Induction and Transferral of Flow in the game Tetris

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Overview

- Introduction
  - Research background
  - Intent and purpose
- Methods
  - Experimental design
  - Experiment diagram
  - Hypotheses
- Results
- Discussion
- Conclusion

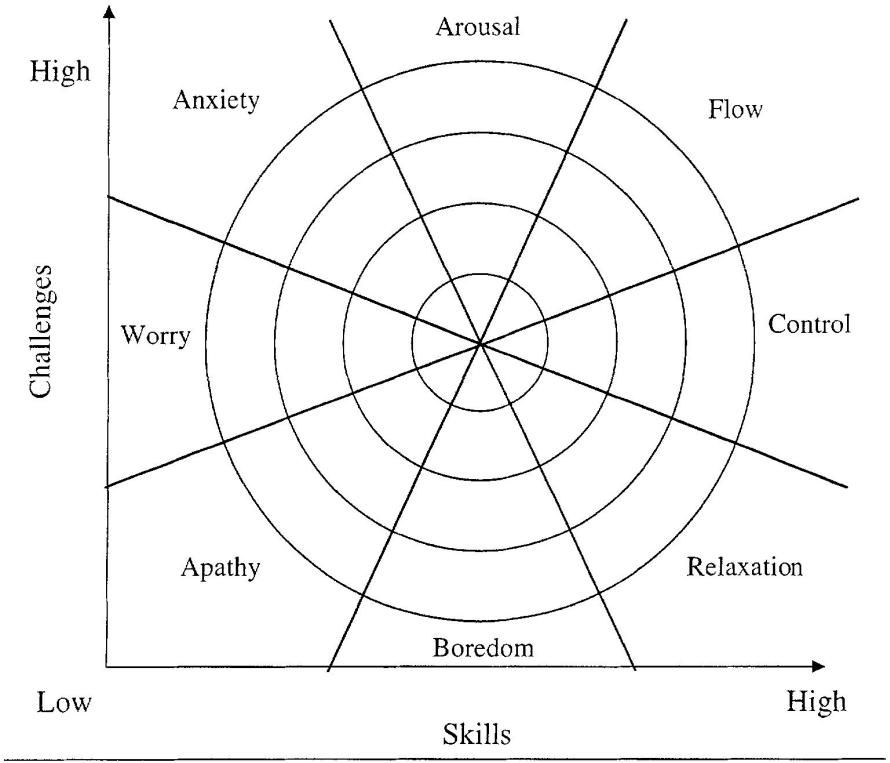
Flow State

- State of high concentration that people often enter into when fully absorbed in a task
  - Lost awareness of time and surroundings
  - Intrinsically motivating
  - “Autotelic personality”
    - Intrinsic factors which predispose a person to enter into flow more easily
- People in flow tend to perform tasks longer without noticeable fatigue
  - Enjoy the task more
  - Will concentrate more for longer

Nakamura, J., & Csikszentmihályi, M. (2014).

Inducing Flow State

- Clear proximal goals
  - Must know what they're meant to do
- Immediate feedback
  - Opportunity to correct improper action immediately after it occurs
- Balance between challenge and skill
  - Difficulty outpaces skills: anxiety, panic
  - Skill outpaces difficulty: boredom, disinterest



Nakamura, J., & Csikszentmihályi, M. (2014).

History of Flow State

- Originally viewed from a positive psychology angle
  - Traditionally: flow as an aspect of lifestyle
  - More recent work: flow from a more experimental and cognitive angle
- Video games designed to induce a state of flow in players
  - Makes game more enjoyable, players want to continue playing it
  - Games capitalize on flow precursors
    - Give player simple clear goal
    - Immediately reward or punish player based on their actions
    - Explicit or implicit alteration of difficulty to match player's skill
  - Ideal for flow research

