# Using error estimation to understand the self-control learning advantage

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## Introduction

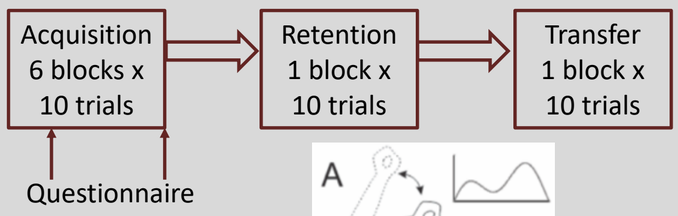
- Self-controlled learning is the ability for a learner to modify a component of their practice regimen, such as when to receive knowledge of results (KR; a type of feedback)
- Strong evidence for the advantages of self-control learning have been shown repeatedly (Janelle et al., 1995, Chiviakowski & Wulf, 2002)
- The reason self-controlled learning is better is still unclear and two mechanisms have been proposed
  1. Motivational approach (Sanli et al., 2013)
  2. Information processing approach (Chiviakowski & Wulf, 2005)

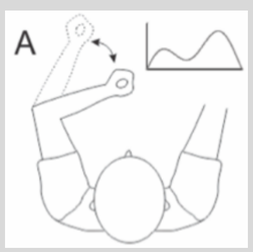
**Research Question**: Does motivation or information processing have more influence on the advantage of self-controlled motor learning?

**Hypothesis**: Error estimation will improve learning by increasing information processing; motivation will not be a major factor influencing learning.

## Methods

- **Task**: Waveform matching task with two outward inward arm movements and a timing goal of 900ms for retention and 1150ms for transfer (n=60)
- Independent Variable
  1. Self-control: choose feedback schedule
  2. Traditional yoked: no choice over feedback
  3. Yoked error estimation: no choice over feedback & estimate movement time after each trial
- Dependent Variables
  - Absolute constant error of movement time
  - Motivation questionnaire derived from IMI (competence, autonomy and task interest)
  - Error estimation accuracy
- Control Variables
  - All participants received KR on 20 of 60 trials




## Results

Practice

- Performance improved over practice blocks, significant main effect for Block ($p < .001$)

Retention/Transfer

- Traditional yoked had the most error
- Self control had least error in retention ($p = .124$)
- Error estimation group had least error in transfer ($p = .089$)
- No significant effects for Group

Error Estimation

- Yoked error estimation group was significantly better at error estimating than traditional yoked ($p = .044$)

Table 1. *Average estimation error (ms) for movement time for SC, YT and YEE.*

| | Retention (ms) | Transfer (ms) |
|---|---|---|
| SC | 121 | 183 |
| YT | 178 | 219 |
| YEE | 118 | 142 |

IMI Questionnaire Results

- Main effect of group revealed no differences in motivation
  - Perceived competence ($p = .367$)
  - Autonomy ($p = .627$)
  - Task interest ($p = .386$)

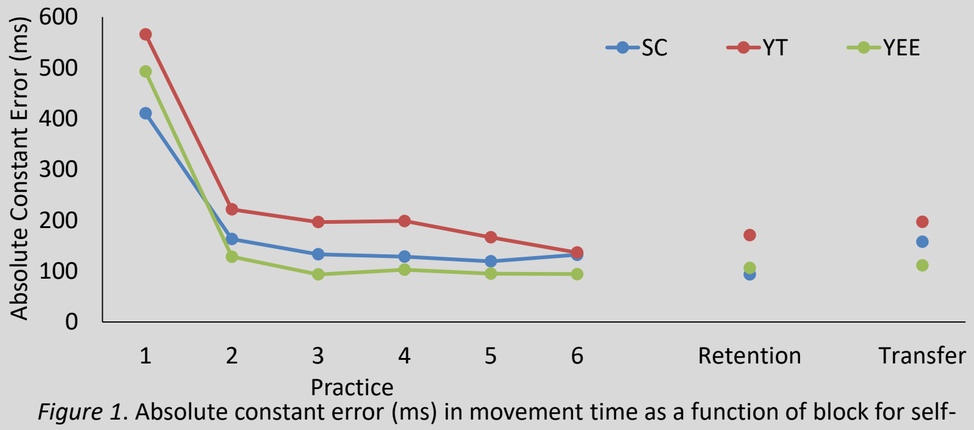



*Figure 1*. Absolute constant error (ms) in movement time as a function of block for self-control (SC), yoked traditional (YT) and yoked error estimation (YEE) groups. (n=60)

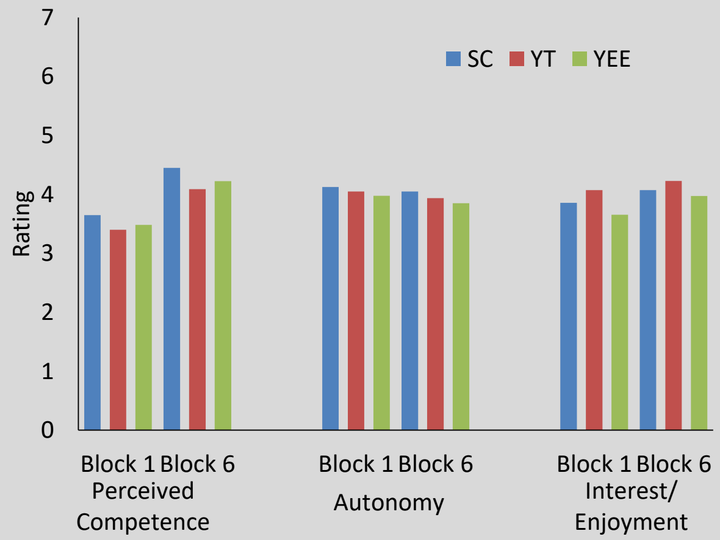



*Figure 2.* Self report measures (scale of 1-7) of competence, autonomy and task interest on blocks 1 and 6 for SC, YT and YEE groups. (n=60)

## Discussion

Information Processing ✓

- YEE group was significantly better at error estimating than YT
- Error estimation group performed similarly to self-control in retention and transfer, albeit not significant

Motivational ✗

- No significant difference in motivational measures between groups
- Error estimation group outperformed yoked traditional in retention and transfer, albeit not significant

## References

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