoned that by then participants would have had enough opportunities to learn about the programmed contingencies. The null-hypothesis of this test was that participants would select the MLCS on 33% of the trials if they behaved completely at random. The results of the test revealed that if participants selected the MLCS on at least 11 out of the 20 trials of Block 3, this indicates that they were behaving in-line with the programmed contingencies during Block 3, $p < .05$. As such, only participants that selected the MLCS on at least 11 out of the 20 trials of Block 3 were included for further analyses. All but one participant from the track group met this criterion. Consequently, 44 participants were included for further analyses. On average, during Block 3 these participants selected the MLCS on 99% of the trials[3].

Second, to test our hypotheses we carried out a binomial general linear mixed model (BGLMM) with a logit link function (using the R package lme4). We specifically examined whether Rule Type (ply, track, no-instructions) (independent variable) would influence participants' probability of selecting the MLCS (dependent variable) during the blocks that followed the (unannounced) reversal of the programmed contingencies (Block Type: 4-6) (independent variable). Importantly, we reasoned that if the probability that participants selected the MLCS was larger than 33% during Blocks 4-6, this would indicate they were insensitive to the programmed contingency reversal. The reported *p*-values for the fixed effects were based on a Type III ANOVA using a χ^2-distribution as included in the R package car. Alpha was set at .05 for all statistical tests and contrasts were always calculated by using Deviation coding.

Results

Mean proportion of MLCS selections after the contingency reversal

The number of participants that selected the MLCS on more than 33% trials during Block 4 was 32 (out of the 44 participants). Thirteen of these were from the ply group (i.e., 86.67% of the entire ply group), 12 from the track group (i.e., 75% of the entire track group), and 7 from the no-instructions group (i.e., 53.85% of the entire no-instructions group). Of these participants, 18 selected the MLCS during all trials (ply group: $N = 8$, track group: $N = 6$, and no-instructions group: $N = 4$). During Block 5, 25 (out of the 44) participants selected the MLCS on more than 33% of the trials (ply group: $N = 14$ [i.e., 93.33% of the entire ply group], track group: $N = 8$ [i.e., 50% of the entire track group], and no-instructions group: $N = 3$ [i.e., 23.08% of the entire no-instructions group]). The majority of these participants ($N = 18$) chose

[3] See Appendix 1 for the proportion of MLCS selections for each participant during Blocks 1-6.

the MLCS during all trials in Block 5 (ply group: $N = 10$, track group: $N = 6$, and no-instructions group: $N = 2$). Finally, in Block 6, 25 (out of the 44) participants selected the MLCS on more than 33% of the trials (ply group: $N = 14$ [i.e., 93.33% of the entire ply group], track group: $N = 8$ [i.e., 50% of the entire track group], and no-instructions group: $N = 3$ [i.e., 23.08% of the entire no-instructions group]). Almost all of these participants ($N = 22$) persistently selected the MLCS (ply group: $N = 12$, track group: $N = 7$, and no-instructions group: $N = 3$). See Figure 1 for the mean proportion of MLCS selections and standard errors as a function of Rule Type and Block Type.

Hypothesis Testing

The results of the BGLMM revealed a main effect for Rule Type, $\chi^2(2) = 10.30$, $p < .01$, and Block Type, $\chi^2(2) = 12.34$, $p < .01$, as well as a two-way interaction between Rule Type and Block Type, $\chi^2(4) = 120.38$, $p < .001$. A series of linear tests were performed to investigate the interaction between Rule Type and Block Type. Analyses revealed that when it came to Block 4 (i.e., the block immediately following the reversal of the programmed contingencies), the three (ply, track, and no-instructions) groups did not differ in their task performance, $\chi^2(1) = .01$, $p = .91$, and continued to select the MLCS with a high frequency. Interestingly, a difference between the three groups did emerge during Blocks 5 and 6. Results indicated that participants in the no-instructions group were less likely to select the MLCS than their counterparts in the ply (Block 5: $\chi^2(1) = 14.62$, $p < .001$; Block 6: $\chi^2(1) = 18.28$, $p < .001$), or track group (Block 5: $\chi^2(1) = 4.37$, $p < .05$; Block 6: $\chi^2(1) = 2.80$, $p = .09$). Furthermore, the ply group was more likely to select the MLCS than the track group (Block 5: $\chi^2(1) = 3.88$, $p < .05$; Block 6: $\chi^2(1) = 8.20$, $p < .01$). See Table 1 for participants' probability of selecting the MLCS and 95% confidence intervals as a function of Rule Type and Block Type.

