Identical Transfer of Perceptual Learning Following Easy and Difficult Task Training

UCI MEMORY ATTENTION PERCEPTION LAB OF UCI

Pamela Jeter*, Barbara Anne Dosher*, Alexander Petrov*, and Zhong-Lin Lu#

* University of California Irvine
# University of Southern California

LOBES Laboratory Of Brain processES
http://lobes.usc.edu

Introduction

There is substantial variability in the literature concerning the degree of task and stimulus specificity in perceptual learning. Several studies have shown that the degree of specificity may vary as a function of task difficulty (Ahissar & Hochstein, 1997; Ball & Sekuler, 1982; Fine & Jacobs, 2002; Liu, 1999; Liu & Weinshall, 2000; Rubin, Nakayama, & Shapley, 1997). Training in a more difficult task or context does not necessarily transfer to similar test paradigms whereas training in an easier task is more likely to generalize. Participants training in a difficult task may improve performance, however, when tested subsequently in a related but different difficult task, participant's performance returns to baseline. When participants are trained in an easy task and tested subsequently in a related easy task, performance generalizes. As a result, a pattern has emerged in the literature describing specificity when switching between two difficult but related conditions and generalization when switching between two easy conditions. Results in the literature describe similar patterns of specificity, however, none have directly tested whether the amount of transfer between tasks depends upon the initial training difficulty, the transfer test difficulty, or both. We ask the question, does the extent of transfer in a task depend on the difficulty level of the initial training task. To address our question we tested two conditions in a psychophysical study. These conditions are EASY Post-test and DIFFICULT Post-test. Two groups in each condition trained in an EASY or DIFFICULT task for a total of 4 groups. EASY and DIFFICULT orientation discriminations are defined by distance in degrees (±12° or ±5°) from an oblique reference angle. It is important to note, the tasks in the transfer phase are identical to one another and that this controlled comparison has not been previously tested. Introducing this comparison revealed identical performance in the transfer task regardless of the difficulty level of initial training.

Method

Observers trained in one difficulty level for 4 sessions and tested in a subsequent post-test condition for 4 sessions with 1248+ trials (including demos) in each session. The stimuli used were Gabor patches differing in orientation by a total of 24 degrees (+/- 12°) in all EASY conditions and by a total of 10 degrees (+/-5°) in all DIFFICULT conditions (See Figure 1). Targets deviate symmetrically either from an oblique reference angle of -35° or of +55°. All distances are measured in degrees of visual angle relative to the center of the screen. Retinal positions are located in four oblique corners: NW, NE, SW, and SE. Each is located approximately 5.67° from fixation. Each stimulus consists of 6 frames lasting for 15.15msec increments. Two Gabor frames are 'sandwiched' between pairs of noise frames (See Figure 2). The Gabor patches are presented within two noise levels: "none" and "high". The dependent variable was contrast threshold.

The task consisted of discriminating between a Gabor tilted clockwise ('Right') or counterclockwise ('Left') from a reference angle. Presentation positions varied on 2 diagonals, NW/SE or NE/SW. Gabor targets were presented at random in one of two oblique corners depending on the diagonal. The Gabor reference angle and diagonal were fixed for each session within the training and testing conditions. Participants trained on one diagonal and one reference angle for 4 sessions and switched to the opposite diagonal and reference angle for the remaining 4 sessions. Feedback was given for incorrect responses. A mean response was computed by averaging all the reversals for each staircase sequence.

