

I. E. (2005), F. (2005), A. & M. (1993), A. (2000; J., M., A., & (2013)), M. D. (1996), D. L. (1998), & (2009), I. (2000), A. (2008; & (2016); & (2010)), w. (B., & (2016)), (2008; (2016)), A. (2008; (2016)), A.

Experiment 1

I. E. 1 w. F. (2005), E. 2-4. f. 1 H. 6 H.

(A., M., L., C., & (1986; I., K., I., & B., 1977; J., (1980; (1970)), w.

Method

Participants. (11 19 $M = 21.2$, $SD = 2.2$) w. (≤ 20 B HL $0.5-6$ H.)

Sample size. (A-F: 900 F., 2B f., M., & F., 2010). $p = .05$, $d = 1.22$ H., w. f. 10 f., w.

Apparatus. A. 3.0 f w. (1997) 15- M. B. HD-499 (G. H. & C., KG, G.).

Stimuli and procedure. f w 15- 100 w. 1 6 H. E. w. 86 B. L. 5- 300 w. 785 M. F. (2010). A. (w. f.). A. w. I. (Δf , 50%, w. Δf 1.414 f. w. 79% E. 60 w.

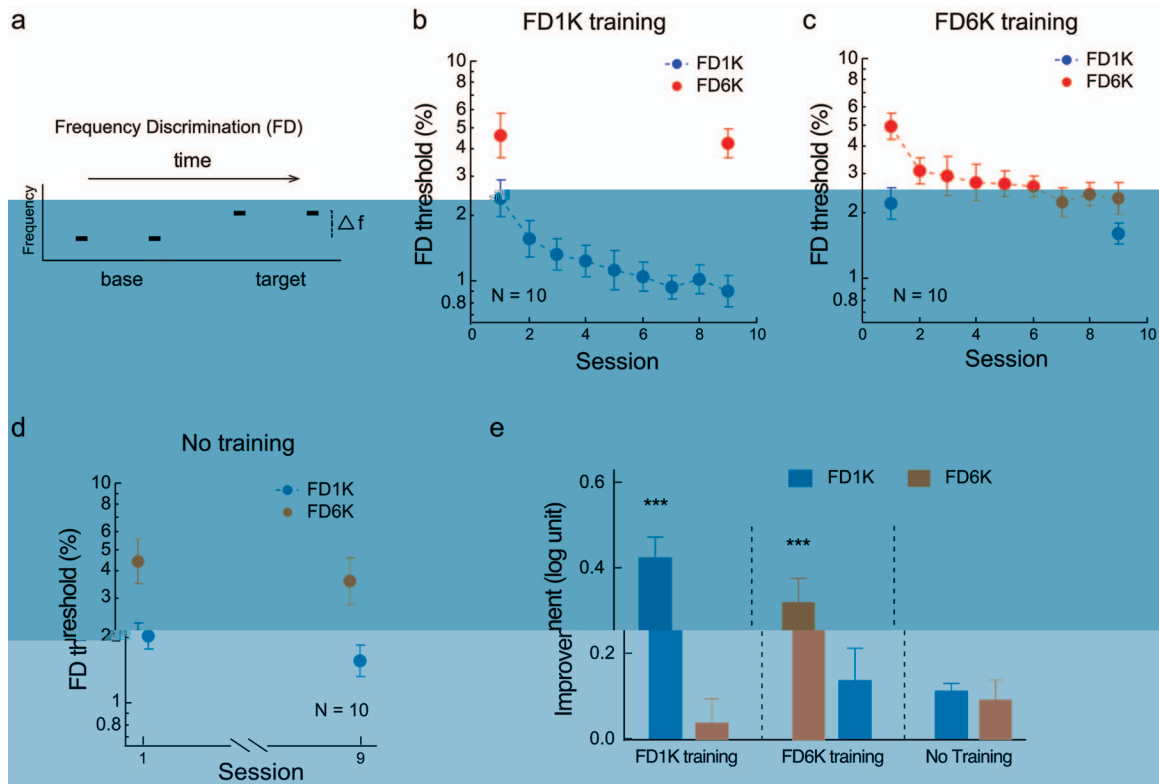


Figure 1. Frequency Discrimination (FD) training results. (a) Schematic of the FD task. (b) FD1K training results. (c) FD6K training results. (d) FD threshold for 'No training' conditions. (e) Improvement in log units for FD1K and FD6K training compared to no training. Error bars represent ± 1 SE. FD: frequency discrimination. *** $p < .001$.

