Vernier learning with short- and long-staircase training and its transfer to a new location with double training

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We previously demonstrated that perceptual learning of Vernier discrimination, when paired with orientation learning at the same retinal location, can transfer completely to untrained locations (Wang, Zhang, Klein, Levi, & Yu, 2014; Zhang, Wang, Klein, Levi, & Yu, 2011). However, Hung and Seitz (2014) reported that the transfer is possible only when Vernier is trained with short staircases, but not with very long staircases. Here we ran two experiments to examine Hung and Seitz's conclusions. The first experiment confirmed the transfer effects with short-staircase Vernier training in both our study and Hung and Seitz's. The second experiment revealed that long-staircase training only produced very fast learning at the beginning of the pretraining session, but with no further learning afterward. Moreover, the learning and transfer effects differed insignificantly with a small effect size, making it difficult to support Hung and Seitz's claim that learning with long-staircase training cannot transfer to an untrained retinal location.

Introduction

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, 1998; , & , 1992; ,
, & , 1995).

98; 3351 25

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8[0.3)9.

Methods

Observers

ï (± SD = 21.6 ± 2.0)

Apparatus

. (2014). -3 (, 1997) 21 . : 2,048 × 1,536 , 0.19 ( ) × 0.19 ( ) , 75 ; : 1,024 × 768 , 0.38 ( ) × 0.38 ( ) , 120 . 50 / 2. 8- - . , - - 1 .

Stimuli

(1) . (2014). 5° (= 3 /°, SD = 0.29°, = 0.47, = , - - = 4λ). 5° (= 1.5 /°, SD = 0.29°, = 36° 126°, = 0.47,). .

Procedure

- 200 .

20

1.5 2

Eye movement control

(, ,)

(2°).

( ).

5.4%

1 (1;

2).

94.4% ± 3.6% (SD)

4°

Results

Experiment 1: Vernier learning through short-staircase training and its transfer with double training

(1),

1 .

( ).

(1).

–0.049, 95% ( ) –0.075, –0.023[,

$t(7) = -4.466$, $p = 0.003$, $d = -1.58$,

, (1 –) × 100,

(2014; 1), 36.31%, 95% 5.78%, 66.85%[, 35.83%, 95% 9.71%, 61.94%[, (1 ,).

$F(1, 7) = 10.58$, $p = 0.014$, $\eta^2 = 0.602$, , $F(1, 7) = 0.003$, $p = 0.96$, $\eta^2 < 0.001$.

(1), 27.43%, 95% 14.58%, 40.28%[, 20.86%, 95% 5.80%, 35.92%[,

$F(1, 7) = 17.65$, $p = 0.004$, $\eta^2 = 0.716$, , $F(1, 7) = 5.36$, $p = 0.054$, $\eta^2 = 0.433$.

(2014) (2014)

(1 . 1 ,).

Experiment 2: Vernier learning through long-staircase training and its transfer with double training

(2).

(2014), (2)

