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What is Pressure? Evidence for Social Pressure as a Type of Regulatory Focus

Darrell A. Worthy, **Arthur B. Markman**, and **W. Todd Maddox**
University of Texas, Austin

Abstract

Previous research suggests that pressure leads to choking when learning to classify items based on an explicit rule, but leads to excelling when learning to classify based on an implicit strategy. In this paper we relate social pressure to regulatory focus theory. We propose that the effects of pressure on performance arise because pressure induces a prevention focus that interacts with the more local reward structure of the task. To test this hypothesis, we repeat this previous research with a losses reward structure, so that participants under pressure are now in a regulatory fit. We also successfully replicate previous results with a gains reward structure. In contrast to participants who were attempting to maximize gains on each trial, participants attempting to minimize losses choked on the implicit learning task but excelled on the explicit learning tasks. The results suggest a three-way interaction between pressure level, task type, and reward structure.

Pressure affects performance on several cognitive and motor tasks (e.g., Markman, Maddox, & Worthy, 2006; Beilock and Decaro, 2007; Beilock and Carr, 2005; Beilock, Kulp, Holt, & Carr, 2004; Beilock and Carr, 2001; Masters, 1992). In these tasks participants often *choke* under pressure whereby they underperform on a task relative to their normal performance level because of an acute stressor. Intriguingly, participants can also *excel* under pressure by performing better than they would otherwise perform without pressure. For example, Markman et al. (2006) found that participants choked under pressure when performing a classification task that required an *explicit* rule-based strategy, but excelled under pressure when performing a task that required an *implicit* information-integration strategy.

These results are consistent with the *Distraction Hypothesis* (Beilock & Carr, 2005; Beilock et al., 2004; Markman et al., 2006; Wine, 1971), which proposes that pressure decreases available executive attention or working-memory resources leading to performance decrements on tasks that require an explicit strategy. A decline in available executive attention resources also increases people's reliance on implicit strategies, which enhances performance on implicit information integration tasks.

Relating Pressure to Regulatory Focus

In this paper, we explore the possibility raised by Markman et al. (2006) that pressure manipulations induce a situational *regulatory focus* in participants (Higgins, 1997; Maddox, Baldwin, & Markman, 2006; Worthy, Maddox, & Markman, 2007; Markman, Baldwin, & Maddox, 2005; Grimm, Markman, Maddox, & Baldwin, 2008). Regulatory focus theory posits that people adopt one of two distinct regulatory foci: a *promotion focus* whereby one becomes sensitive to potential gains in the environment and a *prevention focus* whereby one becomes sensitive to potential losses in the environment. The pressure manipulation used in a number

Please address all correspondence to: Darrell A. Worthy, Department of Psychology, University of Texas, 1 University Station, A8000, Austin, TX 78712, Phone: (512) 232-2883, Fax: (512) 471-6175, worthyda@mail.utexas.edu.

of studies hinges on the potential for a negative social outcome if the participant lets down a partner (e.g. Beilock & Carr, 2001; Markman et al., 2006; Gray, 2004; Beilock et al., 2004). This social pressure may induce a *prevention focus*. In contrast, participants who are not given a pressure manipulation are more likely to have a *promotion focus* because they are simply trying to complete the experiment and earn the required credit for participation.

Previous research suggests that a person's global regulatory focus interacts with the more local gains or losses available on each trial of the task that is being performed (Higgins, 2000; Maddox et al., 2006; Worthy et al., 2007). When there is a fit between regulatory focus and reward structure (i.e., a global promotion focus and gains or a global prevention focus and losses), then people are more capable of solving complex problem solving tasks which require executive attention than when there is a mismatch (i.e., a global prevention focus and gains or a global promotion focus and losses; Maddox et al., 2006; Markman et al., 2005; Worthy et al., 2007; Grimm et al., 2008). Previous research finds that participants in a regulatory fit are better than those in a mismatch at explicit rule-based learning tasks, but worse at implicit information integration learning tasks (Grimm et al., 2008; Maddox et al., 2006; Markman et al., 2005). There is also evidence that increased working memory capacity may enhance performance on rule-based tasks, but actually hinder performance on information–integration tasks (e.g. Decaro, Thomas, & Beilock, 2007; but see Tharp & Pickering, in press). One explanation for the improved performance on explicit rule-based tasks for participants in a regulatory fit is that a fit leads to an increase in executive working-memory resources.

