STUDIES IN PERCEPTION AND ACTION XVI

Twenty First International Conference on Perception and Action

EDITED BY:
PABLO COVARRUBIAS, ÁNGEL A. JIMÉNEZ AND WILLIAM H. WARREN

Studies in Perception and Action XVI

Twenty First International Conference on Perception and Action

June 27-30, 2023

Guadalajara, Mexico

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Preface

The International Conference on Perception and Action (ICPA) is the official conference of the International Society for Ecological Psychology (ISEP). As such, it provides a forum for scientific discussion for those scholars interested in the ecological approach to perception and action, as well as other topics in ecological psychology, inspired by the work of James and Eleanor Gibson. After a 4-year hiatus due to the COVID-19 pandemic, this year the conference is held in Guadalajara, Mexico.

In accordance with previous ICPA, Studies in Perception and Action, Volume XVI, is the Poster Book that represents the posters presented at the meeting. This year we are making copies of the actual posters available in electronic format as a PDF file. All presenters were asked to submit the final electronic versions of their posters before the meeting, a somewhat challenging endeavor. This effort has enabled us to publish the full posters prior to the conference, with the aim of encouraging scientific discussion among attendees. We also hope that the electronic version will make the posters widely available. The Poster Book will be permanently archived on the ISEP website (http://commons.trincoll.edu/isep/).

Readers of this book will find research on a wide variety of topics including perception in any modality, motor control and coordination, perceptual control of action, affordances, social interaction, development, learning, cognition, language, human factors, design, sensory substitution, complex systems, and the dynamics of all of the above. This work represents an excellent cross-section of the fascinating and diverse research inspired by the ecological approach today.

We want to thank Aurelio M. Rodriguez for the technical assistance in the editing process and to Fidel Romero for making the cover and layout of the poster book. Our appreciation and gratitude to members of the Scientific Committee for their timely revisions and comments.

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June 2023

Scientific Committee

Meeting History

1981 – Storrs, CT, USA

1983 – Nashville, TN, USA

1985 – Uppsala, Sweden

1987 – Trieste, Italy

1989 – Miami, OH, USA

1991 – Amsterdam, the Netherlands

1993 – Vancouver, Canada

1995 – Marseille, France

1997 – Toronto, Canada

1999 – Edinburgh, Scotland

2001 – Storrs, CT, USA

2003 – Gold Coast, Australia

2005 – Monterey, CA, USA

2007 – Yokohama City, Japan

2009 – Minneapolis, MN, USA

2011 – Ouro Preto, Brazil

2013 – Estoril, Portugal

2015 – Minneapolis, MN, USA

2017 – Seoul, Republic of Korea

2019 – Groningen, the Netherlands

2023 – Guadalajara, Mexico

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ICPA 2023

Effects of co-verbal gestures on the willingness to interact with people with schizophrenia or depression according to the professions

1 CONTEXT

Goal: to compare the willingness of several professional groups to interact with SZ or DP patients. To investigate the behavioural determinants of willingness to interact

Problematic: Is there a difference in the willingness of general population or mental health professionals to interact with SZ or DP compared to people without psychiatric disorder? Was this related to the number of hand gestures made by these subjects?

Co-verbal gestures: hand gestures, assist speech and give information to listeners. Important for assessing a partner's social skills

Schizophrenia (SZ) and depression (DP): mental disorders. Causes alterations in production of co-verbal gestures (Pavlidou et al., 2021)

Willingness to interact: behaviours of approaching or avoiding social interaction, based on rapid information intake of character traits of the potential social partner

Stigma: reaction of a group or society to minority, different or disadvantaged, individuals or groups by labelling them as not being part of the 'norm'

Stigma by mental health professionals: one of the main sources of stigma. Increases social distance and leads to negative access to treatment (Schulze, 2007)

2 EXPERIMENTATION

Creation of stimuli:

- Records of 2 SZ subjects, 2 DP subjects, 2 control subjects (CT)
- Behavioural modalities: video (Figure 1), audio, video-audio, photo

Creation of the questionnaire :

Visualization of a first stimulus
Willingness to interact questionnaire (Sasson et al., 2017)
Visualization of a second stimulus
Willingness to interact questionnaire
...

Questionnaire respondents:

- Mental health professionals (MHP) : N = 30
- Health and social professionals (HSP) : N = 30
- Control professionals (CTP) : N = 30

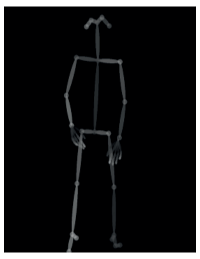


Figure 1. Example of point-light display stimulus

3 RESULTS

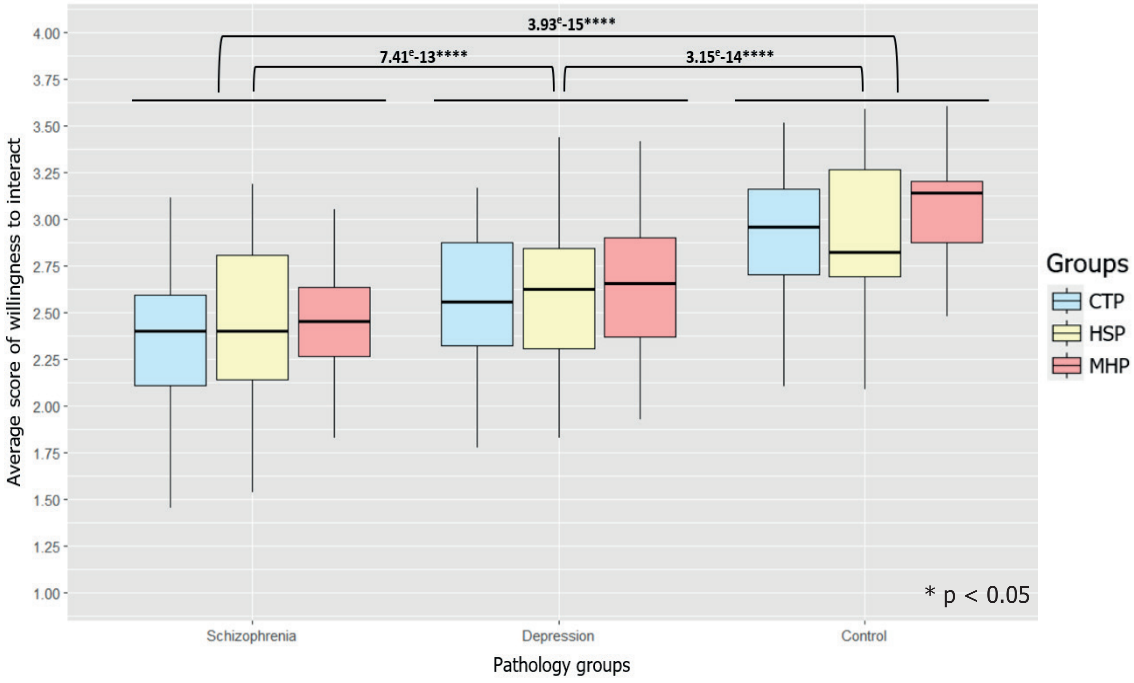
Hypothesis 1: Respondents are less inclined to interact with SZ than with DP or CT subjects.

