Flexibility of implicit sequence knowledge: using transfer to map representation

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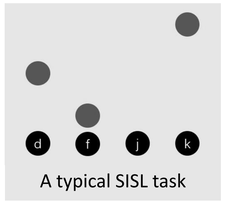
Background

- A fundamental aspect of learning is the ability to apply learned knowledge and skills to a novel context that differs from the original learning conditions.
- Our prior studies of **implicit perceptual-motor sequence learning** have shown significant limitations in the ability to express knowledge across subtle perceptual changes between training and test[1].
- Here we provide an overview of recent studies investigating **transfer** of implicit sequence learning to support a **component-based model of knowledge representation**.

Methods

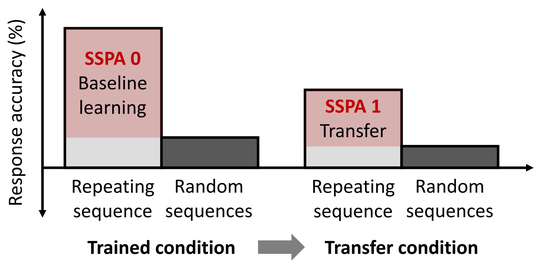
Serial Interception Sequence Learning (SISL) task[2]

- Participants intercept moving cues when they overlap with one of 4 targets by making precisely-timed motor responses with keys (D, F, J, K) corresponding to the targets.
  - Cues follow a covertly-embedded, 12-item **repeating sequence**.



A typical SISL task

- **Learning Measure: SSPA**
  - **S**equence-**s**pecific **P**erformance **A**dvantage = accuracy for practiced sequence (%) – accuracy for unpracticed novel foils (%).
- **Protocol:**
  - **Training:** participants practice the repeating sequence within **one condition**.
  - **Test**: sequence knowledge is then assessed in **trained and transfer conditions**.
- **Transfer**: the accessibility or expression of previously acquired sequence knowledge under novel contexts.



SSPA: Sequence-specific performance advantage

$$\textbf{Transfer of learning (\%)} = \frac{\textbf{SSPA 1 in novel condition}}{\textbf{SSPA 0 in trained condition}}$$

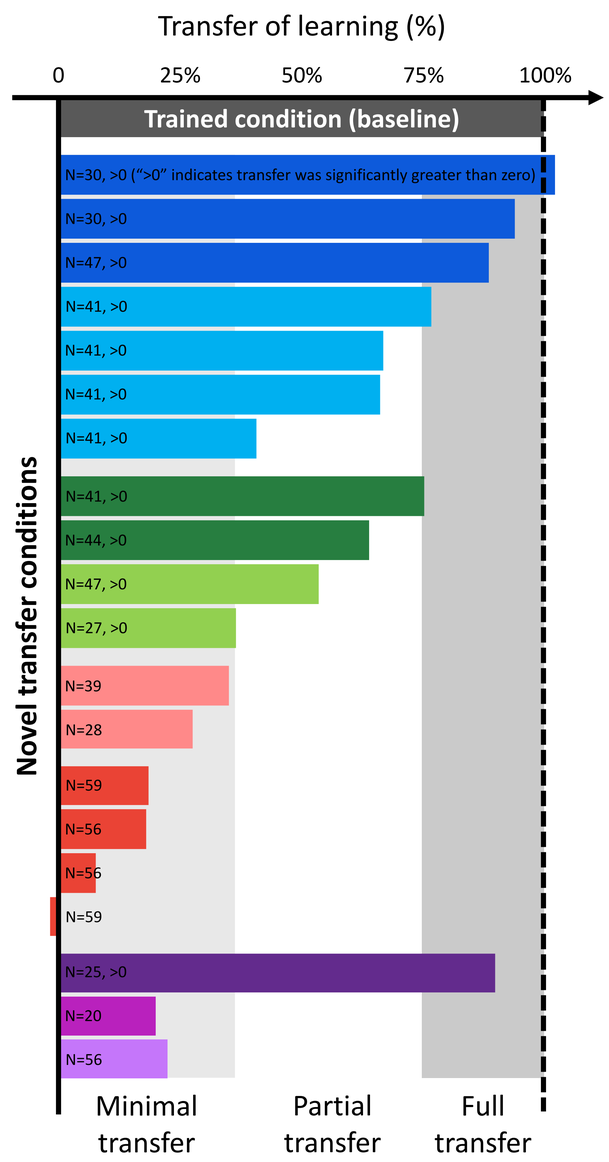
References

1. Sanchez, D. J., Yarnik , E. N., & Reber , P. J. (2015). Quantifying transfer after perceptual motor sequence learning: how inflexible is implicit learning?. Psychological research 79 (2), 327 343.
2. Sanchez, D.J., Gobel, E.W. & Reber, P.J. (2010). Performing the unexplainable: Implicit task performance reveals individually reliable sequence learning without explicit knowledge. Psychonomic Bulletin & Review, 17, 790-76.