Thus, the results from Markman et al. (2006) are consistent with both the Distraction hypothesis and the Regulatory Fit hypothesis. In this paper, we distinguish these possibilities by replicating the previous study with a losses reward structure. In a losses reward structure, people lose points throughout the task and must minimize their losses. The Regulatory Fit hypothesis adds an intermediate step to the Distraction hypothesis. On this view, pressure does not decrease available working memory directly, but rather it induces a prevention focus which interacts with the reward structure of the task to create either a regulatory fit or mismatch. The regulatory mismatch causes decrements in available executive resources.

Thus, we propose that participants performing the task under low and high pressure have different regulatory foci. Those performing under low pressure have a situational promotion focus while those performing under high pressure have a situational prevention focus. These distinct foci *interact* with the local reward structure to produce either a regulatory fit or mismatch. Participants who are in a pressure-induced prevention focus performing a task where responses result in losses should actually be in a regulatory fit. Thus, these participants should actually have an increased amount of available executive attention resources. Those performing rule-based tasks should now excel under pressure, while those performing information-integration tasks should choke. The Distraction hypothesis predicts the opposite because pressure should lead directly to decrements in available executive attention resources regardless of the reward structure of the task. We test these two contrasting hypotheses in the current experiment.

Experiment 1

Participants learned to classify stimuli into one of two categories. Half the participants classified stimuli from a rule-based category structure. Figure 1a depicts a simple rule-based task in which the participant must focus on one of the two dimensions and determine the location on that dimension that separates the two categories. This task is typically thought to involve explicit hypothesis testing, and so it should be harmed by any procedure that decreases executive attention resources (Ashby, Alfonso-Reese, Turken, & Waldron, 1998; Maddox & Ashby, 2004; Maddox, Filoteo, Hejl, & Ing, 2004).

The other participants classified stimuli from an information-integration category structure. The stimulus structure in Figure 1b rotates the category boundary 45-degrees in stimulus space. Thus, the rule that separates the categories cannot be stated easily. This stimulus configuration is thought to be best learned by a procedural or similarity-based process that is limited in its demands on working memory (Maddox & Ashby, 2004; Maddox, Ashby, & Bohil, 2003). Explicit hypothesis testing strategies can be used to solve these tasks, but they lead to suboptimal performance.

In the current experiment participants lost points on each trial, but they lost fewer points for a correct classification than for an incorrect one. Their goal was to minimize how many points they lost. Participants were placed under low pressure or high pressure. Those under low pressure were simply asked to do their best by trying to lose as few points as possible. Participants under high pressure were told that they could earn a monetary bonus if both they and a (fictional) partner lost no more than a certain number of points. Furthermore, they were informed that their partner had already performed the task and had reached the criterion so it was up to them to earn the bonus for themselves and their partner. This type of manipulation has been used in numerous previous studies and has been shown to induce pressure (e.g. Beilock and Carr., 2001; Gray; 2004; Beilock et al., 2004; Beilock and Carr, 2005; Beilock and Decaro, 2007).[1]

Method

Participants were 80 members of the University of Texas community who received course credit for their participation. Participants were randomly assigned to one of four between-subjects conditions which consisted of the factorial combination of two category types (Rule-Based vs. Information-Integration) and two types of pressure (High vs. Low). One participant in the Information-Integration Control condition was excluded because of experimenter error.

Participants in the Low Pressure condition were asked to do their best. Participants in the High Pressure condition were told that they could earn a monetary bonus ($6) if both they and a (fictional) partner achieved a performance criterion (80% correct) over the final 80-trial block of the experiment. They were then informed that their partner had already completed the experiment and had reached the performance criterion, so the participant's partner was relying on him or her to receive the bonus.