→ **YES:** Regardless of the respondents' profession, all participants are less inclined to interact with SZ than with DP or CT, and that in all behavioural modalities.

Hypothesis 2: MHP are more proned to interact with SZ and DP subjects than CTP or HSP.

→ **NO:** We did not find any significant difference between MHP, HSP and CTP in terms of willingness to interact.

Graph 1. Boxplot of mean scores given by respondents according to pathology's and respondents' groups for willingness to interact



Hypothesis 3: There is a correlation between number of gestures and willingness to interact, regardless of their diagnosis.

→ **NO:** We found no significant correlation between the scores obtained by SZ, DP or CT and the number of gestures performed during the stimuli.

4 DISCUSSION

Regarding hypothesis 1: This negative perceptions of SZ and DP traits is observed in all modalities :

- Video : people with SZ have less used their repertory of co-verbal gestures (Pavlidou et al., 2021)
- Audio : people with SZ or DP may have reduced physical functioning which may affect speech production (ibid.)
- Photo : people with SZ exhibited a range of unusual idiosyncratic appearance (e.g. dressing oddly, wearing multiple layers of clothing) (Arnold et al., 1993)

Regarding hypothesis 2: It seems that the time spent to take care of the patients does not reduce stigma (Arbanas et al., 2019) but mostly the knowledge about mental disorders.

Regarding hypothesis 3: It is not a single modality that explains a low interaction willingness. It may be due to the speed of gestures or their synchronization with speech more that number of gestures.

5 CONCLUSION

- All respondents were less willing to interact with people with SZ than with those with DP or with controls.
- Mental health professionals, like other professionals, all seem inclined to interact weakly with people with mental illnesses.
- The (lack of) willingness to interact with people with mental disorder can be attributed to all communicational modalities (gesture, speech and appearance) and not specifically to the number of gestures.

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Learning to grasp: Variability of practice and sensory substitution

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Introduction

- This study investigated the effect of variability of practice on learning the use of sensory substitution devices (SSD).
- The first aim was to show that practice improves performance with the SSD.
- The second aim was to test the differences between variable and constant practice.

Methods

- A motion capturing system and a vibrotactile glove with motors on the index-finger and thumb that vibrated as a function of distance to the nearest object[1] (Fig 1).
- A vibrator was active when the respective finger pointed toward the object[2].

Please follow the link to experiment

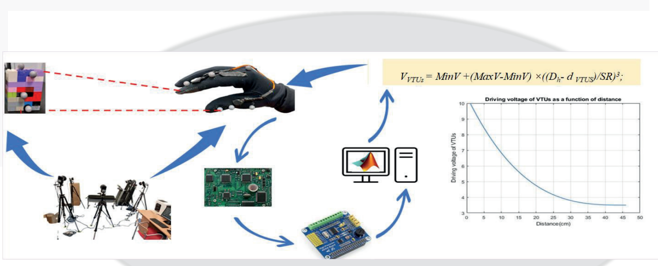

Fig 1: Functioning of Device

- Forty-four blindfolded participants were divided into two equal groups, referred to as constant and variable groups, and asked to grasp an object on a table by using the vibrotactile information.
- A pre-test, training, post-test design was used (Fig 2).

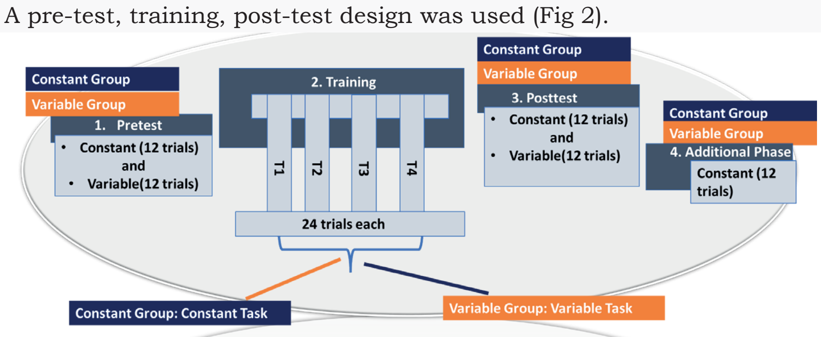

Fig 2: Experimental Design

- **Pretest and Posttest:** Each comprises 12 trials of the constant task and 12 trials of the variable task.
- **Training:** Training comprises four subphases and each comprises 24 trials. Participants in constant group were trained with constant task conditions whereas those in variable group were trained with variable task conditions.
- **Additional Phase:** An additional phase of 12 constant task conditions was run for both groups.
- **Timeline:** The experiment was performed in two sessions of 1.5 hours each, performed on different days.

- **Constant Task:** all trials in a block were similar, used same size and position for the initial and final object (Fig 3).

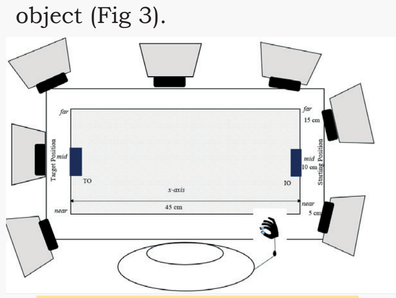

Fig 3: Schematic Representation of Constant Task

- **Variable Task:** all trials in a block were different, depending on the size and position of the initial and target objects (Fig 4).

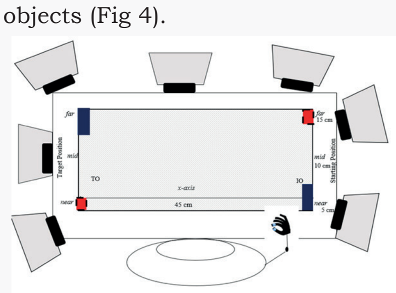

Fig 4: Schematic Representation of Variable Task

Results

Proportion of Correct Grasps:

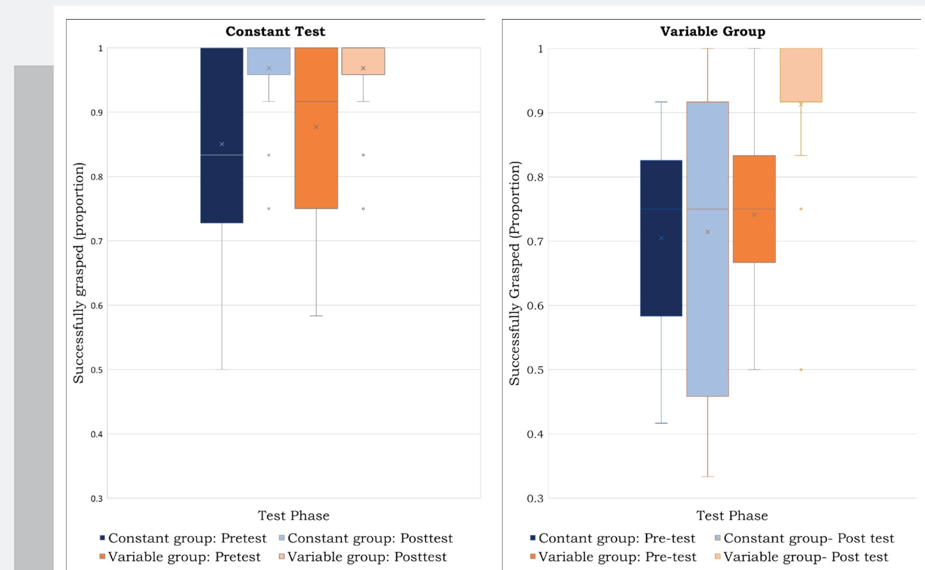

Fig 5: Shows results of proportion of correct grasp.