Flow and Games

- Often use the game Tetris [2][3][4][5][6]
- Manipulate difficulty through measuring skill at start [2], or continuously throughout [3][4][5][6]
  - Create conditions where challenge is greater than, less than, or equivalent to player skill [2][3][4][5][6]
- Findings
  - Challenge-skill match shows greatest flow [1][2][3][4][5], better performance [3], less boredom/anxiety [2]
  - Correlation between flow state and internal locus of control [4]
  - Links with flow and biological markers of stress [5]
    - Flow experiences are subjectively positive, but physiologically stressful, reflecting higher mental load
  - EEG shows differences between flow and boredom [6]

1. Engeser and Rheinberg (2008)
2. Chanel, Rebetez, Bétrancourt, and Pun (2008)
3. Keller and Bless (2008)
4. Keller and Blomann (2008)
5. Keller, Bless, Blomann, and Kleinböhl (2011)
6. Plotnikov et al. (2012)

Connection with Adaptive Training

- Central idea: subjects learn more when the task is adapted to their abilities, rather than a one-size-fits-all task
- Macro-adaptation
  - Task based on initial skill measurement
    - Measure skill beforehand, set Tetris difficulty based on initial baseline
- Micro-adaptation
  - Task based on current performance
    - Measure performance periodically, set difficulty based on current performance

Landsberg et al. (2012)

Flow Transfer

- Some tasks induce flow better than others
  - Could we transfer flow state, or at least some of its beneficial effects, from a flow-inducing task to a non-flow-inducing task?
- Similar concepts
  - Transfer of learning [1]
    - Skills or knowledge gained in one task improve performance in a different task
  - Moods persist over time, and can affect performance on temporally distant tasks [2]

1. Perkins and Saloman (1992)
2. Hills, Hill, Mamone, and Dickerson (2001)

Hypotheses

- Hypothesis 1:
  - Subjects who play in the “adaptive” experimental condition will report higher state flow than those in the “easy” or “hard” conditions.
- Hypothesis 2:
  - Subjects who play in the “adaptive” experimental condition will perform better in the post task, relative to their performance in the pre task, than subjects who play in the “easy” or “hard” conditions.

Methods

Methods overview

- Utilize a pre-test/post-test methodology
  - Subjects are given a questionnaire to assess flow before and after the experimental task
    - Dispositional Flow Scale and Flow State Scale
  - Subjects play an unmanipulated task before and after the experimental task
    - Tetris
  - Subjects are given a task effort assessment
    - Simple 1-10 scale, asking subject how much effort they put into task
- Behavioral measure
  - Effect of manipulation determined by calculating difference between pre and post per subject
    - Simplifies design
    - Control for individual differences