EXAMPLE OF STIMULI

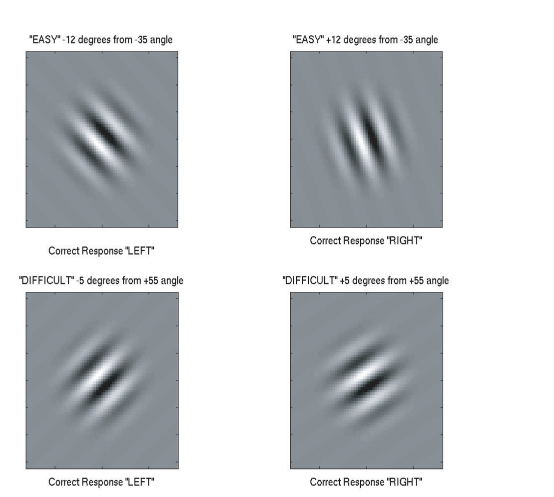

Figure 1. Example of Gabor Stimuli in No Noise. EASY stimuli are tilted +/- 12° from a reference angle (-35°) and the DIFFICULT stimuli are tilted +/- 5° from a reference angle (55°).

EXAMPLE OF TRIAL SEQUENCE

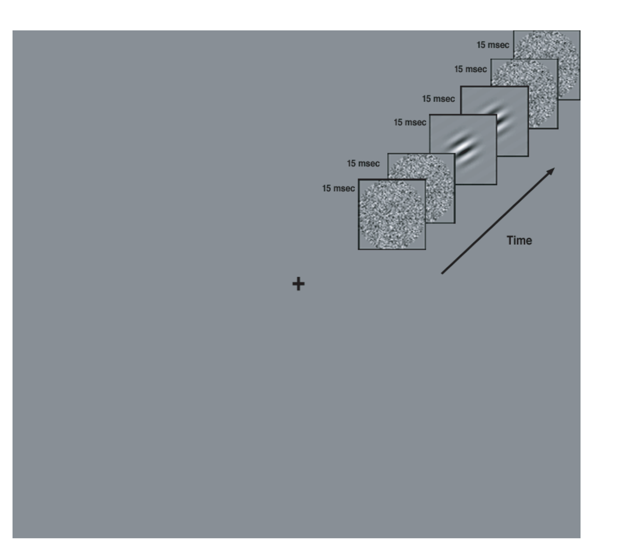

Figure 2. Trial Sequence Example. An observer is cued for an orientation discrimination response while keeping eyes on the fixation point. In this example, the target Gabor is tilted to the right of a 55° reference angle and is embedded in High noise. Only one trial is shown here. Gabor target is presented in NE corner of NE/SW diagonal.