- Left: In the constant test both the constant training group and the variable training group improved after training.
- Right: In the variable test only the variable training group improved after training.

Mean Duration

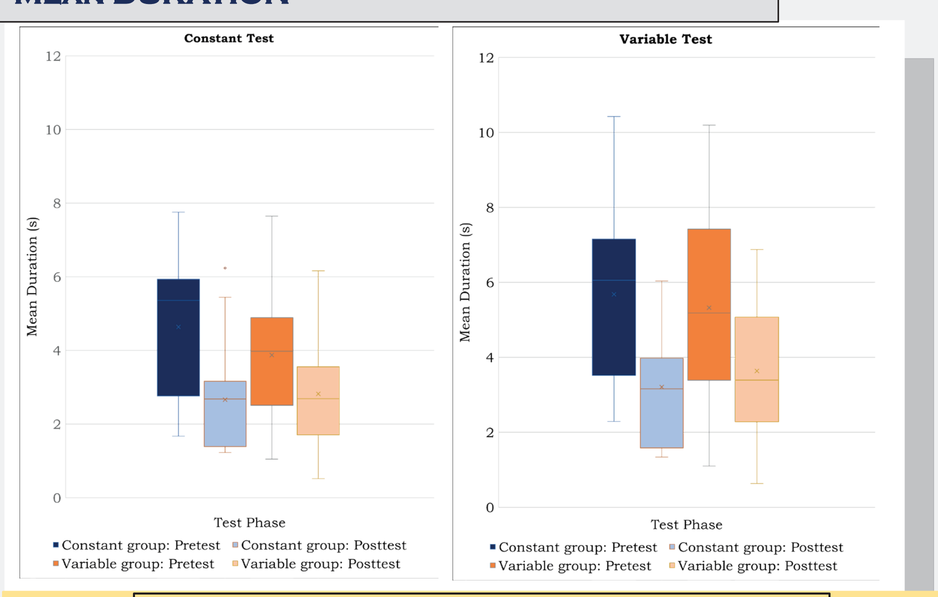

Fig 6: Shows mean duration taken by both groups to complete the task

- Both groups improved task timing from pretest to post test in both tasks.

Conclusion

- The constant training led to substantial improvements only in a posttest with constant task, for the proportion correct grasp.
- In contrast, the variable training led to improvements for the proportion of correct grasp, in a posttest of constant as well as in the variable task.
- Both groups improved the timing of task completion for both constant and variable task.
- The study suggests that incorporating variability of practice when learning to use an SSD may be beneficial.
- In the long run this might have implications to train individuals with visual impairments.

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REPAIRS

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Acknowledgement
This project has received funding from the EuropeaUnion's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie Grant agreement No. 956003.

Embodied Flow in Puzzle Solving: Dynamics of the Tower of Hanoi

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Background

Psychological states of flow have commonly been discussed as an optimal state of inner experience or, more precisely, as a multi-dimensional, positive experiential state that results from engagement in a task that is both difficult and worthwhile (Csikszentmihalyi, 1990). Flow has typically been measured using self-report methods that ask people to assess their subjective experience across several dimensions ranging from feelings of being able to complete the task competently to absorption in the task (Jackson & Marsh, 1996). However, these self-report methods have been criticized for being a "skull bound" form of assessment for a phenomenon that is necessarily embodied (Montul et al. 2020). In addition, self-report measures alone typically are unable to provide information about the relationship between flow and performance in **real time**.

In the present study, we hoped to further the development of methods that might quantify the flow experience behaviorally (Montul et al., 2020) by combining the survey methodology with behavioral timeseries. Previous work has used multifractal measures to index aspects of human performance that correspond to dimensions of the flow experience, including executive functioning and perceptual-motor control (Dotov et al., 2017, Anastas, 2013), where the . multifractal spectrum width (MFSW) is understood as a measure of multi-scale complexity within a system. It stands to reason that if multifractal measures have been used to index these phenomena, then similar metrics may yield insight into the behavioral elements of the flow experience. As an entry point, we investigated whether measures of multifractality reliably correlated with established dimensions of the flow experience.

Method

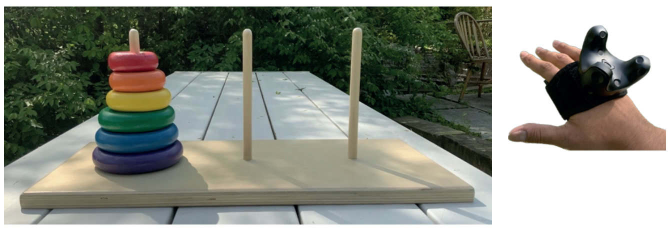

Figure 1: (Left) the tower of Hanoi; (Right) the HTC Vive tracker placed on hand.

A total of 25 people participated in this study. Participants completed a hand-built Tower of Hanoi Puzzle (dimensions 10 in x 30 in x 7 in). All participants performed a set of discrete trials attempting to solve the tower in the minimum number of moves while wearing HTC Vive motion trackers on their hands and sternum. Participants started a first block of trials, beginning with a tower of 2 rings; and after each successful completion another ring was added up to 4 rings. After completion of a 4-ring puzzle, a Flow State Scale (FSS, Jackson & Marsh, 1996) was administered. Between blocks, participants completed a 5-ring puzzle after which, participants completed another block of the 2-ring to 4-ring progression. At the end of the second block another FSS survey was administered. Time-series data from participants hand movements was collected for the entire experiment. While the FSS contains assessments of 9 different subscales, here we focus on responses related to Challenge-Skill Balance (CSB; ability to meet the challenge of the task at hand) and Action-Awareness Merging (AAM, absorption of the awareness of one's actions within the context of the task).

Results

Timeseries of each participant's dominant hand movements were differentiated to created a displacement time-series. These displacement timeseries were then submitted to multifractal analysis (Chhabara & Jensen, 1989) and the MFSW was calculated for each block. Linear mixed-effects models were used to predict each participant's subjective flow report as a function of multifractal spectrum width, block, and their interaction.

