Posture vs. Performance in a Dual-Task Paradigm

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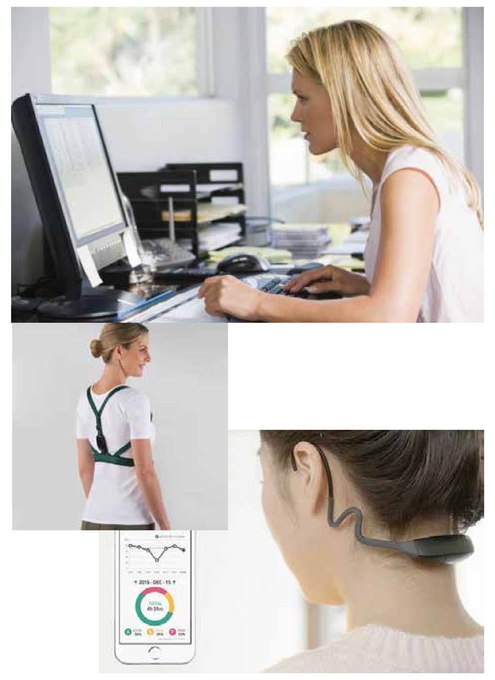
Background & Rationale

Poor posture is common during computer work[1], leading to long-term neck pain[2]

- This pain is thought to result from compression of vertebrae[3]
- Biofeedback interventions are poorly validated[4] and rely on awareness of posture[5]
- Cognitive factors influence alignment[6]
  - Reaching with the head when anticipating movement
  - Poor inhibitory control relates to neck shortening during movement preparation



Hypotheses

Main idea: Effective use of biofeedback requires attention, resulting in dual-task costs

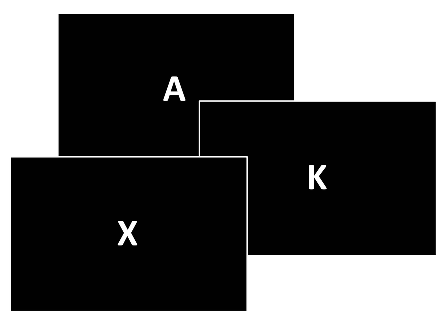
1. The use of biofeedback will improve posture
2. The use of biofeedback will interfere with performance
   - Weaker attentional control will result in greater dual-task costs
   - Cognitive factors will relate to dual-task costs

Method

Procedure

- Basic postural instruction: workspace adjusted to OSHA standard[1]
- 10 minute computer game performed twice (counterbalanced)
  - No posture feedback
  - Posture biofeedback

Measures

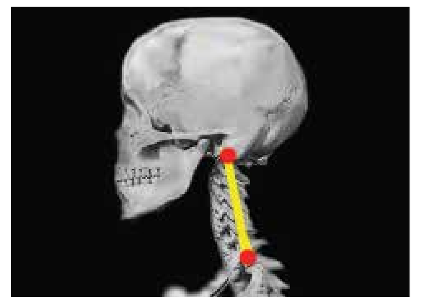


- Simple Reaction Time: Respond as fast as possible
- Go/No-Go: Fast as possible unless it's X
  - Inhibition/processing speed: GnG-SRT reaction time [7]
  - Larger value = greater information processing costs
- Dual-task cost of biofeedback using game score[8]:

$$\frac{\text{no feedback - biofeedback}}{\text{no feedback}} \times 100$$

  - Higher percentage indicates poor attention management

- Measured cervical compression with relative neck length
  - Distance between atlanto-occipital joint and joint below 7th cervical vertebrae
    - Initially measured during "best posture" recording [1]
    - Computed as % of "best posture" during task