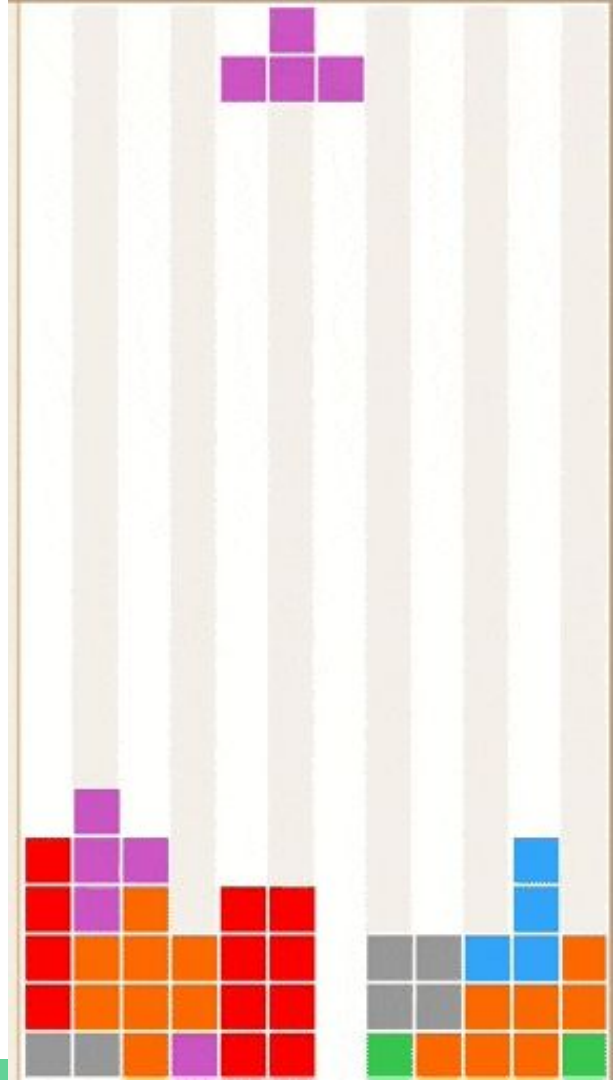
Flow Questionnaires

- Questionnaires are one of the most common methods to measure flow
  - Most cited: Flow State Scale and Dispositional Flow Scale
- Flow State Scale
  - Flow as current state of mind or experience
  - 5 point Likert: Strongly Disagree to Strongly Agree
- Dispositional Flow Scale
  - Flow as habit or occurrence within one's life; tendency to enter into flow states
  - 5 point Likert: Rarely to Always
- Items in both scales are identical, except for tense of wording
  - FSS: I lost my normal awareness of time.
  - DFS: I lose my normal awareness of time.

Jackson and Eklund, (2002)

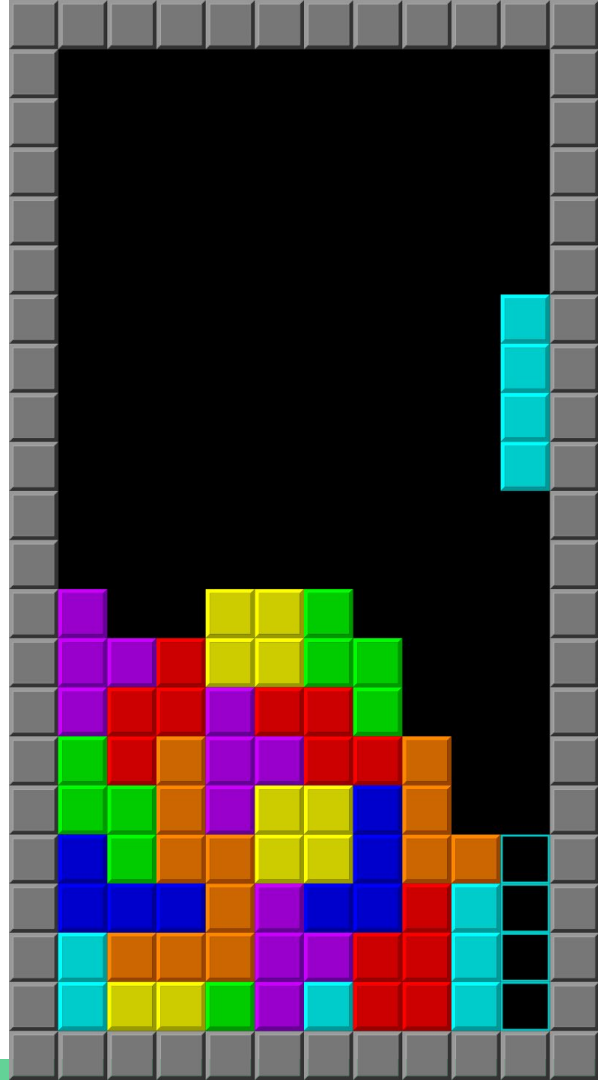
Tetris

- Falling block puzzle game
- Players must guide falling zoids into place at the bottom of game screen
- Goal is to arrange blocks into complete rows
  - Filled rows disappear
  - All blocks above filled row descend to fill the gap
  - Score increases
- When the accumulation (pile of placed zoids) reaches the top, game over
- Speed of falling pieces increases over time