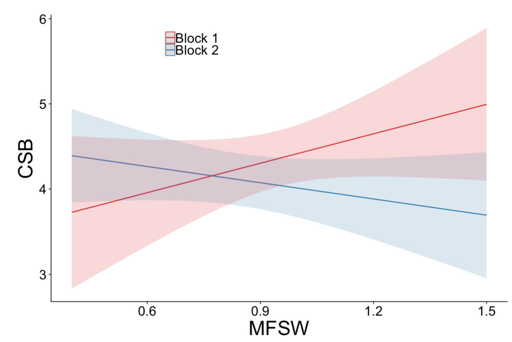

Figure 2: Relationship between CSB and MFSW by Block

CSB scores: The model revealed a significant positive relationship between MFSW and CSB scores, $b = 1.43$, $SE = .62$, $t(17.43) = 2.291$, $p = .031$. However, this effect was qualified by a Block * MFSW interaction, $b = -1.83$, $SE = .80$, $t(20.82) = -2.30$, $p = .032$. Simple slopes analyses revealed a significant positive relationship between MFSW and CSB in Block 1, $b = 1.43$, $SE = 0.65$, $t(16.6) = 2.20$, $p = .042$. The relationship between MSFW and scores in Block 2 was not significantly different from zero.

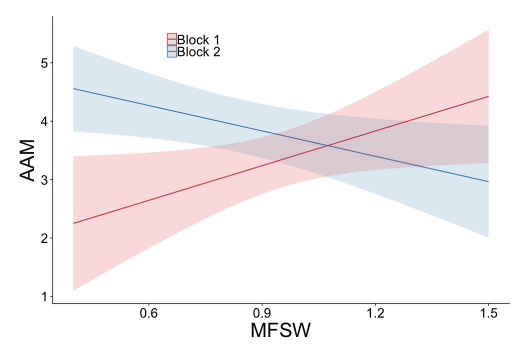

Figure 3: Relationship between AMA and MFSW by Block

AAM scores: The model revealed a significant positive relationship between Block and AAM scores, $b = 3.27$, $SE = .1.13$, $t(19.53) = 2.90$, $p = .009$. This effect was quantified by a Block * MFSW interaction, $b = -2.92$, $SE = 1.19$, $t(20.02) = -2.45$, $p = .024$. Simple slopes analyses revealed a significant negative relationship between MFSW and AAM in Block 3, $b = -1.54$, $SE = 0.56$, $t(20) = -2.73$, $p = .013$. The positive coefficient in Block 1 though similar in absolute magnitude, was non-significant (attributed to increased standard error of the estimate).

Discussion

The aim of the present study was to capture the behavioral dynamics of the tower of Hanoi while assessing covariation with FSS survey scores to determine whether measures of multifractality of movement might be associated with the subjective experience of flow. Here, our results revealed that the magnitude and direction of relationships between MFSW and FSS scores varied across several of the subscales including our focus on CSB and AAM. As it relates to MFSW as an index of complexity, the relationship between high reports of flow and the directionality of spectrum width appeared to change over time with more complex movements corresponding to increased experiences of flow during Block 1. During Block 2 trials, the opposite occurred—greater complexity corresponded to decreased feelings of flow. Provided the recursive dynamics of the tower itself, this change in direction might be explained by the learning process as it relates to movement. A given towers full completion necessitates solving all the towers with lower ring-counts throughout the process. We conjecture that MSFW may be capturing the degree of exploratory activity as participants learn to complete the task, where wider MFSW captures more exploratory activity. Under this interpretation, greater exploration to meet the demands of the Tower of Hanoi task may engender higher experiences of flow. Our results point to the embodied nature of flow and that MFSW is a potential predictor of a flow state. If the flow experience could be reliably captured by embodied measures, this suggests that flow might be more properly defined as an embodied activity than a purely subjective experience.

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Prospective Perception of Occluded Apparent Social Interactions

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Introduction

In our study we implemented an adaptation of Heider and Simmel's (1944) 'Apparent Behavior Paradigm'. The major number of elements of its original version was maintained: a big triangle, two small figures (a triangle and a circle), and a rectangle of a size bigger than the other three figures. A novel feature was that the rectangle served as an occluding object. According to Heft (2017), perception of social structures, can be understood in a similar way to the *occluding edge* phenomenon: providing a background that gives meaning to individual actions retrospectively and affords possibilities prospectively. We tested the idea that social interactions can be prospectively perceived.

In our study, participants after seeing apparent social interactions between the big triangle and the two small figures, they had to respond verbally about what they had seen. Then, after the small figures enter to the rectangle (occlusion) participants had to say what they think small figures were doing inside the rectangle.

Objective To assess whether apparent social interactions of geometric figures can be prospectively perceived.

Method

Participants

Forty-two college students from 18 to 30 years old (32 women and 10 men; *M*= 22.6 years, *SD*= 6.3) participated.

Materials

This study was carried out online. A basic Gloogle Meet platform was used. Videos implemented in the study were edited with the Adobe Premier Pro CS6 version. Data were recorded with a SONY voice recorder.

Procedure

Participants were exposed to two of three types of apparent social interactions (see Figure 1 and Experimental Design). At the last part of each interaction, small figures enter to the rectangle so they went out of participants' sight. After that, the screen went dark, and participants were asked *"what did you see?"* and *"what do you think figures are doing inside the rectangle?"*. This procedure was conducted 12 times, that is, four times per interaction.

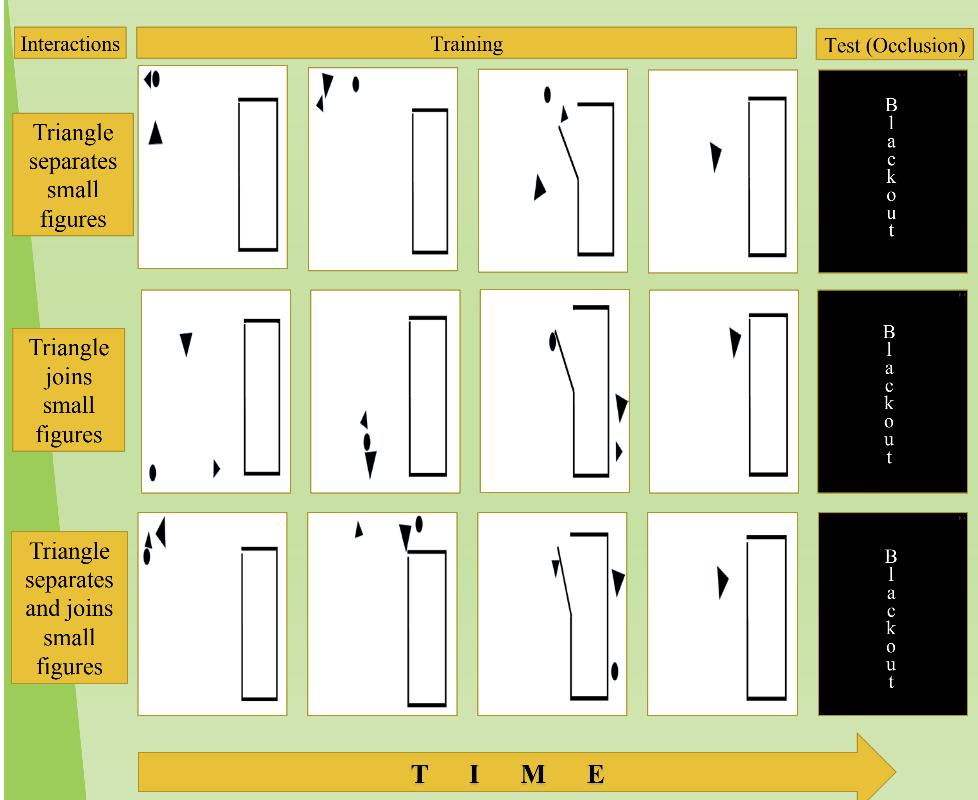

Figure 1. Three ways of how the big triangle interacts with the small triangle and circle