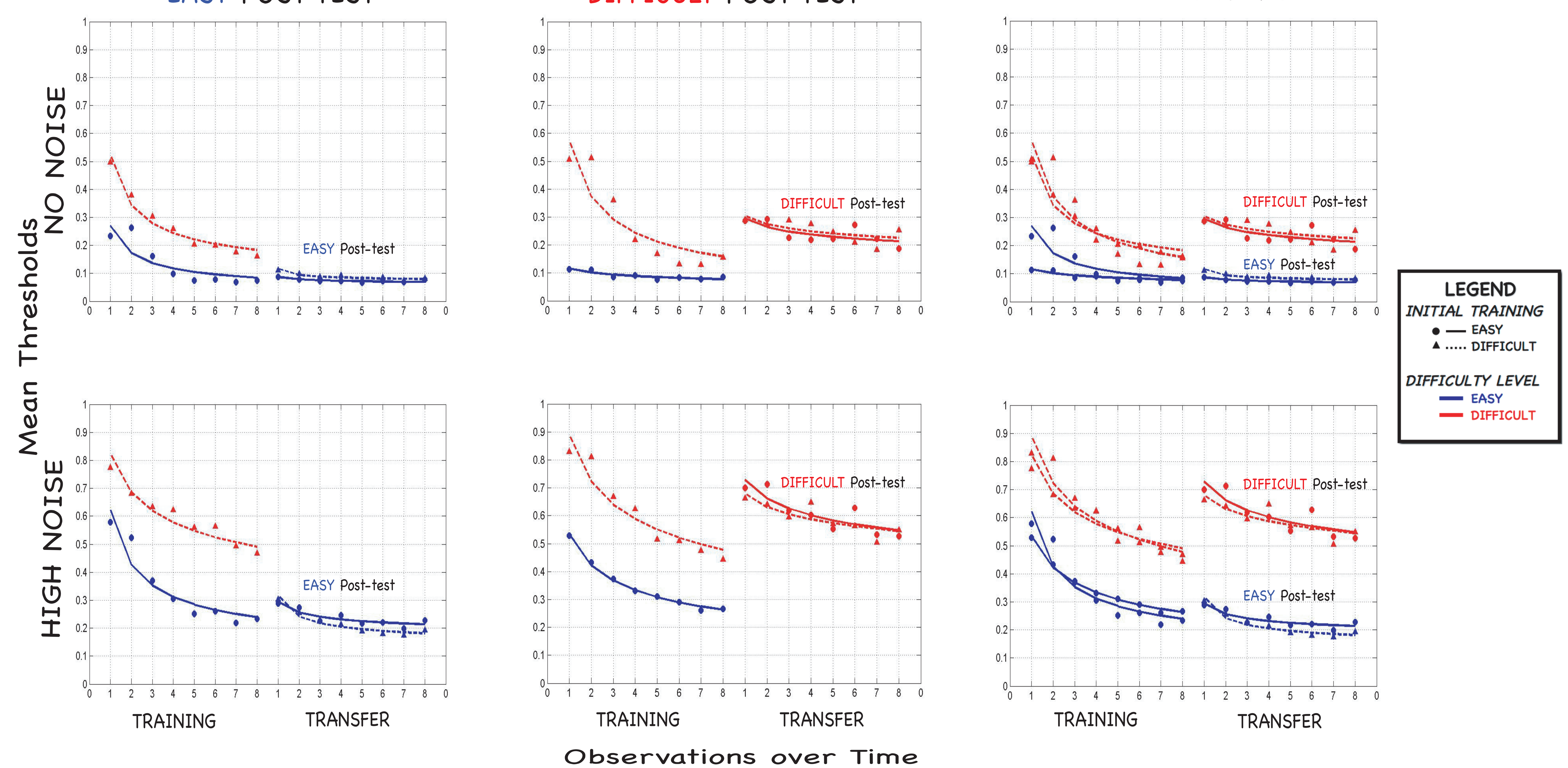

Figure 3. Power fits for aggregate data. All graphs represent training and testing phases in both post-test conditions, EASY and DIFFICULT. The top graphs are data presented in No Noise and the bottom graphs are data presented in Hi Noise. There are 8 data points for each phase. Each data point represents Mean Threshold over two blocks and every two data points represents a session. Each phase consisted of four sessions. N = 8 for EASY and N = 7 for DIFFICULT.