Tetris AI system

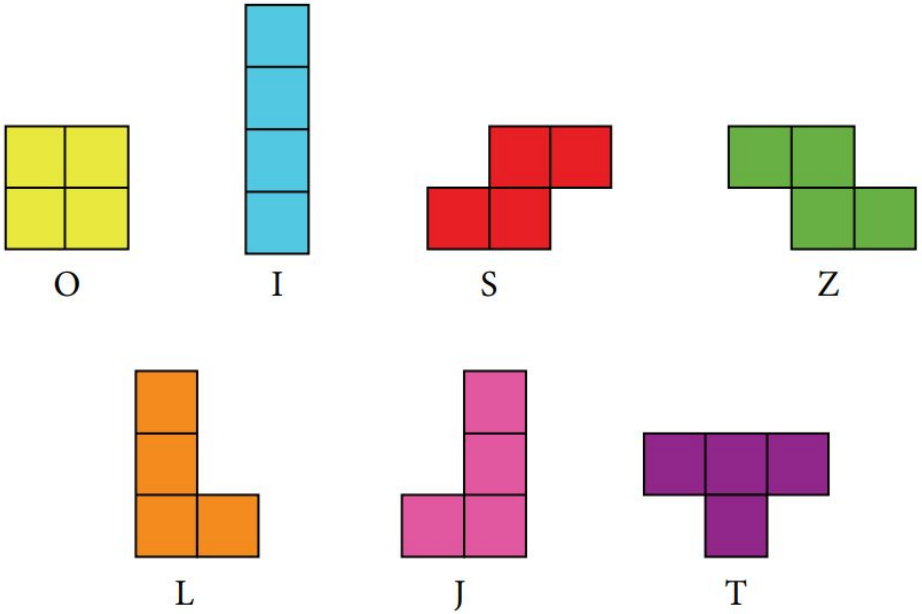
- Meta-T [1]
  - Tetris implementation for behavioral research
  - Contains functionality for Tetris AI solver
- Weighted Feature Sum
  - AI solver computes a numerical value for each possible location and orientation of the given zoid
    - Higher number means more ideal placement
  - AI solver picks the placement and rotation with the highest weighted feature sum
    - Solvers of this type can surpass 660,000 line clears [1]



1. Lindstedt and Gray, (2015)
2. Algorta and Şimşek, (2019)

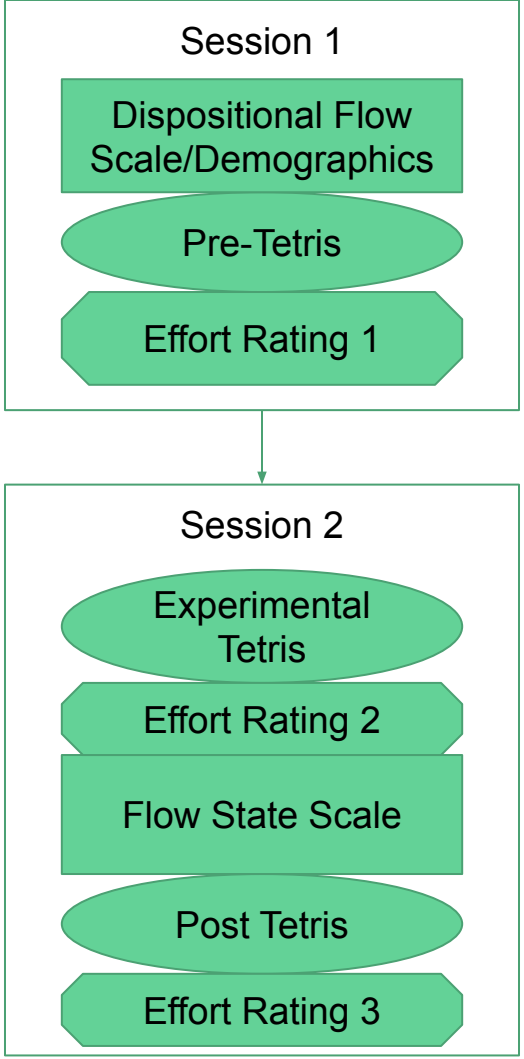
Difficulty Manipulation

- Use AI solver capability to find all feature sums for all possible placements and orientations of every possible zoid
- Order list of 7 zoids based on the maximum weighted feature sum value for each zoid
    - In other words, order zoids based on how good the best possible placement is for each zoid