Experimental Design

Groups	Phase 1 Training	Phase 1 Test	Phase 2 Training	Phase 2 Test	Phase 3 Training	Phase 3 Test
1 (n=7)	Separates	Occlusion	Joins	Occlusion	Separates	Occlusion
2 (n=7)	Separates		Separates & Joins		Separates	
3 (n=7)	Joins		Separates		Joins	
4 (n=7)	Joins		Separates & Joins		Joins	
5 (n=7)	Separates & Joins		Separates		Separates & Joins	
6 (n=7)	Separates & Joins		Joins		Separates & Joins	

Results

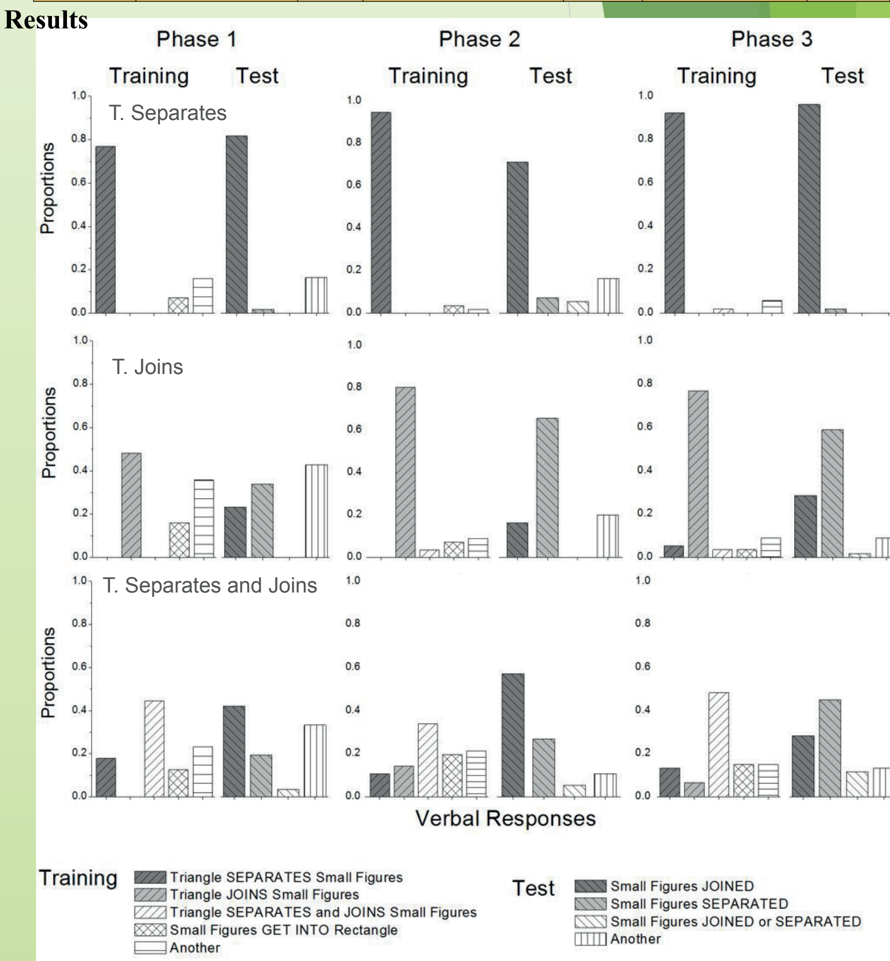

Figure 2. Proportions of verbal responses under three types of apparent social interactions.

Conclusions

*The interaction 'Triangle separates small figures' generated the highest proportions of verbal responses of "*Triangle separates small figures*" in training sessions, which suggests that this was the most differentiated social interaction among the three interactions, followed by 'Triangle joins small figures' and 'Triangle separates and joins small figures'.

*Similarly, the interaction 'Triangle separates small figures' generated the highest proportions of verbal responses of "*Small figures joined*" in test sessions (occlusion) which suggests that apparent social interactions perceived in training were related to occluded apparent social interactions perceived in test.

*The correspondence between verbal responses in training and test suggests that apparent social interactions of geometric figures might have been prospectively perceived.

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Task history alters the structuring of synergies in a precision finger force task: Implications for understanding resilience

University of Cincinnati

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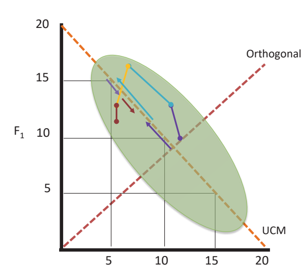
[1]University of Cincinnati, Center for Cognition, Action, and Perception

Introduction

- Resilience, or preservation of performance in the face of challenges or stressors, is supported by one's ability to achieve a motor task through multiple motor solutions.
- Uncontrolled Manifold Analysis (UCM) is one method for differentiating variance in motor elements that preserves (compensatory variance; V_{UCM}) versus hinders (orthogonal variance, V_{ORT}) performance.
- However, better motor performance has been associated with increases, decreases, or even no change in the extent of V_{UCM} (Wu & Latash, 2014).
- In two studies isometric force production studies, we examined how the not only the *extent* of V_{UCM} matters, but also *how* individuals move through this space over time ($SampEn_{UCM}$) for predicting resiliency in challenging task conditions.
- Grover et al. (2022) had participants complete low and high force conditions. In both conditions, more regularity in V_{UCM} (lower $SampEn_{UCM}$) predicted better performance. For the high force condition in particular, the benefit of greater regularity was boosted when individuals showed more compensatory behavior (greater V_{UCM}).
- In Pinto et al. (in-prep), participants matched a single force level but with the addition of a gain in some conditions that required greater force production precision. A similar pattern of results to Grover et al. (2022) was found.
- Features of synergy are mutable. It is unknown how history with a task might alter our previous findings or synergy characteristics themselves.



Objectives

- To examine the effect of history with task demands on performance resilience and to determine how this effect is modified by the amount compensation in motor elements (V_{UCM}) and regularity of compensatory patterns ($SampEn_{UCM}$).
- To examine whether history with task demands alters the amount (V_{UCM}) and the regularity ($SampEn_{UCM}$) of compensation.

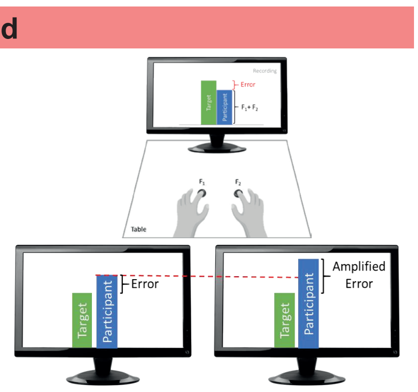
Method

Participants

- Thirty-two adults (19 female, 11 male, 2 non-binary) aged from 18 to 39 years.
- Normal or corrected-to-normal vision and free of any neurological, motor, or balance disorders or recent injuries.