Stimuli were Gabor patches varying in the frequency of the bars and their orientation relative to the computer screen shown. Participants performed eight blocks of 80 trials. On each trial a stimulus was presented on the screen and participants were asked to indicate which category they thought the stimulus belonged to by pressing a key. They were given corrective feedback. Participants under high pressure also heard a 'ching' or 'buzzer' sound as feedback for correct and incorrect classifications on each trial. Participants were told that they would lose points on each trial and that their goal was to minimize their losses. Participants lost only one point for a correct response, but three points for an incorrect response. A point meter on the right-hand side of the screen indicated how many points had been lost, and a line indicated how many points had to remain for reception of the bonus. The meter was reset before the beginning of each block.

[1]It should be noted that participants receiving the pressure manipulation in some studies cited were videotaped so their performance could be evaluated by 'experts' (e.g. Beilock et al., 2004; Beilock and Carr, 2005; Beilock and Decaro, 2007). This was not part of our manipulation because a.) it was not part of our manipulation in our previous paper (Markman et al., 2006), and b.) we were worried about participants' potential skepticism regarding the existence of 'experts' in category learning. Future studies should address whether differences in pressure manipulations employed affect performance in different ways.

Results

Performance Measures

Figure 2 shows the mean accuracy for each condition for each block. The data were subjected to a 2 (Pressure Level) × 2 (Category Type) × 8 (Block) ANOVA. There was a significant Category Type X Pressure Level interaction, $F(1,75)=5.32$, $p<.05$, $\eta^2 = .07$. To examine the nature of the interaction we compared the performance of participants in the Low and High Pressure conditions within each category structure. In direct contrast to the data from Markman et al. (2006) participants in the Rule-Based High Pressure condition outperformed participants in the Rule-Based Low Pressure condition during every block of the experiment *(p<.01* by sign test). Also in contrast to Markman et al.'s (2006) findings, participants in the Information-Integration Low Pressure condition outperformed those in the Information-Integration high pressure condition on each block ($p<.01$ by sign test).

Model-Based Analyses

One advantage to using simple stimuli is that we can fit mathematical models to each participant's data to determine what strategy they used to solve the task. We fit decision bound models to the data from individual participants on a block-by-block basis (Maddox & Ashby, 1993; Maddox, 1999). Decision bound models assume that participants use a decision bound to separate stimuli into categories with stimuli on one side of the bound being classified into one category and stimuli on the other side of the bound being classified into the other category. The optimal decision bound in the Rule-Based condition is depicted by the vertical line in Figure 1a. The optimal decision bound in the Information-Integration condition is depicted by the diagonal line in Figure 1b.

Four models were fit. One was a (2-parameter) rule-based model that assumed a unidimensional decision boundary along the spatial frequency dimension (with another variant that assumed a decision boundary along the spatial orientation dimension). The location of the decision bound was a free parameter along with a "noise" parameter that represents variability in the trial-by-trial memory for, and application of, the decision boundary. The second was a (3-parameter) rule-based model that assumed a conjunctive strategy. This model assumed one decision boundary along spatial frequency and a second along spatial orientation and the decision rule: respond "A" if the spatial frequency is low and the orientation is steep; otherwise respond "B". A second variant assumed a different rule: respond "B" if the spatial frequency is high and the orientation is low; otherwise respond "A". The third was a (3-parameter) information-integration model that assumed a linear decision boundary. The slope and the intercept of the linear decision boundary were free parameters along with the "noise" parameter outlined above. The fourth was a (1-parameter) guessing model that assumed that the probability of responding category A (a free parameter in the model) was not affected by the location of the stimulus in space. The AIC criterion was used to determine the model that provided the best account of the data (Akaike, 1974). AIC penalizes a model for each free parameter, and thus a model with fewer parameters can provide a better account of the data than a model with more free parameters.