Exploratory Questions

In response to the question *"What leads to earning points?"* (which was asked after Block 1 for the ply and track groups, and Blocks 3 and 6 for the no-instructions group) revealed the following results: all participants from the ply group and all but one participant from the track group correctly reported that they had to select the MLCS. For the no-instructions group, the majority of participants reported that they had to select the MLCS during Blocks 1-3 (N = 11), and the LLCS during Blocks 4-6 (N = 9).

The answers to the question "*What do you think the experiment was about?*" showed that most participants in the ply (N = 10) and track (N = 9) groups reported that the experiment's aim was to examine the extent to which people adhere to inaccurate rules. In the no-instructions group, all but one participant reported that the experiment was about learning.

When participants were asked "*What were the instructions that you received?*", the ply (N = 14) and track (N = 15) group stated that they were instructed to select the MLCS. In the no-instructions group, 10 participants reported that they were instructed to select the correct comparison stimulus. Despite not being told to select a particular comparison stimulus, two participants from the no-instructions group reported being told to select the MLCS, whereas one participant stated that he/she was instructed to select the LLCS.

Finally, answers to the question: "*Why did you choose the alternative that was most-like the one presented at the top of the screen?*" showed that 10 and five participants from the ply and track group, respectively, reported usually selecting the MLCS because they were instructed to do so. One participant from the no-instructions group stated he/she selected the MLCS because he/she was given this instruction.

Additional Analyses

We also examined the comparison stimuli that participants selected on the first trial of the MTS task. This analysis revealed that 42 of 44 participants selected the MLCS. In fact, in the instruction groups all but one participant (from the ply group) selected the MLCS. An identical pattern of results was observed in the no-instructions group, such that all but one participant selected the MLCS.

Discussion

Learning via instructions is a double-edged sword: not only can it rapidly accelerate adaption to the world around us, but it can also make us insensitive to other environmental contingencies. In the current paper we sought evidence for this IE and set out to investigate if it is moderated by the type of instructions or rules provided.

We had three main hypotheses. First, we expected participants who were given any type of (initially accurate) instruction to demonstrate evidence of the IE. In-line with previous work (e.g., Donadeli & Strapasson, 2015; Harte et al., 2017; Hayes et al., 1986c; Henley et al., 2017; Kudadjie-Gyamfi & Rachlin, 2001; Ninnes & Ninnes, 1998; Otto et al., 1999), we obtained support for this hypothesis, such that participants in the ply and track group were more likely than those in the no-instructions group to select the MLCS after the programmed contingency reversal.

Second, we expected the IE to be moderated by the *type* of instruction or rule participants received. We assumed that plys would occasion larger IEs than tracks (see Törneke et al., 2008). We found that this difference emerged gradually, such that both groups continued to respond in-line with the original programmed contingencies (in Block 4) and that the ply group did so to a larger extent across time than the track group (in Blocks 5 and 6). As an aside, it is important to acknowledge that although the definitions of plys and tracks stress consequences for rule-following which are speaker-mediated (plys) or contingent upon the way the world is arranged (tracks), they often also differ in their directive nature. For example, Miller et al. (2014) noted that the differential impact of plys and tracks on the IE may be due to the fact that plys are generally more directive than tracks (also see Henley et al., 2017). In the current experiment, the plys and tracks might have also differed in this way given that participants in the ply group were told that the experimenter wanted them to select the MLCS, whereas those in the track group were told they should only select the MLCS if they wanted to gain points. The fact that participants in the ply (but not the track) group were told that their task performance would be monitored, might also explain why the ply group was more insensitive to the contingency change than the track group. Indeed, it has been asserted (e.g., Donadeli & Strapasson, 2015; Kroger-Costa & Abreu-Rodrigues, 2012) that people are generally more inclined to follow instructions if they believe that their behavior is being monitored. Yet, given that we did not examine the unique effects of the directive nature of the instructions or monitoring, we recommend that future work examines the extent to which these variables contributed to the IE.