Procedure

- Participants sat at a desk and placed each index finger on a small force sensor.
- During a 30s trial, participants pressed both sensors in order to make a blue bar appear on the monitor in front of them and match the target force bar (green).
- Some trials had a gain added to them, altering the precision demand of the task. Higher gain values resulted in greater sensitivity of the blue bar to changes in force, amplifying the error participants saw.
- Participants were randomly assigned to one of two groups representing different task histories (see Table).



Group (Task History)	Gain Ordering
High to low precision demand (H-L)	8,8,7,7,6,6,5,5,4,4,3,3,2,2,1,1,0,0
Low to high precision demand (L-H)	0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8

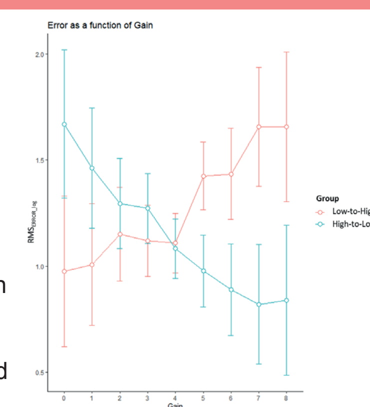
Analyses

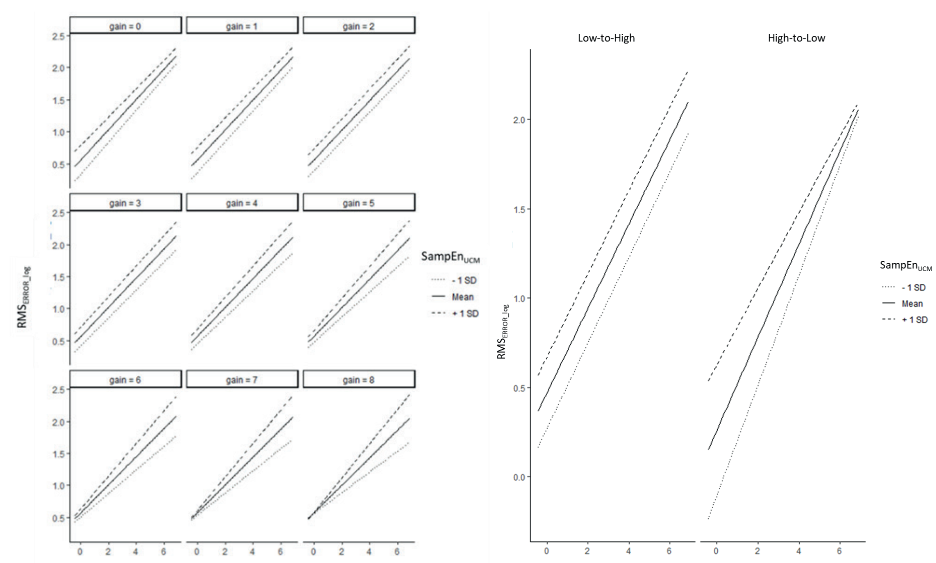
- As a performance metric, we calculated root mean square error (RMS_{ERROR}) between each participant's target force and total force values.
- After conducting UCM analysis on each trial, we took the V_{UCM} values and ran sample entropy on them for each trial.
- Model 1: Mixed effect modeling of RMS_{ERROR}
  - Predictors: Trial (main effect only), Group, Gain, V_{UCM_log}, $SampEn_{UCM}$
- Model 2: Mixed effect modeling of V_{UCM}
  - Predictors: Group, Gain, Trial
- Model 3: Mixed effect modeling of $SampEn_{UCM}$
  - Predictors: Group, Gain, Trial

Results

Model 1: RMS_{ERROR}

- Significant (p<.05) effects of interest:
  - Trial (b = -0.05)
  - Gain (b = 0.19)
  - Group × Gain (b = -0.18)
  - Group × V_{UCM} × $SampEn_{UCM}$ (b = -0.28)
  - Gain × V_{UCM} × $SampEn_{UCM}$ (b = 0.05)
- H-L Group performed significantly better at high gains than L-H and similarly at low gains.
- The potential benefits of reduced V_{UCM} and $SampEn_{UCM}$ vary depending on both Group and Gain.





Model 2: V_{UCM}

- Significant effects:
  - Gain (b = 0.07)
  - Gain × Group (b = -0.12)
- V_{UCM} decreases at higher gains for the H-L group. V_{UCM} increases with gain for the L-H group.

Model 3: $SampEn_{UCM}$

- Significant effects:
  - Trial (b = 0.003)
- $SampEn_{UCM}$ decreases (i.e., greater regularity) with subsequent trials, regardless of gain or group assignment.

Discussion & Conclusion

- History of task demand did alter performance resilience. Specifically, the H-L group displayed less error at higher gains than the L-H group. One path to understanding this finding is the Challenge Point Framework (Guadagnoli & Lee, 2004) and the unique role of amplifying feedback in performance.
- Performance resilience was affected not only by the amount of compensatory variance, but also how individuals expressed this variance over time. The benefits of more regularity in this variance was dependent on both the task and task history.
- Task history affected V_{UCM}, while changes in $SampEn_{UCM}$ are time related.
- Changes in attention may explain time-related changes in $SampEn_{UCM}$ and why the H-L group was potentially more sensitive to the additional information provided by the high gain conditions.

Future Directions:

- Explore Latash's (2010) two-stage learning theory with the addition of $SampEn_{UCM}$.
- Find more ecologically valid tasks in which this methodology is appropriate.

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GRFP

Motion sickness and postural activity during head-mounted display virtual driving

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Introduction

Motion sickness is a type of physical symptom that causes dizziness, headache and even nausea, vomiting and other discomfort (Kennedy et al., 1993). Besides the possibility of motion sickness on transportation, the virtual reality (VR) has also created the problem of motion sickness. The head-mounted display (HMD) is a device commonly used in virtual reality (VR). Curry et al., (2020) found that when individuals were seated and exposed to HMD driving games, 43 % of them reported motion sickness, but there was no sex difference in the incidence rate. The present study further investigated the effects of heel shoes and sex on postural control and motion sickness while standing individuals controlled a driving games in an HMD virtual environment.

Method

Participants

There were 119 participants recruited, and randomly assigned to the following four groups according to sex and heel shoes: male barefoot (MB) group; male heel shoes (MH) group; female, barefoot (FB) group; female heel shoes (FH) group. The basic information of groups is as shown in Table 1. The experimental protocol was approved by the Research Ethics Committee for Human Behavioral Sciences of National Cheng Kung University.