Figure 3a displays the proportion of Rule-Based participants best fit by a unidimensional rule model on the frequency dimension (i.e. the optimal model). A higher proportion of high-pressure participants were best fit by a rule-based model in six of eight blocks, although the difference was not significant. Most participants whose data were not fit best by the unidimensional rule-based model on the frequency dimension were better fit by the guessing model or an information-integration model. Figure 3b shows the proportion of Information-Integration participants whose data were fit best by an information-integration model. A higher proportion of data sets from low-pressure participants in the Information-Integration condition were fit best by an information-integration model in all eight blocks (p<.05 by sign test). Data that were not fit best by an information-integration model were usually fit better by a conjunctive or unidimensional rule-based model.

Our process-based account whereby a regulatory fit leads to an increase in executive resources would suggest that overall rule use should be higher for participants in the pressure conditions performing both tasks (i.e. the proportion of data sets fit best by either one of the two unidimensional rule models or the conjunctive model). This is exactly what we found when we examined the proportion of participants in each block fit by any of the three rule models (unidimensional frequency, unidimensional orientation, and conjunctive). More participants performing rule-based tasks under pressure were best fit by rule models in seven of eight blocks of the experiment (p<.01 by sign test), and more participants performing information-integration tasks under pressure were best fit by rule models in all eight blocks of the experiment. The greater use of explicit rules indicates that when given a task with a losses reward structure, pressure causes an increase in executive resources as predicted by Regulatory Focus theory.

Experiment 2

To ensure that these results did not differ from Markman et al.'s (2006) results because of a difference in the time when the studies were conducted, we replicated the original experiment that used a gains reward structure. An additional 40 participants were randomly placed into one of four between-subjects conditions that consisted of the factorial combination of two category types (Rule-Based vs. Information-Integration) and two types of pressure (High vs. Low). In contrast, to the experiment presented above, these participants gained two points for each correct classification and earned zero points for each incorrect classification. All other methods, including the pressure manipulation, were the same as Experiment 1.

Results

We obtained the same pattern of results as that of Markman et al. (2006). The data were subjected to a 2 (Pressure Level) × 2 (Category Type) × 8 (Block) ANOVA. There was a significant Category Type X Pressure Level interaction, $F(1,36)=7.74$, $p<.01$, $\eta^2 = 18$. Figure 4 shows the accuracies averaged across blocks for participants in each of the eight conditions across Experiments 1 and 2. In contrast to the results of Experiment 1, participants performing rule-based tasks choked under pressure, and participants performing information-integration tasks excelled under pressure when they were gaining points for correct responses.

To examine the effect of altering the reward structure we conducted a 2 (Reward Structure) X 2 (Pressure Level) X 2 (Category Type) X 8 (Block) repeated measures ANOVA using the combined data from Experiments 1 and 2. There was a significant Reward Structure X Pressure Level X Category Type interaction, $F(1,111)=12.84$, $p<.01$, $\eta^2 = .10$. When participants gained points on each trial, those performing a rule-based task choked under pressure, and those performing an information-integration task excelled under pressure. In contrast, when participants lost points on each trial those performing a rule-based task excelled under pressure, while those performing an information-integration task choked under pressure.

Discussion

The combined data from Experiments 1 and 2 offer clear support for the view that social pressure induces a situational prevention focus. Pressure alone did not reduce the amount of available working-memory resources as predicted by the Distraction hypothesis. Instead pressure induced a situational prevention focus that interacted with the reward structure of the task to influence the regulatory fit of participants in each condition. The results also support our hypothesis that participants in the Low Pressure conditions had a situational promotion focus (as opposed to having a prevention focus or no motivational focus at all). These participants were attempting to do their best in order to earn course credit or monetary compensation for their participation. This result is consistent with a situational promotion focus. The notion that participants in our Low Pressure conditions were in a promotion focus is supported by differences in performance for Low Pressure condition participants based on the reward structure of the task.

The different foci for participants under different levels of pressure led to different interactions with the local reward structures of the tasks. When participants were in a regulatory fit (Low Pressure receiving gains or High Pressure receiving losses) they performed well on rule-based tasks, but poorly on information-integration tasks. In contrast, when participants were in a regulatory mismatch (Low Pressure receiving losses or High Pressure receiving gains) they performed well on information-integration tasks, but poorly on rule-based tasks.