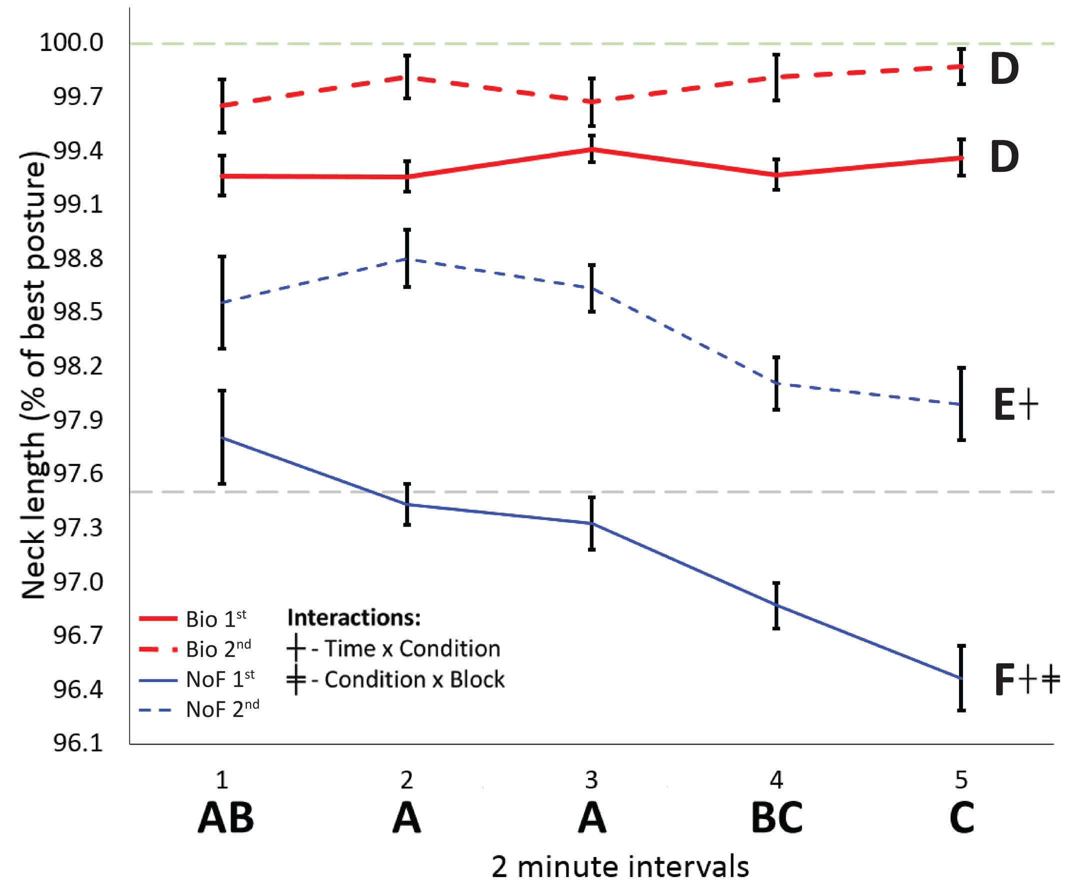
- Correlated changes in posture with cognitive measures
  - % neck length for the entire task
  - Difference in neck length with and without biofeedback (biofeedback - no feedback)

Postural Biofeedback

- Relative neck length used to generate warnings
  - Audible tone when average per 10 sec was < 97.5%