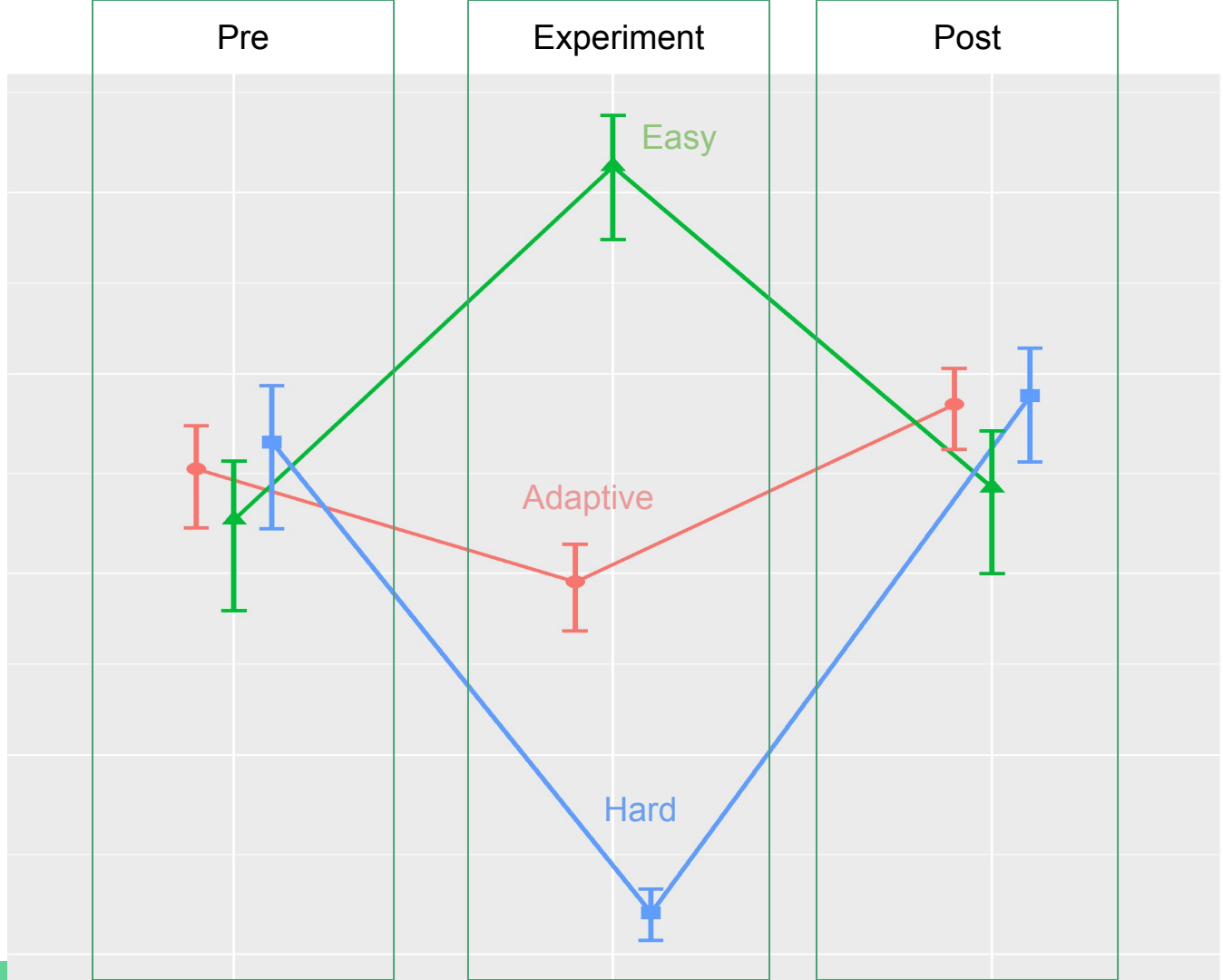
Conditions

- Easy condition: always gets easiest zoid
  - Zoid with highest maximum weighted feature sum
- Hard condition: always gets hardest zoid
  - Zoid with lowest maximum weighted feature sum
- Adaptive condition: gets zoid based on height of accumulation
  - Height of accumulation used as proxy for performance
    - Accumulation near top:
      - Player doing poorly, given easier pieces, challenge is lowered
    - Accumulation near bottom:
      - Player doing well, given harder pieces, challenge is raised
  - Zoid given to player is mapped linearly from height of accumulation