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Experimental design.

FD1 FD6
 2
 9, 14
 E
 12
 (L 6 H). E
 1 H FD1
 6 H FD6
 A
 7, 12

Data processing and statistical analysis.

(F C, 2015). I
 : $p < .001$ 1 H $p < .001$ 6 H

; $p = .67$ 1 H $p = .10$ 6 H

A (LME)
 E 13
 & B, 2000).
 (L 6 H),
 (FD1, FD6
 1; ED6
 FD1 / 6, / 6
 E 3)
 F
 A
 A
 2004).

Results

FD1 (1 H: 0.42 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.04 ± 0.06 , $F(6, 190) = 141.90, p < .001$), FD6 (1 H: 0.32 ± 0.06 , $F(1, 190) = 6.87, p < .001$; 6 H: 0.14 ± 0.08 , $F(6, 190) = 3.19, p = .005$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

LME ($F(1, 190) = 120.99, p < .001$; 6 H: 0.04 ± 0.06 , $F(6, 190) = 141.90, p < .001$), E ($F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I ($F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E ($F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I ($F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

Discussion

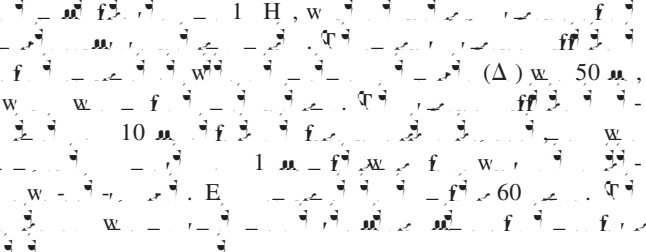
L (6 H: 0.04 ± 0.06 , $F(6, 190) = 141.90, p < .001$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

Experiment 2

E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

Method

Participants. 12 participants ($M = 22.8$, $SD = 2.7$), w...
Stimuli and procedure. 6-H...
 E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).



Experimental design

E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

Results

D (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

Discussion

6 H: 0.04 ± 0.06 , $F(6, 190) = 141.90, p < .001$), E (1 H: 0.46 ± 0.05 , $F(1, 190) = 120.99, p < .001$; 6 H: 0.31 ± 0.06 , $F(6, 190) = 141.90, p < .001$), I (1 H: 0.11 ± 0.02 , $F(1, 190) = 3.89, p = .001$; 6 H: 0.09 ± 0.05 , $F(6, 190) = 1.3$).

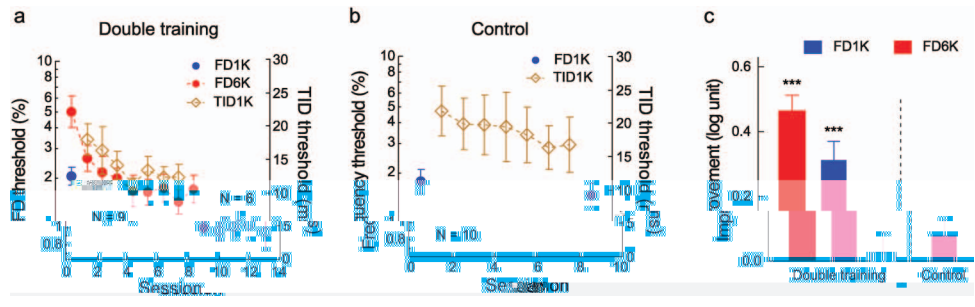


Figure 2. (a) Double training. (b) Control. (c) Improvement (log unit). Error bars represent ± 1 SE. FD = frequency threshold; TID = TID threshold. *** $p < .001$.