Third, we hypothesized that participants who were not given a ply or track would be *sensitive* to the programmed contingency reversal. Yet, the results showed that this was not the case. Instead, when the contingencies reversed the no-instructions group was also inclined to respond in a manner consistent with the initial contingencies (i.e., evidence emerged for an overall IE; see Rosenfarb et al., 1992 for similar findings).That said, this persistent adherence to the initial programmed contingencies appeared to be smaller than that observed in the ply and track group and reduced across time (i.e., during Block 5; see Harte et al., 2017 for similar findings). Interestingly, no difference emerged between the instruction and no-instructions groups in the block immediately following the contingency reversal (i.e., all groups tended to respond in-line with the initial rather than reversed contingencies in Block 4).

The IEs observed in the no-instructions group can be explained in at least two ways. First, participants might have been insensitive to the programmed contingency reversal, because their behavior was primarily controlled by the programmed contingencies operating during Blocks 1-3 (non-verbal hypothesis). Indeed, it is possible that participants were inclined to select the MLCS after the contingency reversal, because doing so was frequently reinforced prior to the reversal. From this perspective, behavior during Blocks 4-6 was slow to extinguish in the face of a competing set of contingencies. Second, it may be that participants privately developed verbal instructions (similar to those provided in the ply and track group) about the contingencies they encountered during Blocks 1-3, which in turn undermined their contact with the contingencies during Blocks 4-6 (verbal hypothesis). Support for this explanation can be found in the answers given by the no-instructions group on the exploratory questions. Indeed, almost all participants in the no-instructions group accurately reported the contingencies during the first (Blocks 1-3) and second phase of the task (Blocks 4-6). This suggests that if humans are not provided with rules or instructions, they formulate rules about the environmental regularities they encounter (e.g., Hayes et al. 1986d; Mitchell, De Houwer, & Lovibond, 2009; Shimoff, Matthews & Catania, 1986) and adhere to these rules even when they no longer apply (see Rosenfarb, Newland, Brannon & Howey, 1992). If true, then this might suggest that not only the type (ply vs. track) but also the *source* of the rule (i.e., whether the rule was self- as opposed to socially-generated) moderates the IE. Nevertheless, it should be noted that the no-instructions group may have been prompted to generate rules concerning the task contingencies because they were asked "*What leads to earning points?*". Perhaps if this question had not been asked, a different pattern of results would have emerged. We recommend that future work examines this possibility.

On a related note, the results revealed that the majority of participants in the no-instructions group selected the MLCS on the first MTS trial. This was unexpected given that we assumed that they would initially respond at chance level (i.e., because they did not receive any instructions about the task contingencies). We believe that there are two possible explanations for this finding. The first is that participants selected the MLCS because matching stimuli based on their physical similarities is a generalized operant response (i.e., the ‘default’ way of relating stimuli based on a long learning history of doing so). Alternatively, it might be that participants begin the MTS task with a pre-existing rule of responding that matching stimuli according to their physical similarities is the right way to go, and apply that rule from the outset. In either case, the results suggest that participants have a history of reinforcement for matching stimuli on the basis of their physical similarities. It may then be that the reinforcement provided for responding in-line with this learning history further increased the probability that participants selected the MLCS throughout the entire task (i.e., before and after the contingency reversal). We therefore recommend that future work takes this possibility into account when examining the IE. We also recommend to replicate and extend our study by, for example, using other tasks (i.e., tasks that do not require participants to match stimuli according to their physical similarities before the contingency reversal) (see Miller et al., 2014, Harte et al., 2017 and Henley et al., 2017 for examples).

