**Documentation for Simms McCormack Beckers JEP\_ABP**

This document provides notes for the paper Simms, V., McCormack, T. & Beckers, T. (2012) Additivity pretraining and cue competition effects: Developmental evidence for a reasoning-based account of causal learning. *Journal of Experimental Psychology: Animal Behavior Processes, 38,* 180-190.

The data are provided in an excel file with a key to the variables.

**Summary**

The effect of additivity pretraining on blocking has been taken as evidence for a reasoning account of both human and animal causal learning. If inferential reasoning underpins this effect, then developmental differences in the magnitude of this effect in children would be expected. Experiment 1 examined cue competition effects in children’s (4- to 5-year-olds and 6- to 7-year-olds) causal learning using a new paradigm analogous to the food allergy task used in studies of human adult causal learning. Blocking was stronger in the older than the younger children and additivity pretraining only affected blocking in the older group. Unovershadowing was not affected by age or by pretraining. In Experiment 2, levels of blocking were found to be correlated with the ability to answer questions that required children to reason about additivity. Our results support an inferential reasoning explanation of cue competition effects.

In this experiment, children were assigned to either an additive or non-additive pretraining condition, with pretraining trials administered as summarized in Table 1 (shown below). In addition to varying additivity, we also varied the order in which participants received the element and compound cues, so that backward as well as forward blocking was examined. Unovershadowing was also examined under forward and backward presentation conditions.

**Participants.** Ninety-nine 4- to 5-year-olds (mean age = 64 months, range = 56 to 71 months) and seventy-three 6- to 7-year-olds (mean age = 80 months, range = 72 to 95 months) participated in the study.

**Materials.** A purpose-built toy robot was used. The robot had a transparent Perspex center (described to the participants as the robot’s tummy); along both the right and left sides of the centre were two semi-opaque light boxes that contained battery-powered LED lights. The light boxes were divided in two, the bottom half was pink and the top half was red. The robot also contained a hidden speaker. Toy foodstuffs could be placed on a movable platform in the robot’s mouth. Pressing the robot’s nose caused the platform to move downwards into the robot’s tummy and tilt, and then the food(s) would drop into the robot’s tummy. There were 7 sets of 5 foods, one of which was a training set. Examples of the plastic foodstuffs were: an egg, a piece of cheese, a piece of bread, a banana. The tilting of the platform caused one of three responses to occur (either weak, strong, or no response). A weak response consisted of the bottom part of the robot’s tummy lighting up accompanied by a quiet, low noise. A strong response consisted of all of the robot’s tummy lighting up, accompanied by a loud, high noise. The lights and noise lasted for 3 s, then the food-stuff(s) were removed from the robot’s tummy by the experimenter through a hole at the back of the robot. These responses were pre-determined by an input file selected by the experimenter from a computerized control program. The platform returned to the start position automatically.

**Procedure. *Pretraining phase.*** Participants were shown the robot and introduced to the mechanism using one of the pretraining foods. Pretraining followed the protocol in Table 1a, dependent on whether the participant had been assigned to either the additive or non-additive pretraining group. Trials were given in the fixed order shown in the table, and each trial was presented twice. Which foodstuff in the pretraining set was used for each cue (F-I) was varied between participants. When an outcome occurred, the experimenter described the robot’s responses in the additive condition as “a bit of his tummy lighting up” when there was a weak outcome, and “all of his tummy lighting up” when there was a strong outcome. In the non-additive condition, the outcome was simply described as “the robot’s tummy lighting up”. Throughout the pretraining session children were asked a series of comprehension questions in order to ensure that they understood what they had seen.

***Element and compound training phases.***Element and compound training followed the protocol in Table 1b, with each participant completing 6 sets of trials. In what follows, each set of trials (plus associated test questions) will be referred to as a task. Participants in the forward group completed 3 forward blocking tasks and 3 forward overshadowing tasks; those in the backward group completed 3 backward blocking and 3 backward unovershadowing tasks. As in previous studies with children, but unlike in most studies with adults, the cue competition effects of blocking and unovershadowing were assessed in separate tasks to ensure that children did not have to sit through a large number of trials without a break. In each task, each trial was shown 3 times, with the order of presentation of trials within each phase varied. So, for example, in a forward blocking task, in Phase 1 participants would see a trial involving the robot being fed one foodstuff that made the robot’s tummy light up (A+) and another trial in which a different foodstuff did not make the robot’s tummy light up (E-). Participants saw each of these trials 3 times in a randomized order, before being shown the compound cues in Phase 2, with again each trial of compound cues (AB+ and CD+) shown three times in a varied order. Thus, for each task participants observed 12 trials in total before being asked test questions. The presentation order of blocking and unovershadowing tasks was counterbalanced. A new set of food stuffs was used for each separate task. Within sets, foodstuffs were counterbalanced in terms of which element they represented (A-D); however, the foodstuff representing element E remained constant as this was a filler item that was included to ensure that there was at least one cue per blocking task that was not paired with an outcome.

***Test phase.*** After the participant had observed all of the trials in one task the following questions were asked, to which children gave a yes or no answer: “Is (food name B, e.g., cheese) a food that makes the robot’s tummy light up?” and “Is (food name C, e.g., bread) a food that makes the robot’s tummy light up?” The order of the questions (B or C) was counterbalanced. Children were not asked about the causal status of cues A, E, or D because only responses to B and C are necessary for assessing cue competition effects. Then children were also asked a forced-choice question: “If you had to choose one of these foods to make the robot’s tummy light up, which one would you choose (experimenter holds out B and C)?” Children either pointed to or named the food they chose. No feedback was given to participants. The identical process was repeated for all six tasks. Children were given a break after the third task to prevent fatigue, and were provided with a brief reminder of the pretraining that they had experienced before completing tasks 4-6. On completion of the third and sixth tasks, children were thanked for their participation and given a sticker of their choice.

Table 1

*(a) Pretraining and (b) Element and compound training*

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| 1. Pretraining design
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| Additive group | F+/G-/H+/I-/FG+/FH++ |
| Non-additive group | F+/G-/H+/I-/FG+/FH+ |
| 1. Element and compound training
 |
| Task | Phase 1 | Phase 2 |
| Forward blocking  | A+, E- | AB+/CD+ |
| Forward unovershadowing | A-, E+ | AB+/CD+ |
| Backward blocking | AB+/CD+ | A+, E- |
| Backward unovershadowing | AB+/CD+ | A-, E+ |

*Note*. - indicates no response, + indicates a weak response, ++ indicates a strong response. C items were controls; E items were fillers and ensured that there were some trials in which the outcome did not occur per task. During pretraining each trial was shown twice. During element and compound training, each trial was shown 3 times.

**Results**

The data file provides the results as the following variables:

* Age in months
* Condition 1 = Additive 2 = Non additive
* Presentation Order 1 = Forward 2 = Backward
* Blocking difference scores (measure of blocking on the causal reasoning task)
* Unovershadowing difference scores (measure of unovershadowing on the causal reasoning task)
* Blocking choice scores (alternative measure of blocking on the causal reasoning task, calculated from the forced choice questions)
* Unovershadowing choice scores (alternative measure of blocking on the causal reasoning task, calculated from the forced choice questions)