Experiment 3

Experiment 3 was designed to test the effects of double training on the frequency and TID thresholds. Participants were divided into three groups: FD1K, FD6K, and TID1K. The FD1K group received 1 hour of training per session, while the FD6K and TID1K groups received 6 hours of training per session. The results showed that the double training condition significantly improved the frequency and TID thresholds compared to the control condition.

Method

Participants. Thirteen participants were recruited for Experiment 3. The mean age was 24.1 years, and the standard deviation (SD) was 3.1 years.

Stimuli and procedure. The stimuli consisted of 1-H and 6-H words. The procedure involved a series of trials with different word lengths and frequencies. The words were presented at 300 Hz, 200 Hz, and 100 Hz. The procedure was repeated for 2,000 trials, with 6 H words and 1 H words.

Experimental design. The experimental design was a 2 (Condition: Double training, Control) \times 3 (Group: FD1K, FD6K, TID1K) design. The double training condition involved 12 sessions of 1 H and 6 H words, while the control condition involved 6 sessions of 1 H and 6 H words.

Experiment 3 was designed to test the effects of double training on the frequency and TID thresholds. Participants were divided into three groups: FD1K, FD6K, and TID1K. The FD1K group received 1 hour of training per session, while the FD6K and TID1K groups received 6 hours of training per session. The results showed that the double training condition significantly improved the frequency and TID thresholds compared to the control condition.

Results

The results showed that the double training condition significantly improved the frequency and TID thresholds compared to the control condition. The mean frequency threshold for the double training condition was 0.42 ± 0.05 , while for the control condition it was 0.31 ± 0.05 . The mean TID threshold for the double training condition was 0.11 ± 0.04 , while for the control condition it was 0.08 ± 0.03 . The results were significant ($t = 6.02, p < .001, 95\% \text{ CI } 0.28, 0.56, C d = 1.90$ for frequency threshold; $t = 4.44, p < .001, 95\% \text{ CI } 0.17, 0.45, C d = 1.40$ for TID threshold).

Discussion

The results of Experiment 3 demonstrate that double training significantly improves the frequency and TID thresholds. This suggests that the combination of 1-hour and 6-hour training sessions is more effective than either condition alone. The results are consistent with the findings of previous studies on the benefits of spaced repetition and interleaved practice.

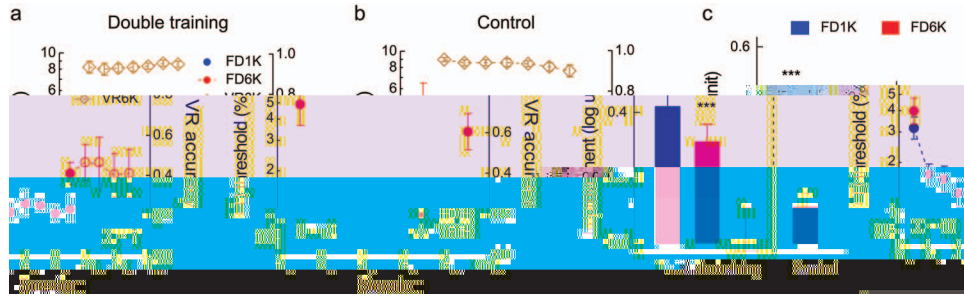


Figure 3. VR accuracy and threshold for Double training (a), Control (b), and FD groups (c). Data are shown for FD1K (blue) and FD6K (red). Error bars represent ± 1 SE. FD = f...; *** $p < .001$.

Experiment 4

H w ... (& ... , 2003). ... B ... I ... w ... F ... (4 H)

Method

Participants. ... 14 ... = 23.6 ... SD = 3.0 ... Tasks. ... E ... 2 w ...

Experimental design.

E ... f ... (1, 4 ... 6 H) ... 1.5 I ... 6 H w ... 1 H ... 6 H w ... E ... 1 ... F ... w ... w ... 12 17 ... 2 ...