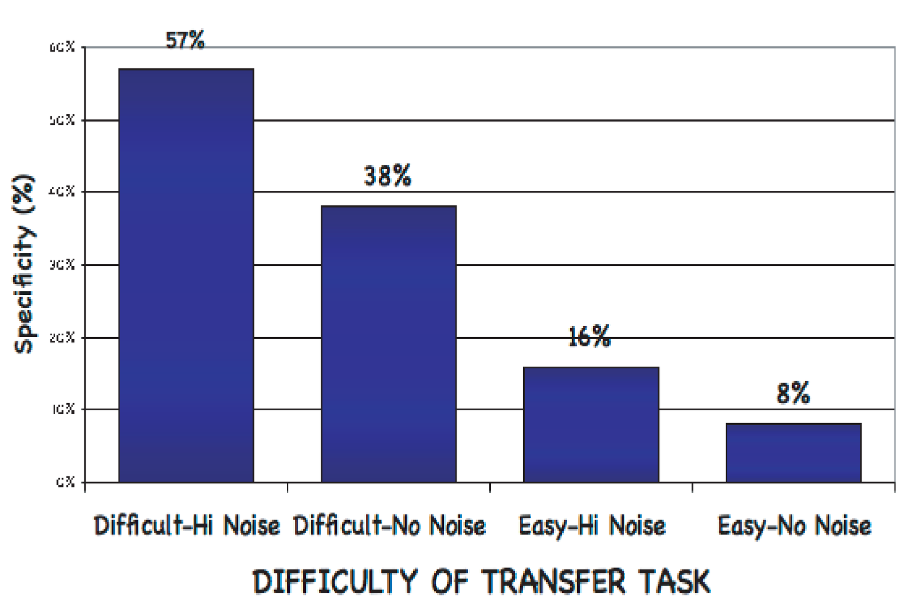

Figure 4. Specificity Index, following Ahissar & Hochstein's convention. The index compares the initial starting level for the transfer tests averaged over group to the size of learning in the same condition of initial training, averaged over subject group. Higher % of specificity is found for the DIFFICULT conditions than for the EASY conditions.

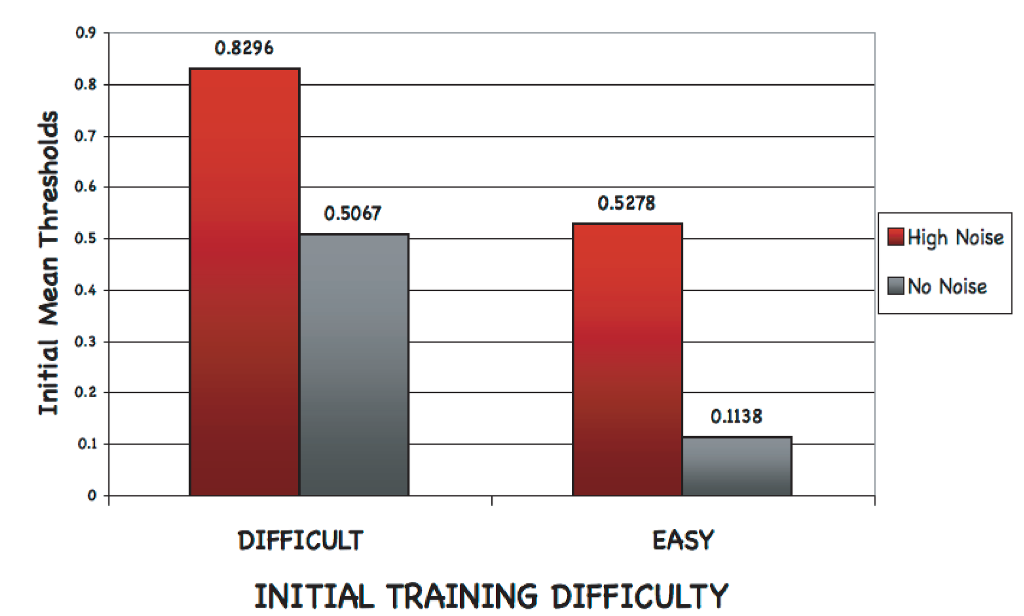

Figure 5. Effects of Noise and Difficulty. Initial points are plotted to compare the effects of noise and difficulty. When comparing 'within' training types, bars show a noise effect. Comparing 'between' training types, bars show a difficulty effect within noise conditions.