It is worth mentioning that the IE observed in this and previous work might reflect what initially happens when an unannounced contingency change occurs: behavior extinguishes slowly. It could, however, be that as the number of trials increases after an announced contingency change, individuals become more inclined to explore other strategies and generate novel rules which may foster adaption to the new contingencies. Future work should examine this possibility, and also at what point in time individuals generally tend to explore alternative ways of adapting to unannounced changes in contingencies or rules (see Berger-Tal, Nathan, Meron, & Saltz, 2014 for work in this vein). This work could also investigate whether the point in time in which this shift occurs is different when participants are provided with plys, tracks, or no-instructions.

The current findings differ from those found by Baruch et al. (2007) and McAuliffe et al. (2014, Experiment 2). Both studies examined whether high compared to low dysphoric students were more insensitive to contingency changes, and whether this IE was larger when they received a ply rather than a track. Baruch et al. only observed an IE in low dysphoric students, which was not moderated by the type of rule. McAuliffe et al. only found an IE in high dysphoric students who were given a ply. We believe there are several factors that may account for the discrepancy between our findings and those of Baruch et al. and McAuliffe et al.. First, in our experiment participants could earn points that were printed on the computer screen. It may be that this manipulation made participants more insensitive to the contingency reversal because points were weaker (or less important) consequences compared to the monetary rewards that could be earned in Baruch et al. and McAuliffe et al. (i.e., the nature of the consequence might also moderate the IE; see Matthews et al., 1977). Second, in Baruch et al. and McAuliffe et al. participants were only given instructions in the beginning of the experiment. In our experiment, plys and tracks were repeated at the beginning of each block which may have increased the likelihood that participants adhered to these instructions. Third, Baruch et al. and McAuliffe et al. only included students scoring high or low on symptoms of dysphoria, whereas we did not control for the potential effects of (sub-)clinical symptoms. Hence, it is possible that the presence or absence of unknown (sub-)clinical factors might have contributed to the differences between our and Baruch et al.'s and McAuliffe et al.'s findings. We recommend that future work examines the potential impact of each of the abovementioned factors on the IE.

This study has several limitations. First, a relatively small sample was used and it has been shown that conclusions drawn from publications with small sample sizes may result in overestimations of effects (see Kühberger, Fritz & Scherndl, 2014). It is, therefore, crucial that future work replicates our findings with larger samples to determine the reliability of our results. Second, it is possible that relatively high IEs were observed in the current study because students mainly served as participants (given that they usually have an extensive history of reinforcement for rule-following). We therefore recommend that future research compares whether rule-following differently affects the way students versus non-students adapt to a contingency reversal. Finally, the answers on the exploratory question: *"What do you think the experiment was about"* showed that most participants in the instruction groups were aware of the study objectives. These ideas about the study objectives might have increased demand compliance or motivated participants to live up to the experimenter's expectations so that they would be perceived as good participants (Orne, 1962). Alternatively, it might be that participants adhered to the instructions because they have an extensive history of being punished for not complying with instructions (see Miller et al. 2014). Future work should take these possibilities into account when examining the effects of instructions on adaptation to changes in contingencies. Finally, we acknowledged that the IE observed in the current experiment might reflect a delayed extinction effect and that the nature of the consequences for rule-following (i.e., points vs points exchangeable for money) might moderate this effect. Yet, given that we did not directly examine these assertions we recommend that future work investigates these ideas, and also how other behavioral processes such as behavioral momentum might contribute to the IE (see Nevin & Grace, 2000; Podlesnik & DeLeon, 2015 for ideas).