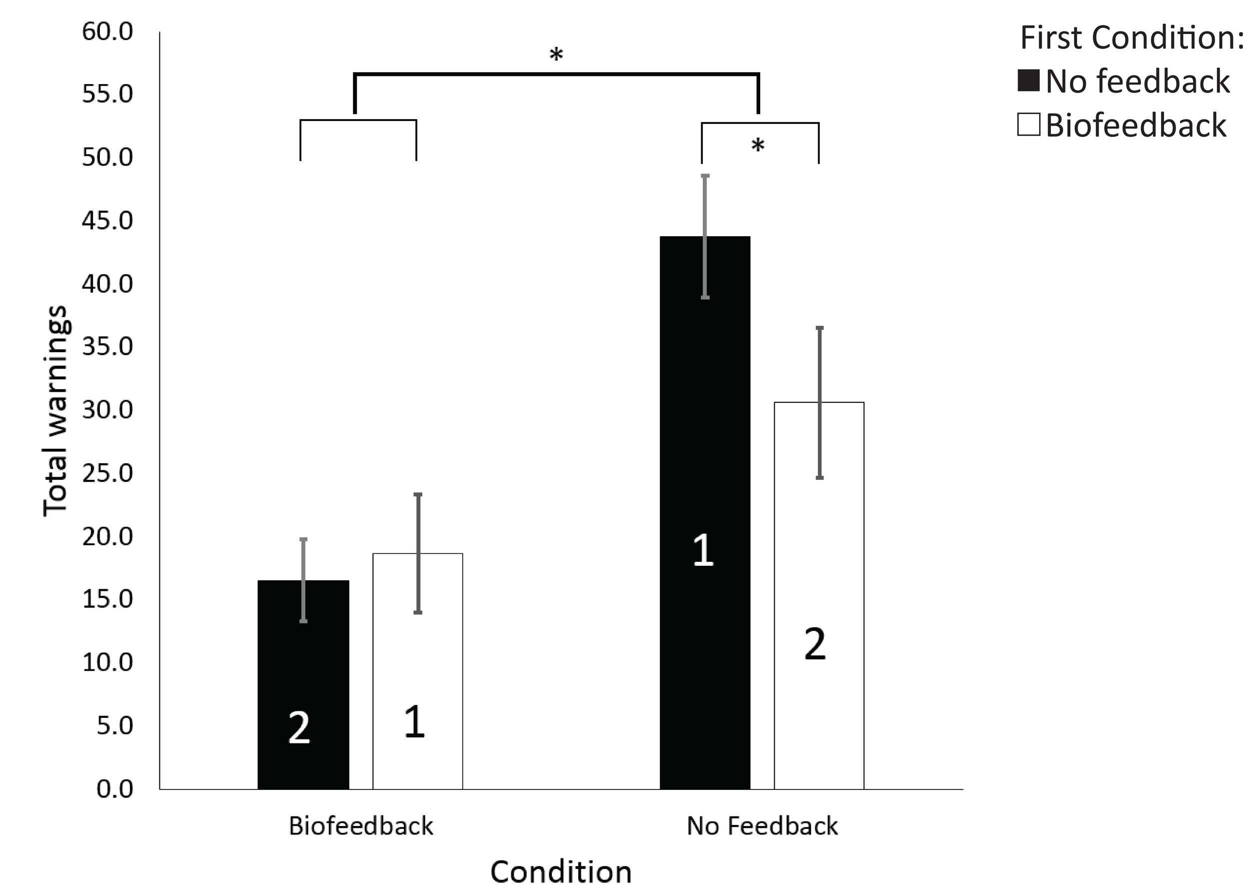
Results: posture and task performance

Neck length decreases over time without feedback



With biofeedback, neck length was longer than without (p<0.001). Neck length decreased over time: (p=0.001). Time was subject to an interaction with condition (p<0.001); without biofeedback, neck length decreased (p<0.001), but with biofeedback it did not. Condition was subject to an interaction with block (p=0.01). Neck length was lower without feedback than with biofeedback for those who did the task 1st (p=0.049), but not for those who did the task 2nd.