Session 1
Dispositional Flow Scale/Demographics
Pre-Tetris
Effort Rating 1
Session 2
Experimental Tetris
Effort Rating 2
Flow State Scale
Post Tetris
Effort Rating 3

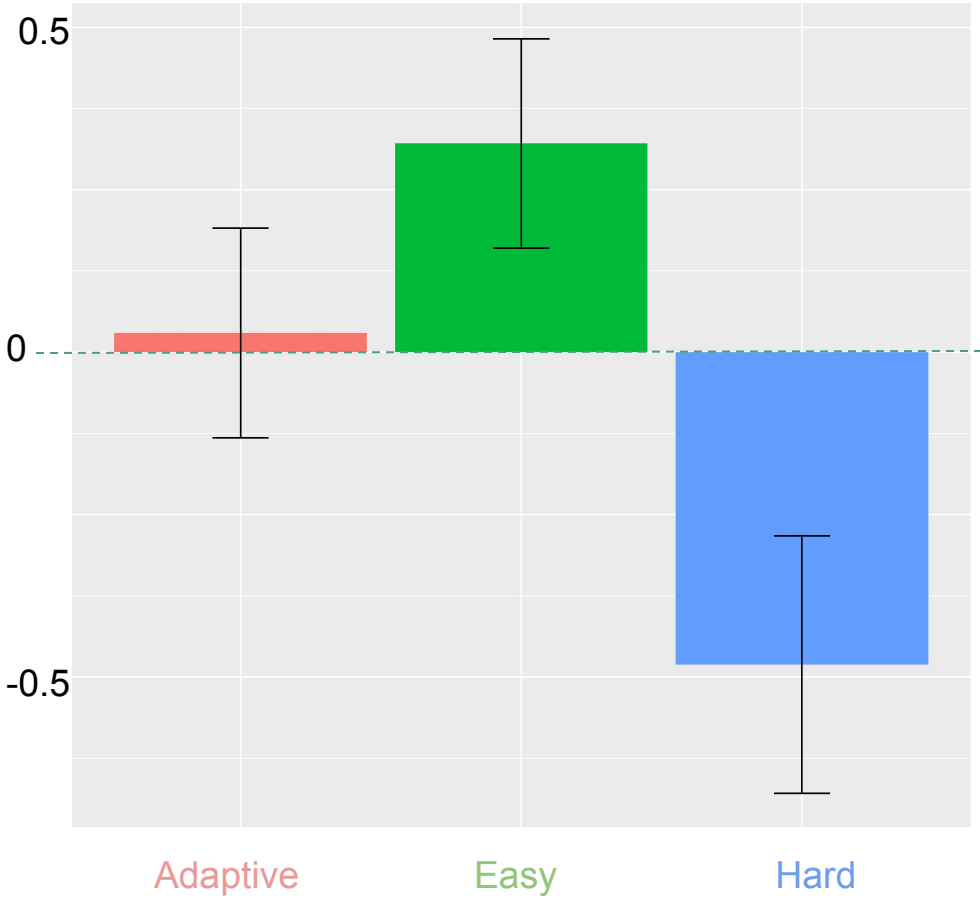
Results

- 137 subjects ran total
  - Dropped 23 due to incomplete data
- Remaining 113 subjects
  - 69 female, 43 male, 1 non-binary/other
  - Age (M=20.02, SD=3.59)
- Number of subjects in conditions (adaptive=48, easy=32, hard=33)
  - Error in config file in first week of testing led to class imbalance
  - Unable to easily correct