Data analysis.

A LME ... (1, 4 ... 6 H) ... (& B ... , 2000). F ... LME ... w ... B ... (... , 2004).

Results

F ... 6 H ... 0.11 \pm 0.06 ... 1 H , 0.12 \pm 0.06 ... 4 H ... 0.39 \pm 0.06 ... 6 H . Af ... 1 H ... 0.20 \pm 0.07 ... 1 H , 0.05 \pm 0.03 ... 4 H ... -0.01 \pm 0.03 ... 6 H (F ... 4 ... 4).

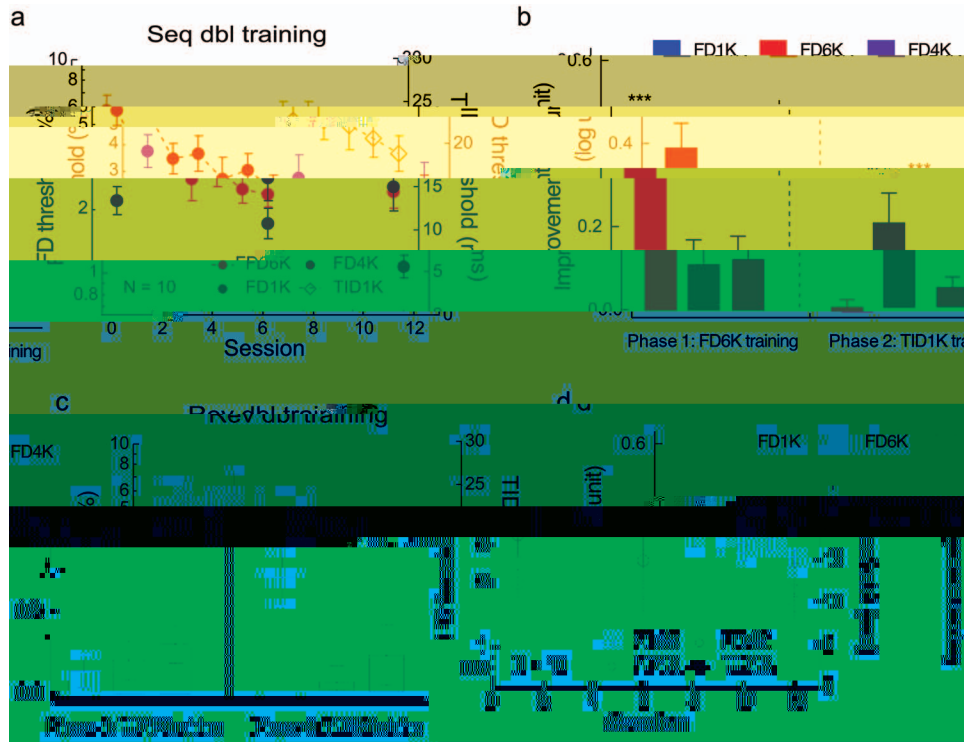
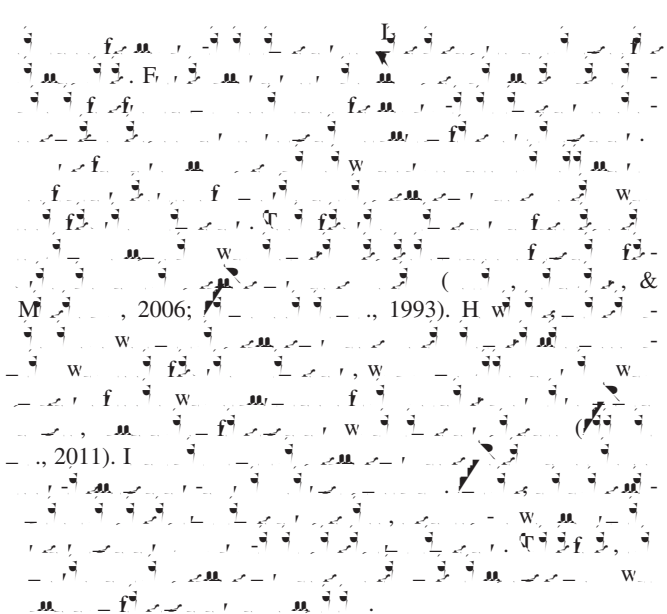