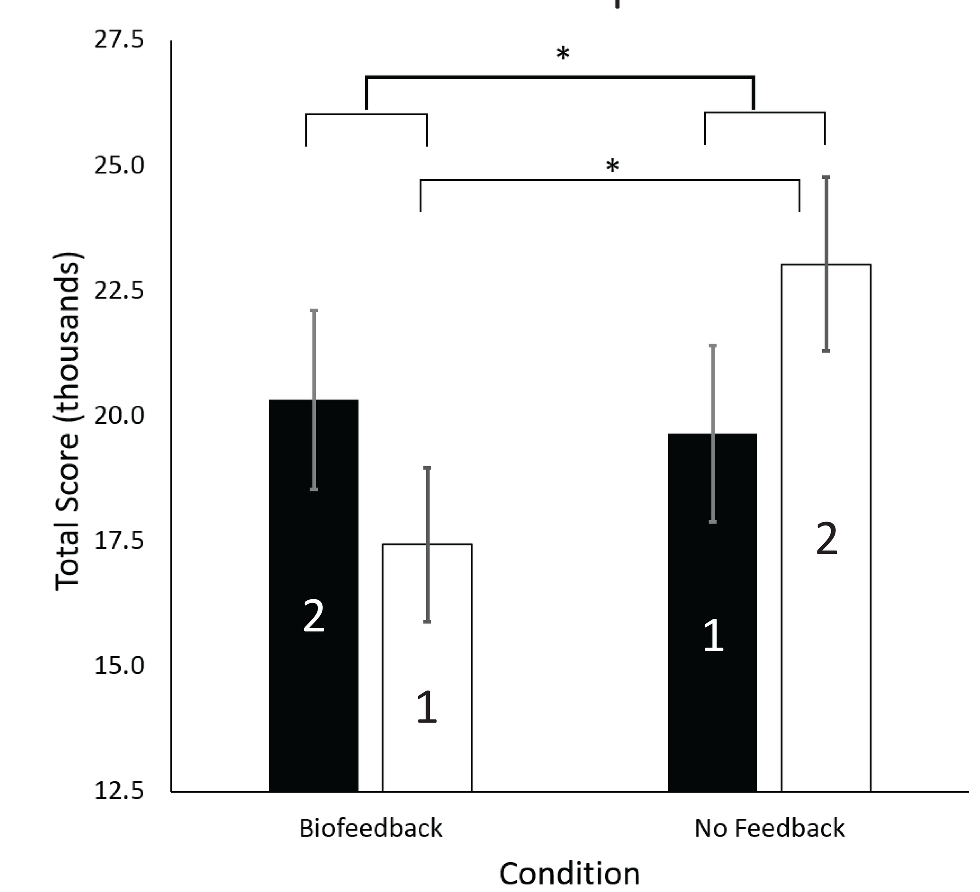
Order influences effect of biofeedback



To analyze warnings, recordings were divided into 10 sec bins. Total bins with warnings were counted. More warnings = worse posture.

Posture was better when participants played with biofeedback than without (p<0.001). There was no main order effect, but there was a interaction between order and condition (p=0.001). When playing without biofeedback, those who did the task 2nd maintained posture better than those who did the task 1st (p=0.03).

Order influences task performance

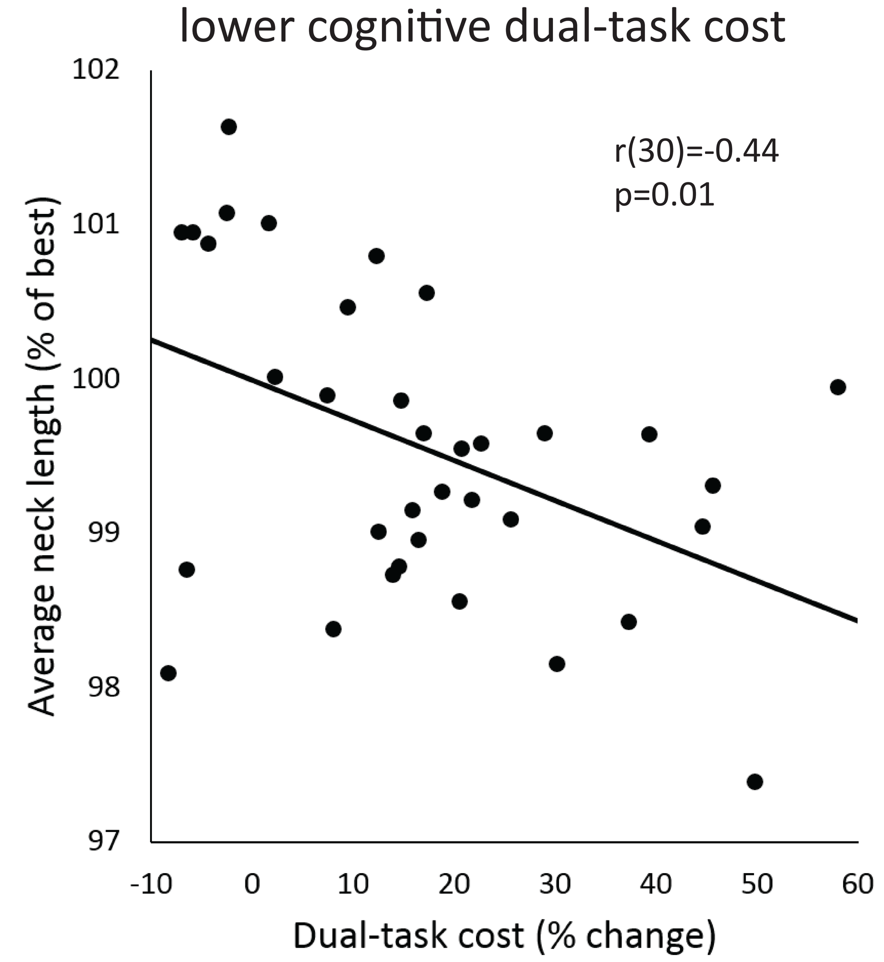


To analyze game score we recorded total score for each participant during each condition.

Scores were worse when participants played with biofeedback than without (p= 0.03). There was no main order effect, but there was a interaction between order and condition (p<0.001). Participants who played with biofeedback 1st did worse with biofeedback than without (p<0.001), those that played without 1st had no difference in score.