–0.013, 95% –0.028, 0.002[,

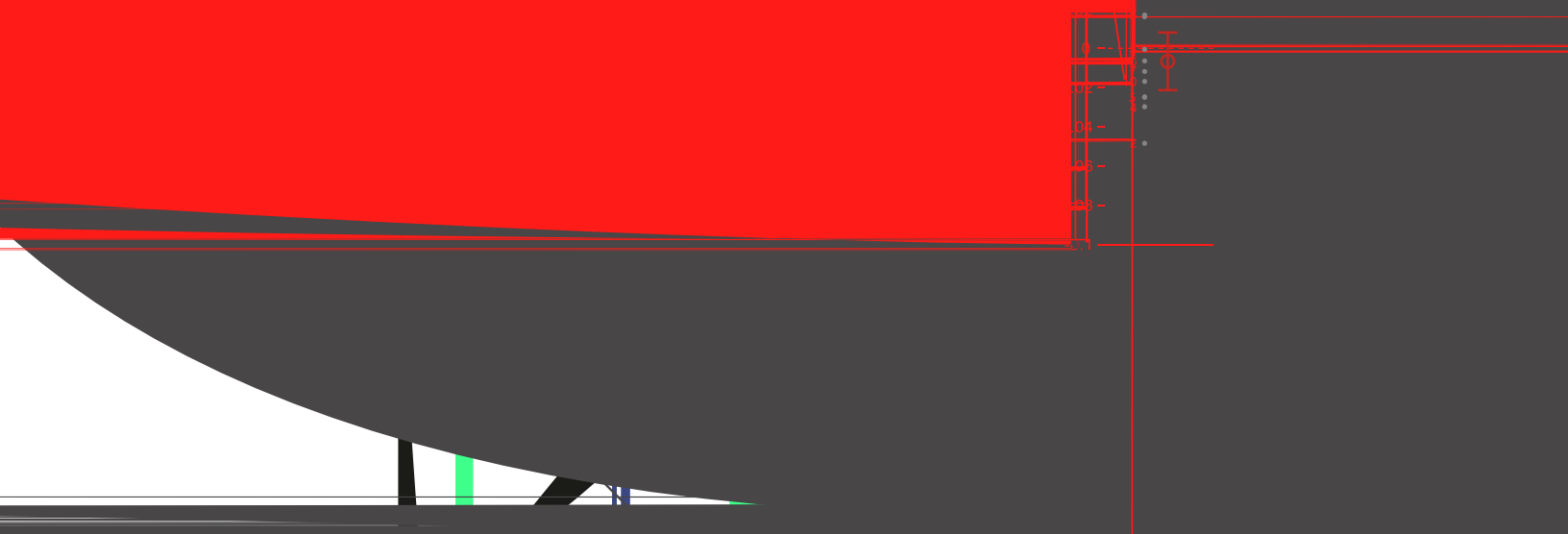

Figure 2. The training and transfer effects after double training with long-staircase Vernier training and multiple short-staircase orientation training at the same location. (a) Left: The staircase-by-staircase changes of Vernier thresholds at the training (open symbols) and transfer (solid symbols) locations. The red line is the loglinear fit of the Vernier thresholds at the training location. Right: Individual (gray dot) and mean (open circle) slopes of loglinear fits of the Vernier learning functions with long-staircase training. (b) Left: The session-by-session Vernier threshold changes at the training (open symbols) and transfer (solid symbols) locations when the first-staircase thresholds were used to represent session thresholds. Right: Individual (gray dot) and mean (open circle) percentage improvements at training and transfer locations. Each pair of gray dots connected by a gray line indicate a different observer's data. (c) Left: The session-by-session Vernier threshold changes at the training (open symbols) and transfer (solid symbols) locations when the geometric means of all staircases in the corresponding pretraining and posttraining sessions were used to represent session thresholds. Right: Individual (gray dot) and mean (open circle) percentage improvements at training and transfer locations. Each pair of gray dots connected by a gray line indicate a different observer's data. The error bars represent 95% CIs.

(2014)

$F(1, 9) = 14.48$, $p = 0.004$, $\eta^2 = 0.617$,

, $F(1, 9) = 2.98$, $p = 0.118$, $\eta^2 = 0.249$,

2 ,). p ($p = 0.118$)

($n = 10$; $n = 6$

&). , ($\eta^2 = 0.249$),

(2014),

−2.21%, 95% −17.58%, 13.16%[,

−2.23%, 95% −13.04%, −8.58%[,

, $F(1, 9) = 0.223$, $p = 0.648$, $\eta^2 = 0.024$, , $F(1, 9) < 0.000$, $p = 0.997$, $\eta^2 < 0.001$.

Discussion

(& , 2014; ., 2014; ., 2011).

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(2014)

(2014)

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” (8424).

1 2).

( ) , & , 1995; & , 1993).

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(& , 1997; , & , 1997). 50

Keywords: perceptual learning, Vernier discrimination, transfer, double training

Acknowledgments

31470975 ( )
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