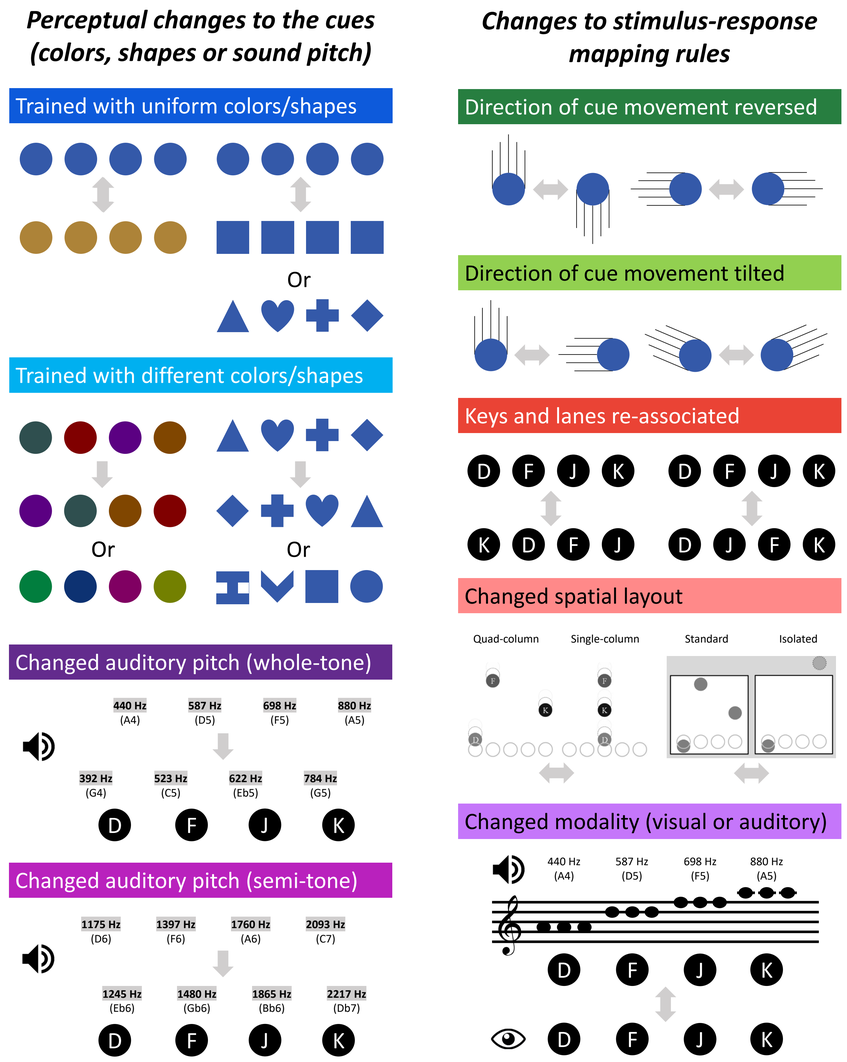
Acknowledgements

Rebecca Chen, Thomas Dixon, Caelie McRobert; T32 Training Grant NS047987

Results



These task elements was changed in novel conditions…



The amount of transfer of implicit sequence knowledge and illustrations of test conditions (indicated by color).

Conclusions

We identified conditions of graded degrees of transfer of sequence-specific learning across 12 experiments:

- **Full transfer**: implies <u>flexible expression</u> of knowledge.
  - Task-irrelevant changes to cue features. ■ ■
- **Partial transfer**: implies <u>multiple components</u> of the knowledge representations.
  - Location-specific perceptual changes. ■
  - Changes to the moving direction. ■ ■
- **Minimal transfer**: implies that the knowledge was <u>generally not accessible</u>, but sometimes still reliable (<u>not zero transfer</u>).
  - Changes to spatial layout. ■
  - Changes to stimulus-response mapping. ■ ■
  - Changes to cue modality (visual - auditory). ■

Component Model of Sequence Knowledge Representation

- Response-associated color/shape information is a component of the representation. Changes lead to impaired transfer.
  - Task-irrelevant consistent color/shape information is not incorporated into learning.
- Direction/layout/modality are substantial knowledge components. Only low levels of prior sequence knowledge can be applied to a transfer condition after these changes.
- Across studies, minimal transfer does not equal zero transfer. We speculate that there is a component of slower learning at an abstract level that transfers across all conditions.
  - This aspect of learning may not produce robust sequence-specific effects on our relatively short training paradigms but may play a role in the long-term development of expertise.