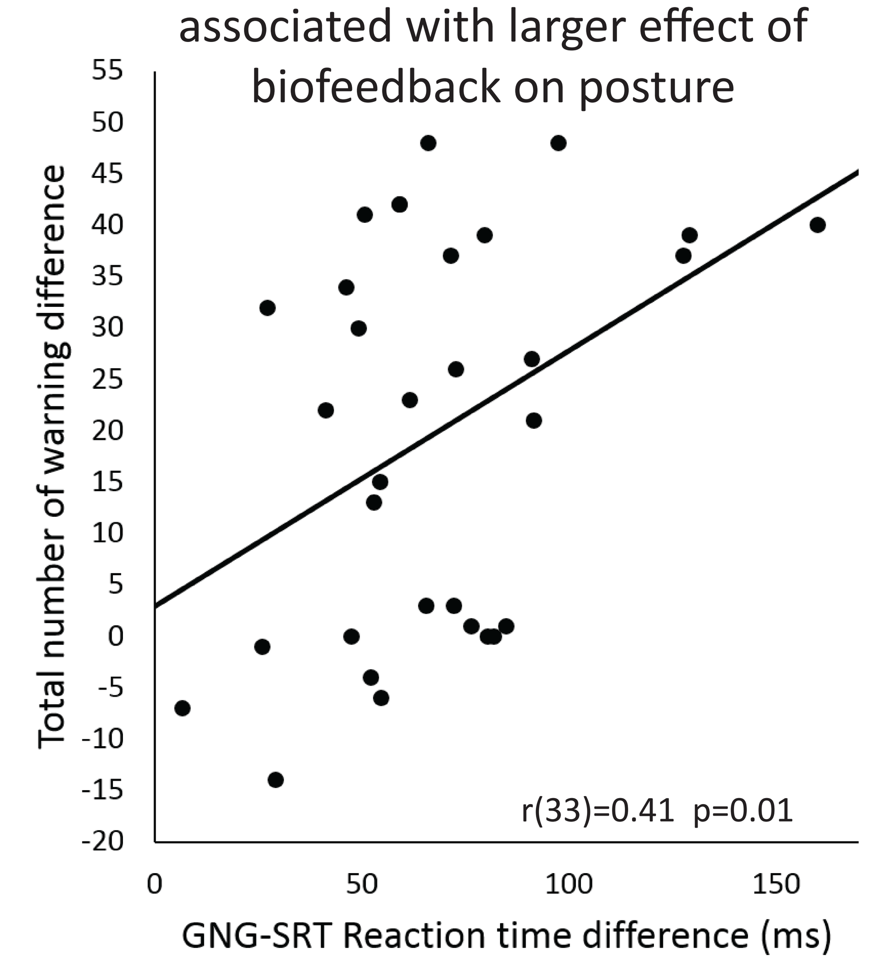
Results: posture and cognition

Greater neck length is associated with lower cognitive dual-task cost



When playing with biofeedback, participants with lower dual-costs maintained greater neck length for the duration than those with greater dual-cost.

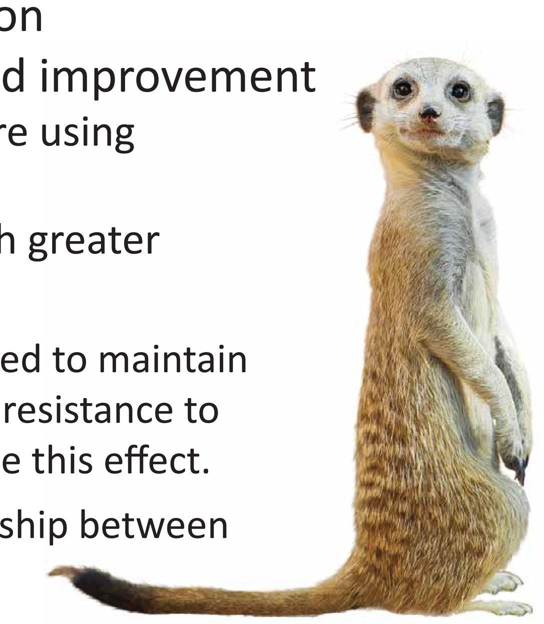
More slowing during GNG task was associated with larger effect of biofeedback on posture



More improvement in posture with biofeedback than witout was associated with greater processing costs for the GNG task relative to SRT.

Conclusions

1. Biofeedback improved posture and led to retention
2. Biofeedback interfered with task performance and improvement
   - Lower dual-task cost was associated with better posture using biofeedback
   - Higher information processing cost was associated with greater feedback-dependence to maintain posture



Our results support the hypothesis that attention is required to maintain posture with biofeedback. The dual-task tradeoff may explain resistance to biofeedback. Future studies should examine ways to remediate this effect.

These findings open new paths for understanding the relationship between cognition and posture.

References

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