Compliance with Ethical Standards:

Funding: The preparation of this paper was made possible with the support of the Ghent University Grant BOF16/MET_V/002 and the Interuniversity Attraction Poles Program initiated by the Belgian Science Policy Office (IUAPVII/33).

Conflict of Interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval: All procedures performed with the (human) participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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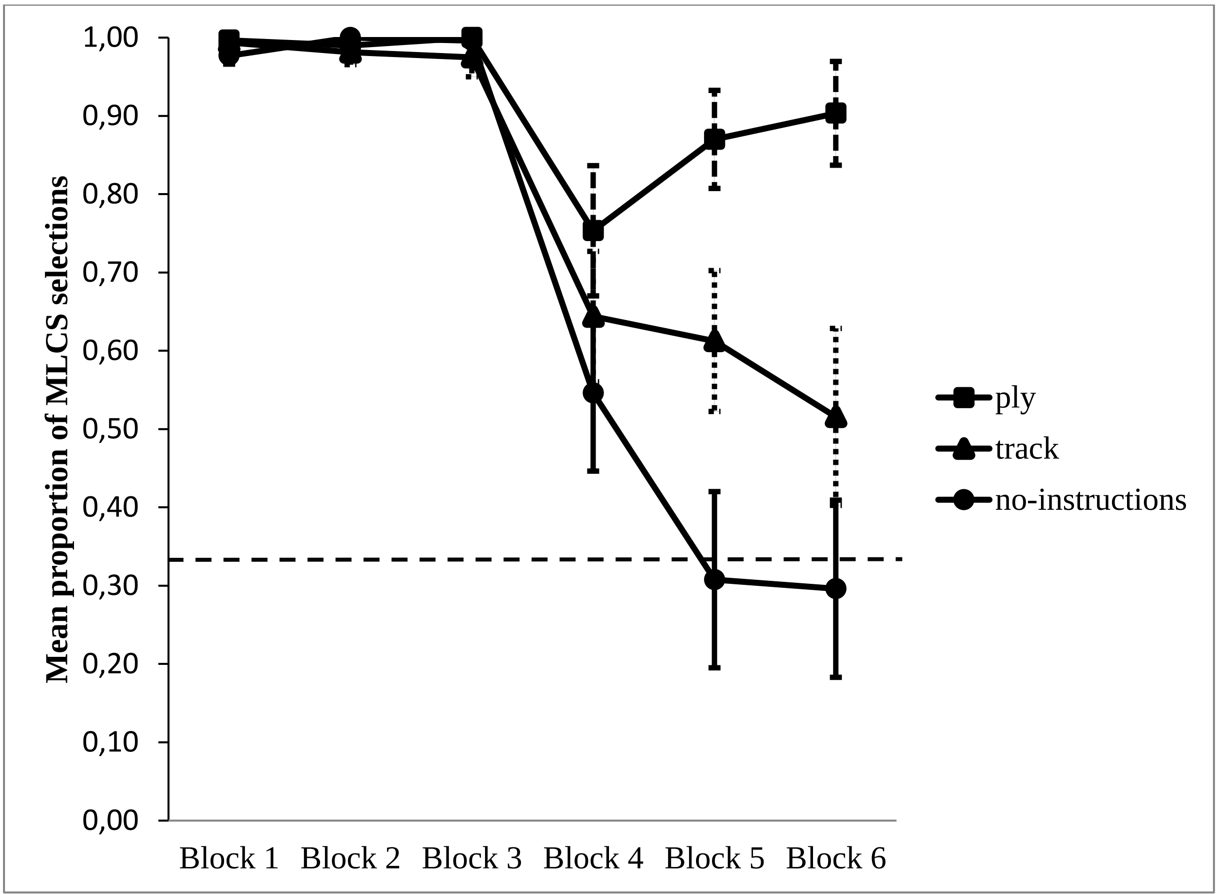
Figure 1. *Mean proportion of most-like comparison stimulus (MLCS) selections and standard errors as a function of Rule Type (ply, track, no-instructions) and Block Type (Blocks 1-6).*