One key question is *why* a regulatory fit leads to an increase in executive resources? Much work to date suggests that a regulatory fit leads to an increased experience of “feeling right” that leads to engagement in reactions, and increased confidence in performance (e.g. Higgins, 2000; Aaker & Lee, 2006). This increased engagement and confidence in performance may increase executive attention resources. In contrast, a regulatory mismatch may lead to a decreased sense of “feeling right” which may produce the type of worry or anxiety about one’s performance that can decrease executive resources.

From a processing standpoint it is important to point out that the Distraction hypothesis is still correct when the task has a gains reward structure. Pressure still causes decrements due to cooption of the working memory available for the task. Here we are simply extending the theory by showing that the working memory ‘distraction’ is caused by an interaction between the pressure-induced situational prevention focus and the more local reward structure of the task. Pressure does not simply cause a reduction in executive resources, but alters one’s motivational state which then interacts with the reward structure of the environment. While it may seem counterintuitive to suggest that heightened pressure can actually *increase* executive resources, anecdotal accounts of *excelling* under pressure are perhaps as ubiquitous as those of *choking* under pressure (e.g. Worthy, Markman & Maddox, in press). In this paper we have presented experimental evidence for both choking and excelling and proposed an intriguing explanation for the existence of both phenomena.

This work demonstrates the need for a broader view of the effects of pressure on performance. Most laboratory tasks are conducted using a reward matrix in which participants gain points on each trial. However, not all real-world tasks involve maximizing gains. For example, academic test-taking situations may be viewed by the test-taker either as a situation where he or she attempts to get as few problems wrong as possible, or as many problems correct as possible. Our results suggest that test-takers performing a task that involves explicit cognitive processing would perform better under pressure when viewing the test as a task where they avoid giving incorrect answers because they would be in a regulatory fit. Analogously, our results suggest that test-takers performing a task that involves implicit cognitive processing would perform better under pressure when viewing the test as a task where they attempt to maximize the number of correct answers because they would be in a regulatory mismatch. Future research examining the effects of pressure on performance should take account of the three-way interaction between pressure, task type, and reward structure to develop a fuller understanding of phenomena that involve choking and excelling.

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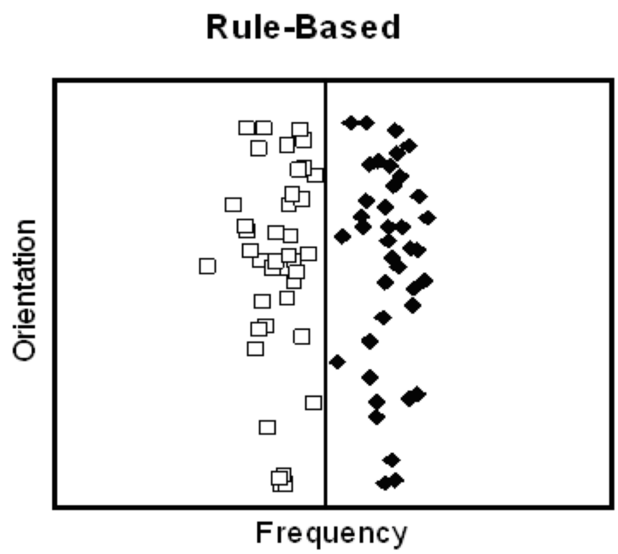
a.



b.