Pre
Experiment
Post
Easy
Adaptive
Hard

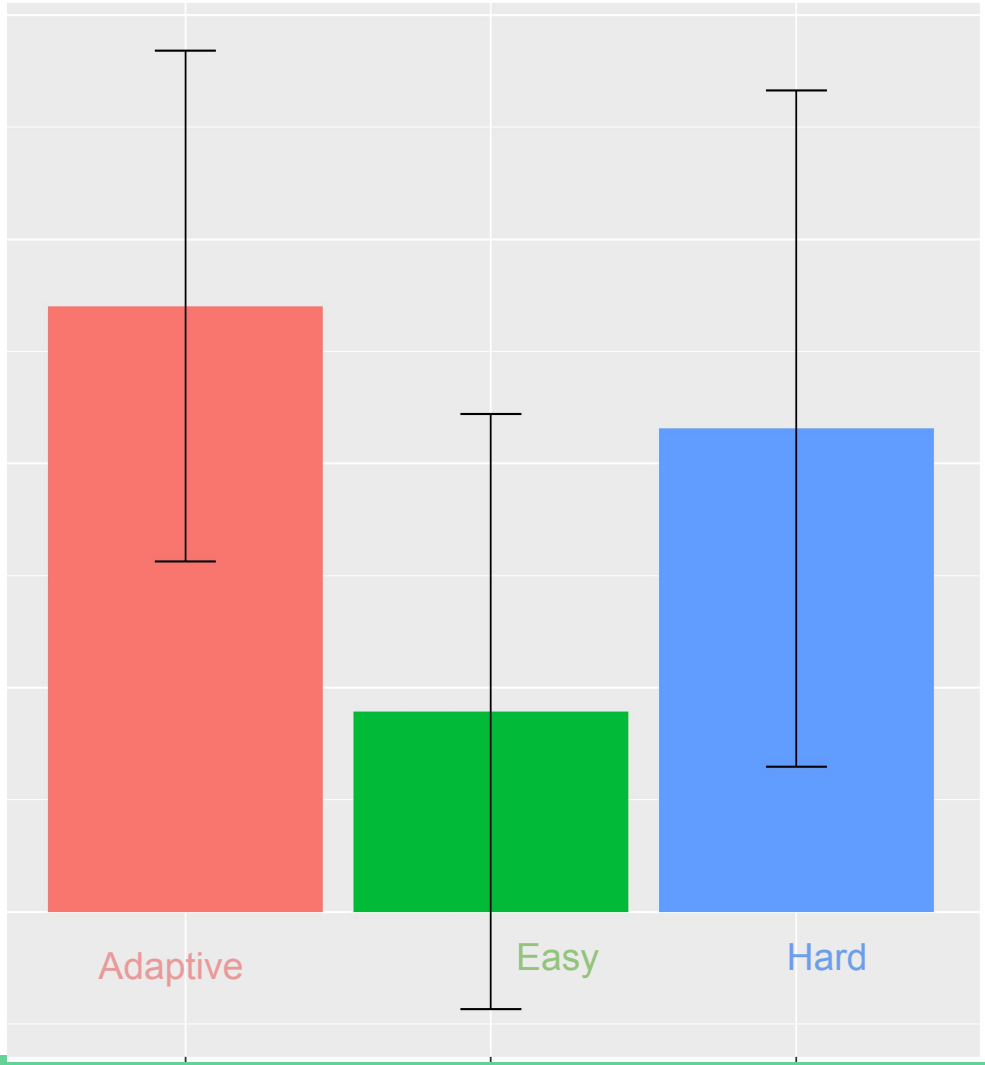
Hypothesis 1 ANOVA

- Hypothesis 1: effect of Tetris difficulty manipulation on reported flow via questionnaires
  - 5-point Likert-type scales converted to 1-5 integer values
    - 1 is least flow, 5 is most flow
  - Difference value, post-pre
  - $F(2,110)=19.37$, $p<0.001$; $Eta^2 = 0.26$
  - Tukey's HSD: significant differences between all pairwise comparisons ($p<.05$ for all)
- Easy condition led to greatest flow, rather than adaptive condition, contrary to hypothesis



Hypothesis 2 ANOVA

- Hypothesis 2: effect of Tetris difficulty on performance with post Tetris task compared to pre Tetris task
  - Criterion score: average score of best 4 games
    - Standard way of determining performance with Meta-T software
    - Reduces effect of unlucky zoid sequences on performance, increasing effect of player skill & ability
  - Difference value, post-pre
  - No significant effect
    - F(2,110)=2.031, p=0.135, Eta^2 = 0.035