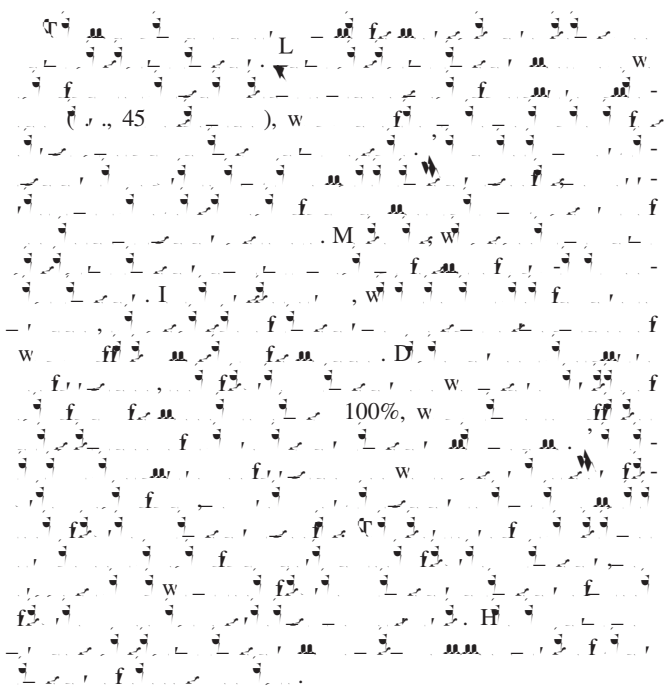
Figure 4.

FD1K, FD6K, FD4K. LME $F(2, 144) = 43.06, p < .001$; $F(2, 144) = 32.44, p < .001$; $F(1, 18) = 0.68, p = .42$. $F(2, 144) = 3.60, p = .008$; $F(4, 144) = 6.96, p < .001$. $F(2, 144) = 6.94, p < .001, 95\% \text{ CI } 0.26, 0.52, C \text{ (} d = 2.19$). $1 \text{ H } (t = 1.94, p = .16, 95\% \text{ CI } -0.02, 0.24, C \text{ (} d = 0.61)$. $4 \text{ H } (t = 2.15, p = .10, 95\% \text{ CI } -0.01, 0.25, C \text{ (} d = 0.68)$. $1 \text{ H } (t = 3.61, p = .001, 95\% \text{ CI } 0.07, 0.34, C \text{ (} d = 1.14)$. $4 \text{ H } (t = 0.82, p = 1.00, 95\% \text{ CI } -0.09, 0.18, C \text{ (} d = 0.23)$. $6 \text{ H } (t = 0.21, p = 1.00, 95\% \text{ CI } -0.12, 0.15, C \text{ (} d = 0.07; F(2, 4) = 4.4)$. $1 \text{ H } (t = 1.46, p = .44, 95\% \text{ CI } -0.05, 0.22, C \text{ (} d = 0.46)$, $4 \text{ H } (t = 2.14, p = .10, 95\% \text{ CI } -0.01, 0.25, C \text{ (} d = 0.68)$, $6 \text{ H } (t = 0.94, p = 1.00, 95\% \text{ CI } -0.08, 0.19, C \text{ (} d = 0.30)$. $6 \text{ H } (t = 4.91, p < .001, 95\% \text{ CI } 0.14, 0.41, C \text{ (} d = 1.55)$, $1 \text{ H } (t = 0.36, p = 1.00, 95\% \text{ CI } -0.11, 0.15, C \text{ (} d = 0.11)$. $4 \text{ H } (t = 1.57, p = .36, 95\% \text{ CI } -0.04, 0.22, C \text{ (} d = 0.50; F(2, 4) = 4.4)$.

Discussion



Context



References

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