Table 1 Basic information of participants and incidence rate of motion sickness

Group	Number	Age (years)	High (cm)	Weight (kg)	Incidence rate (%)
MB	30	21.67 ± 1.63	172.91 ± 6.04	68.19 ± 12.79	26.67
MH	30	21.08 ± 1.31	175.02 ±7.80	70.74 ± 11.79	26.67
FB	30	21.08 ± 0.95	160.50 ± 5.78	58.46 ± 8.89	56.67
FH	29	20.70 ± 0.93	162.87 ±4.68	60.41 ± 10.76	55.17

Male barefoot (MB) group; Male heel shoes (MH) group; Female, barefoot (FB) group; Female heel shoes (FH) group

Procedure

Participants were require to fill out the SSQ (Kennedy et al., 1993) to measure the severity of motion sickness before the expose to the HMD. Two sensors of a Magnetic tracking system (Flock of Birds, FOB) (Ascension Technologies, Inc., Burlington, VT) were attached to the head and torso (the 7th vertebra) of the participants at 60 Hz to measure their body movement during exposure. Participants performed visual search task and visual inspection tasks for 1 minute each. And then they were required to play a driving game in HMD for up to 15 minutes. Oral response to a yes/no question was used to determine if participants were motion sick. Then, they were required to complete SSQ2 to measure the severity of motion sickness symptoms after the expose to the virtual reality.

Results and Discussion

Incidence rate of motion sickness

The overall incidence of motion sickness was 41.18 % (49/119). The results showed significant Sex effect, $x^2(1) = 10.52$, $p = .001$, The incidence of motion sickness is higher among female (33/59 = 55.93 %) than male (16/60 = 26.67 %). The Heel Shoes effect was not significant, $x^2(1) = 0.01$, $p = .913$. Data on motion sickness are summarized in Table 1. The overall incidence rate were comparable to the study of Curry et al. (2020). However, the present finding of sex difference is distinct compared to Curry et al. (2020). The differences could be attributed to different postures: standing in the present study compared to being seated in Curry et al. (2020). Due to word limitations, the results of SSQ will be presented in the full manuscript.

Positional variability

A Sickness Groups × Sex × Shoe Height × Time Windows mixed effects 4 way analysis of variance, with the last factor as repeated measure was used to analyze the during exposure head and torso movement in anterior-posterior (AP) and mediolateral (ML) axes. The Time Windows effect was significant in both the head and torso movements, *ps* <.05, the results of the post-hoc analysis and the mean for each time window is as Table 2.

Table 2 Significant main effects of Time Windows on positional variability

	W1	W2	W3	Post-hoc test
Head AP	1.66 ± 0.47	1.85 ± 0.75	2.02 ± 0.84	W3>W2=W1
Head ML	1.66 ± 0.87	1.99 ± 1.05	2.25 ± 1.56	W3>W2>W1
Torso AP	1.22 ± 0.35	1.33 ± 0.56	1.39 ± 0.59	W3>W2=W1
Torso ML	1.07 ± 0.51	1.22 ± 0.74	1.47 ± 1.51	W3>W2>W1

positional variability (cm); W1=Window 1, W2=Window 2, W3 Window 3; ±denotes standard deviation

For head movement in the AP axis, the Sex × Time Windows interaction was significant, F (2, 184) = 6.62, $p = .002$, partial $\eta^2 = .07$. For head movement in the ML axis, Sickness Groups × Shoe Height × Time Windows interaction was significant, F (1.67, 153.14) = 3.54, $p = .039$, partial $\eta^2 = .04$ (Fig 1).

For torso movement in the AP axis, Sex × Time Windows interaction was significant. F (2, 188) = 5.54, $p = .005$, partial $\eta^2 = .06$. For torso movement in the ML axis, Sickness Groups × Shoe Height × Time Windows interaction was significant, F (1.38, 129.23) = 7.30, $p = .004$, partial $\eta^2 = .07$ (Fig 2). Sickness Groups × Shoe Height interaction was significant, F (1, 94) = 4.40, $p = .039$, partial $\eta 2 = .05$.

Results showed significant Sex × Time windows effect of the AP axis of the head and torso movement. Postural control of male is different from female (Chiari, et al., 2002; Era, et al., 2006) while individuals exposed to a HMD driving game. The Motion sickness × Shoes height × Time windows effect was significant in the ML axis of the head and torso movement. Although, shoes height did not affect the incidence and symptom severity of motion sickness, the present study is the first one to verify that it affects postural control and motion sickness with increases of time.

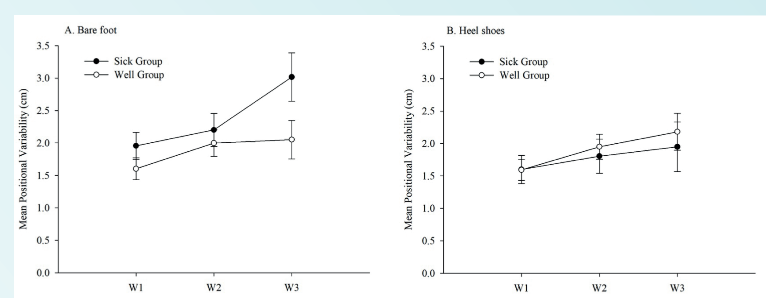

Fig. 1 Interaction effects of Sickness Groups × shoes height × Time Windows on the variability of body movement in the ML axis of the head exposed to VR. A. Barefoot group. B. Heel shoes group. The error bars represent the standard error of the mean.

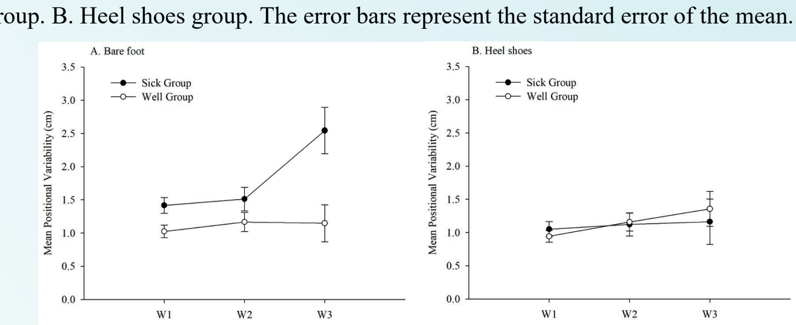

Fig. 2 Interaction effects of Sickness Groups × shoes height × Time Windows on the variability of body movement in the ML axis of the torso exposed to VR. A. Barefoot group. B. Heel shoes group. The error bars represent the standard error of the mean.

Conclusion

The present study investigated the effects of sex and heel shoes on postural control and motion sickness while individuals driving a virtual car in a head-mounted display (HMD) environment. We found that female had a higher incidence of motion sickness than male when driving virtual vehicles. During exposure to the HMD, the sex difference of postural sway changed as a function of time and it also changed as a function of heel shoes, motion sickness, and time. The results of during exposure postural activity supported the theory of postural instability of motion sickness (Riccio & Stoffregen, 1991).

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Acknowledgements

The present study was supported by the Ministry of Science and Technology, Taiwan (MOST 110-2410-H-017-019)

Styles of braking reveal scaling differences in cycling

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Introduction

Affordance-based control (Fajen, 2007)

Action boundary constraint

keep required deceleration to stop below the maximum achievable deceleration (Fajen, 2005a; 2005b; 2005c; 2007).

different styles of control

Aim: We investigated whether active- and inactive-cyclists show different styles of braking in a naturalistic cycling task.