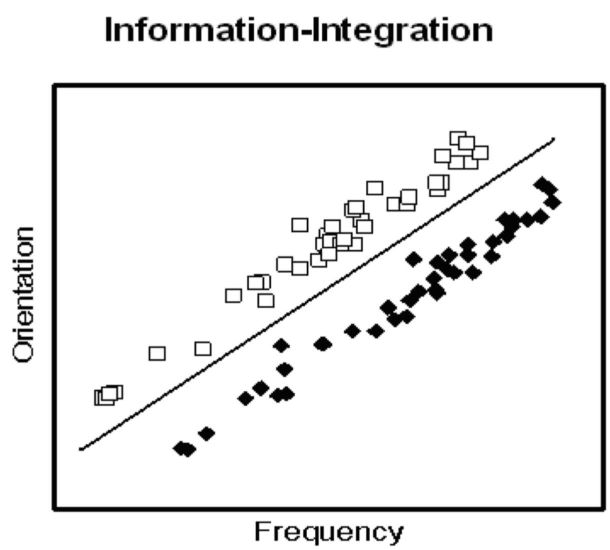


Figure 1.

Two category structures used in the Experiment. (a) A unidimensional rule-based structure, and (b) a two-dimensional information integration structure.

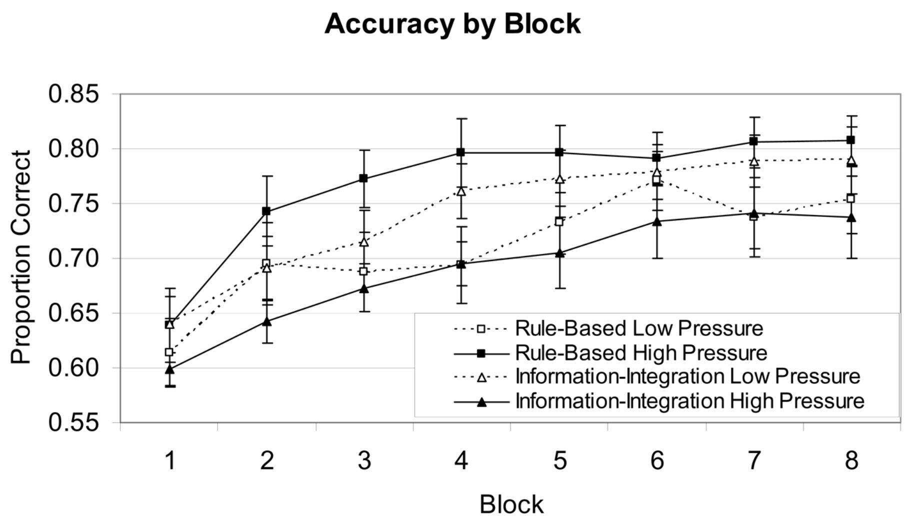
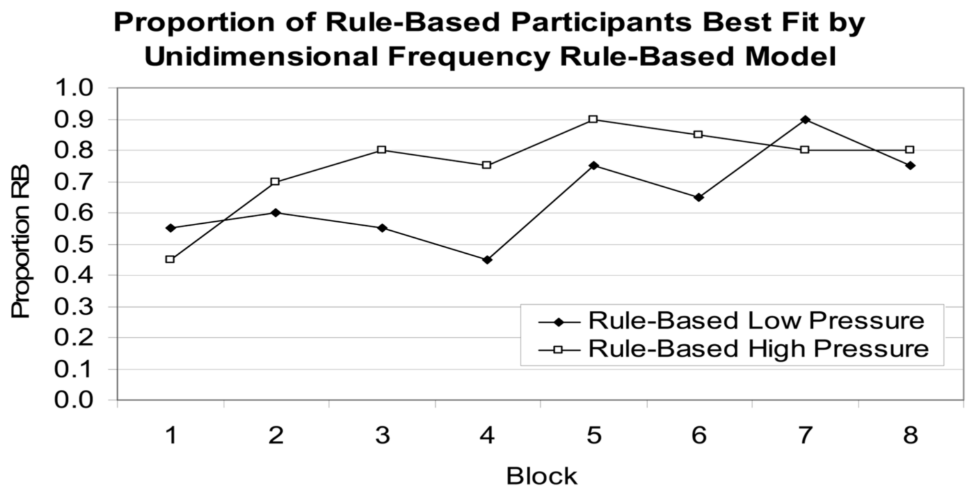


Figure 2.
Mean accuracy for the two category structures in the Low and High Pressure conditions from Experiment 1.

a.