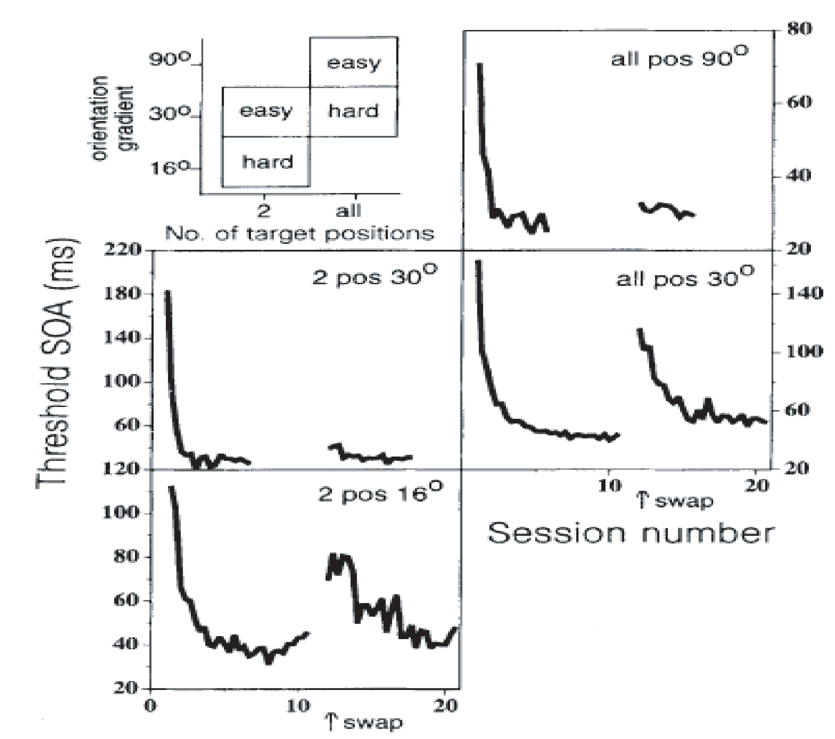

Figure 6. From Ahissar and Hochstein (1997). For comparison, we see similar patterns in transfer from Easy to Easy and Difficult to Difficult.

Results

- The most surprising and compelling results of this study are that the difficulty of training had no effect on the amount of transfer to the second task. Initial training in EASY and DIFFICULT shows 'identical' transfer in the EASY and DIFFICULT post-test. We show a lack of statistically significant difference in the learning curves between groups in the training and transfer testing phases (see Table 1).
- A Specificity Index calculated by Ahissar and Hochstein's convention compares performance after the switch over total improvement in the initial training phase for each task difficulty (see Figure 4). We find greater specificity for DIFFICULT transfer conditions than for EASY transfer conditions, regardless of the type of initial training.
- Discrimination thresholds were higher for smaller orientation angles and discrimination thresholds were also affected by external noise. Averaging over groups, the thresholds for DIFFICULT and EASY discrimination angle tasks in high noise and no noise conditions from the initial training show these effects (see Figure 5).
- THE DIFFICULT LEVEL OF THE TRANSFER TEST, NOT THE DIFFICULTY LEVEL OF THE INITIAL TRAINING, CONTROL THE DEGREE OF TRANSFER.

Discussion

Ahissar and Hochstein (1997) argued that training on DIFFICULT tasks showed specificity while training on EASY tasks did not. Their results show training in a DIFFICULT task resulted in specificity in the DIFFICULT transfer test and transfer resulted from an EASY training task to an EASY transfer test (see Figure 6). Our data concur with this pattern, however, we find under our experimental conditions that the extent of transfer is determined by the transfer task and is not closely dependent upon the initial training task.

Our study included a comparison for EASY and DIFFICULT transfer tasks following initial training in EASY and DIFFICULT tasks. It is this difference in experimental design that provides a more complex view of the relationship between task transfer and task difficulty. Our results strongly suggest that it is not the difficulty of the initial training that determines the amount of transfer, but rather the difficulty of the transfer task.

What predicts the amount of transfer from training to post-test deserves further contemplation and study.

Table 1. ANOVAs for the curve fits

TRAINING PHASE	NO NOISE	HIGH NOISE
EASY	F(1, 6) = 1.491, p = 0.268	F(1, 6) = 0.014, p = 0.910
DIFFICULT	F(1, 6) = 0.119, p = .0742	F(1, 6) = 0.152, p = 0.710
TESTING PHASE	NO NOISE	HIGH NOISE
EASY	F(1, 7) = 1.792, p = .222	F(1, 7) = 0.587, p = 0.469
DIFFICULT	F(1, 6) = 0.037, p = .854	F(1, 6) = 0.062, p = 0.812

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