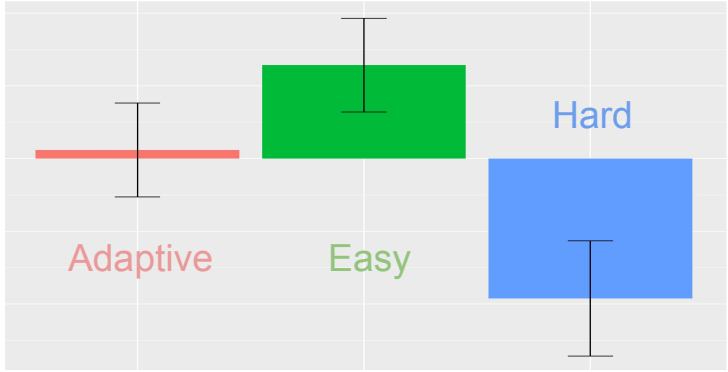


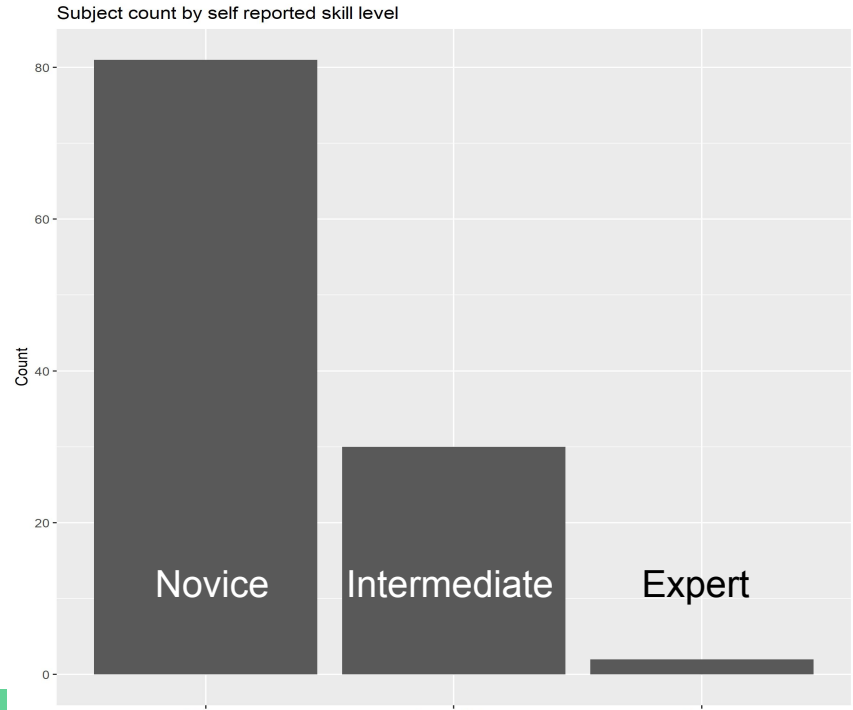
Recap

- Flow Transfer using Tetris
  - Easy, hard, and adaptive conditions to induce and transfer flow to varying extents
- Hypothesized adaptive would caused most flow increase
  - Easy condition showed most flow increase
  - Adaptive condition showed very little flow increase
- Hypothesized flow transfer would lead to higher performance in adaptive condition
  - No significant differences in performance for any condition

Discussion

- Easy condition led to greater flow than adaptive condition
  - Contrary to hypothesis
  - Adaptive condition largely did not affect flow for subjects
- Possible challenge floor effect
  - Time pressure present even at easiest levels
  - Majority of subjects reported being “Novice” at Tetris
  - Maybe easy condition didn’t lead to boredom as expected, since many players would be challenged by the easiest levels





Future Research

- More investigation into how the different elements of Tetris affect flow
    - Removing time pressure lead to greater flow, or boredom?
    - Different methods of manipulating difficulty
- Relationship of flow and expertise
    - Are experts in a task more likely to get into flow than novices?
    - Chicken and egg of expertise and flow

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Questions

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