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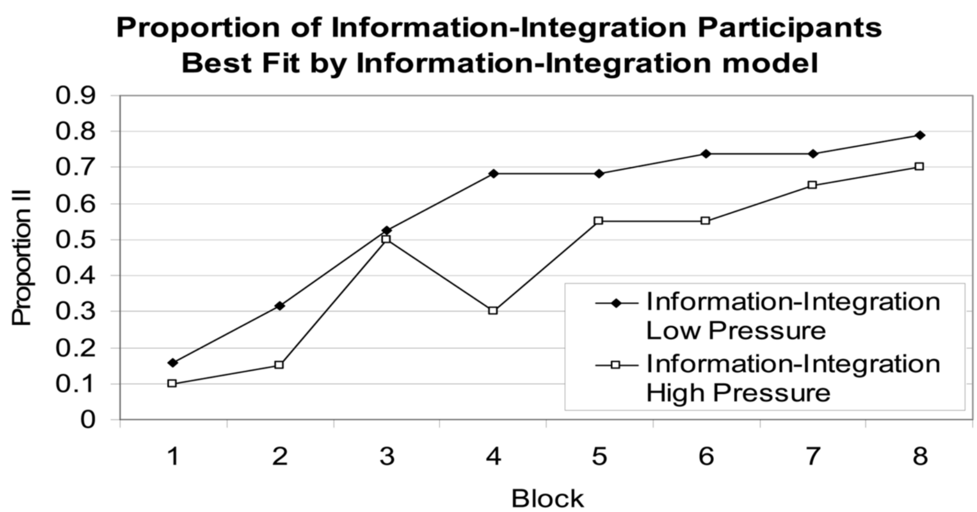

Figure 3.

Model results from Experiment 1. (a) Proportion of participants learning rule-based categories best fit by a unidimensional rule-based model on the spatial frequency dimension. (b) Proportion of participants learning information integration categories best fit by an information integration model.

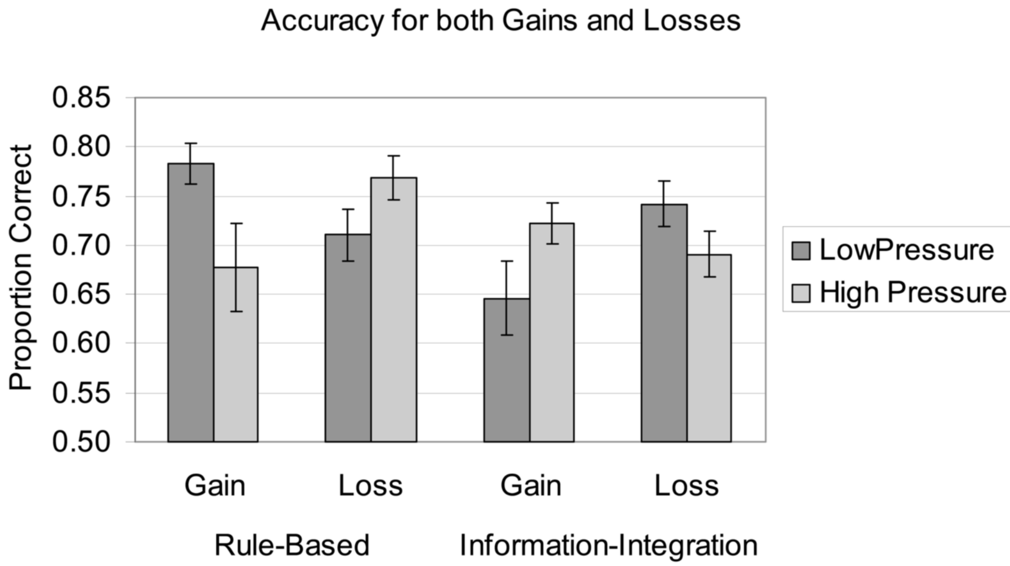

Figure 4.
Mean accuracy for participants in each condition in Experiments 1 and 2 averaged across block.