Note. The dashed horizontal line denotes chance-level responding (i.e., .33)

Table 1. *Probability ($\hat{\pi}$) of selecting the most-like comparison stimulus and 95 % confidence intervals as a function of Rule Type (ply, track, and no instructions) and Block Type (Blocks 4, 5, and 6).*

	Block Type					
	Block 4		Block 5		Block 6	
Rule Type	$\hat{\pi}$	95 % CI	$\hat{\pi}$	95 % CI	$\hat{\pi}$	95 % CI
Ply	.96	(.76, .99)	.99	(.92, 1.00)	.99	(.95, 1.00)
Track	.88	(.56, .98)	.86	(.51, .97)	.74	(.33, .94)
No instructions	.79	(.36, .96)	.28	(.05, .72)	.24	(.05, .68)

Appendix 1. *Mean proportion of most-like comparison stimulus selections for each participant during Blocks 1-6.*

	Subject	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Ply Group	1	1.00	1.00	1.00	1.00	1.00	1.00
	2	1.00	1.00	1.00	1.00	1.00	1.00
	3	1.00	.90	1.00	.20	.45	.50
	4	1.00	1.00	1.00	1.00	1.00	1.00
	5	1.00	1.00	1.00	1.00	1.00	1.00
	12	.95	1.00	1.00	.40	1.00	1.00
	25	1.00	1.00	1.00	1.00	1.00	.95
	37	1.00	1.00	1.00	.80	.20	.10
	38	1.00	1.00	1.00	.50	.70	1.00
	39	1.00	1.00	1.00	.75	.85	1.00
	41	1.00	1.00	1.00	1.00	1.00	1.00
	42	1.00	1.00	1.00	.55	.85	1.00
	43	1.00	1.00	1.00	.10	1.00	1.00
	44	1.00	.95	1.00	1.00	1.00	1.00
	46	1.00	1.00	1.00	1.00	1.00	1.00
Track Group	13	1.00	1.00	1.00	.20	.25	.00
	14	1.00	1.00	1.00	.65	.35	.15
	15	1.00	1.00	1.00	.55	.15	.10
	16	1.00	1.00	1.00	.65	.20	.00
	21	1.00	1.00	1.00	.80	.15	.10
	31	1.00	1.00	1.00	1.00	1.00	1.00
	33	1.00	1.00	1.00	.25	.70	.10
	53	1.00	1.00	1.00	1.00	1.00	1.00
	54	1.00	1.00	1.00	.15	.20	.15
	55	1.00	1.00	1.00	1.00	.45	.45
	56	.95	.75	.60	.40	.55	.20
	55	1.00	1.00	1.00	.25	.80	1.00
	57	1.00	1.00	1.00	1.00	1.00	1.00
	58	1.00	.95	1.00	1.00	1.00	1.00
	74	1.00	1.00	1.00	1.00	1.00	1.00
	76	.95	1.00	1.00	.40	1.00	1.00
No-instructions Group	24	1.00	1.00	1.00	1.00	.95	1.00
	26	1.00	1.00	1.00	1.00	.50	.30
	27	1.00	1.00	1.00	.30	.05	.05
	28	1.00	1.00	1.00	.25	.05	.05
	29	.95	1.00	1.00	.30	.15	.05
	34	1.00	1.00	1.00	.70	.10	.15
	35	1.00	1.00	1.00	.15	.05	.05
	68	.90	1.00	.95	1.00	1.00	1.00
	69	1.00	1.00	1.00	.15	.00	.05
	70	.90	1.00	1.00	.70	.00	.00
	71	1.00	1.00	1.00	1.00	1.00	1.00
	72	.95	1.00	1.00	.20	.05	.05
	73	1.00	1.00	1.00	.35	.10	.10