Methodology

Participants

- 19 active-cyclists (> 20 km/week)
- 18 inactive-cyclists (no weekly practice)

Conditions

- Load (no-load, 5kg-load, 10kg-load)
- Speed (low-speed, high-speed)

1a)

Experimental task

- Stop as close as possible to the obstacle and to avoid the collision

1b)

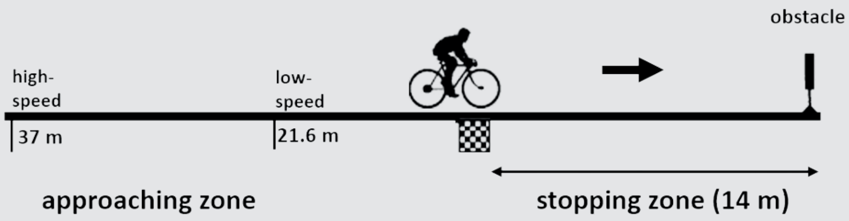

Figure 1. a) The experimental bicycle with the cargo bag attached to the frame; **b)** The approaching and stopping zones of the cycle path until the obstacle (white foam cuboid). Initial distances placed at 21.6m and 37m to the obstacle were used for low-speed and high-speed conditions, respectively.

Data analysis

- Dcurrent: current or momentary deceleration ($v_f - v_i/t$)
- Dideal: ideal deceleration required to stop ($v^2/2z$)
- ObsDmax: observed maximum peak of Dcurrent in each bicycle load condition
- Brake adjustment: when brake lever was pressed by at least 10% of maximum brake displacement (Fajen, 2008)
- Braking onset: time (s) at first brake adjustment
- Aggressive style (fig. 2a): characterised by a late braking onset and a high, steep peak in Dideal
- Conservative style (fig. 2b): characterised by an early braking onset and gradual, linear increase in Dideal

Results

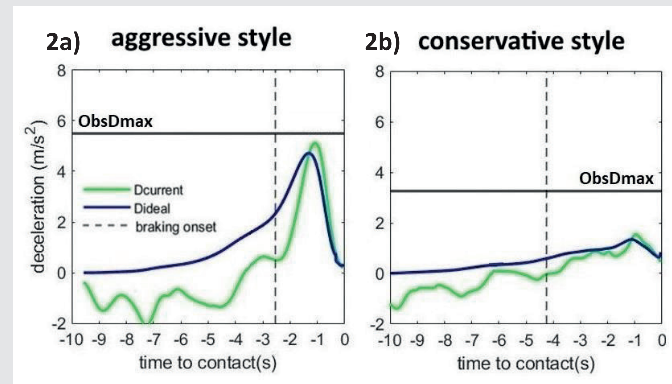

Figure 2. Styles of braking control: **a)** aggressive style, Dideal curve shows a skewed parabolic shape, with a late braking onset and a high and steep peak; **b)** conservative style, Dideal curve grows linearly flat and low peak**.**

Table 1. Contingency table that displays the frequency distribution of the braking styles per group across load and speed conditions.

		active-cyclists		inactive-cyclists		
		aggressive	conservative	aggressive	conservative	TOTAL
no-load	low-speed	14	5	10	8	37
	high-speed	18	1	7	11	37
5kg-load	low-speed	14	5	12	6	37
	high-speed	17	2	10	8	37
10kg-load	low-speed	14	5	11	7	37
	high-speed	18	1	10	8	37
	TOTAL	95	19	60	48	222

$\chi 2$ (1) = 22.42, p < .001

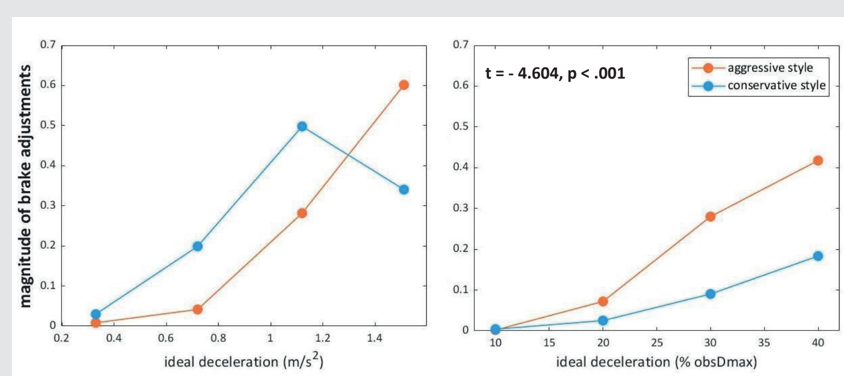

Figure 3. a) magnitude of brake adjustments as a function ideal deceleration (m/s^2) and **b)** relative ideal deceleration (% ObsDmax) by the braking styles. All frames used in this analysis showed a deceleration error close to zero (or 'nulled').

Conclusions

- Mapping from brake adjustment to deceleration was proportional among aggressive brakers but not for conservative brakers.
- These observations support the hypothesis that braking styles emerge from differences in scaling between perception and action.

Funding

This work was funded by the Brazilian Federal Agency CAPES Foundation (grant number 88881.362087/2019-01)

Exploring the configuration of the caregiver-child-environment system in a feeding situation: a preliminary study in behavioral science

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Introduction

- The psychological development of children is considered by Pelaez and Monlux (2020) to be the inseparable interaction between children and their caregivers. Through these interactions, children gradually acquire certain daily life skills.
- Nonaka & Goldfield (2018) point out that to understand the process by which children acquire daily life skills, it is necessary to study the mother-child interaction and the development of utensil use acquisition. From our perspective, this process involves the interaction as a caregiver-child-environment system.
- Longitudinal studies have consistently observed the interaction between the child, caregiver, and environment during feeding in natural settings (home and daycare) in order to identify how children learn to use utensils.
- The results of these studies have shown that caregivers provide various forms of assistance, such as in the use of utensils (Ishiguro, 2016) and vocal communication (Norimatsu, 1993), by adapting their behavior to the behavioral characteristics of the children (Belza et. al, 2020).
- Capella (1981) highlights a dynamic of mutual influence between children and their caregivers called compensatory, which means that decreases in caregiver behavior should be followed by increases in the same (or associated) behavior of the child and vice versa.
- From our perspective, this dynamic is involved in a broader system that includes the environment: caregiver-child-environment interactions. It would be expected that by restricting one of the behaviors in the system, such as caregiver assistance, compensatory behaviors would be observed that keep the system functioning for feeding purposes.

Purpose

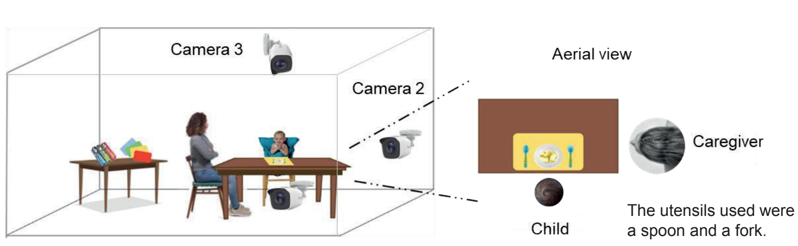
Identifying changes in the interactions between the caregiver, the child, and the use of utensils based on the restriction of utensils and verbal assistance by the caregiver in a feeding situation.

Method

Participants

A 15-month-old child and their primary caregiver.

Scenario

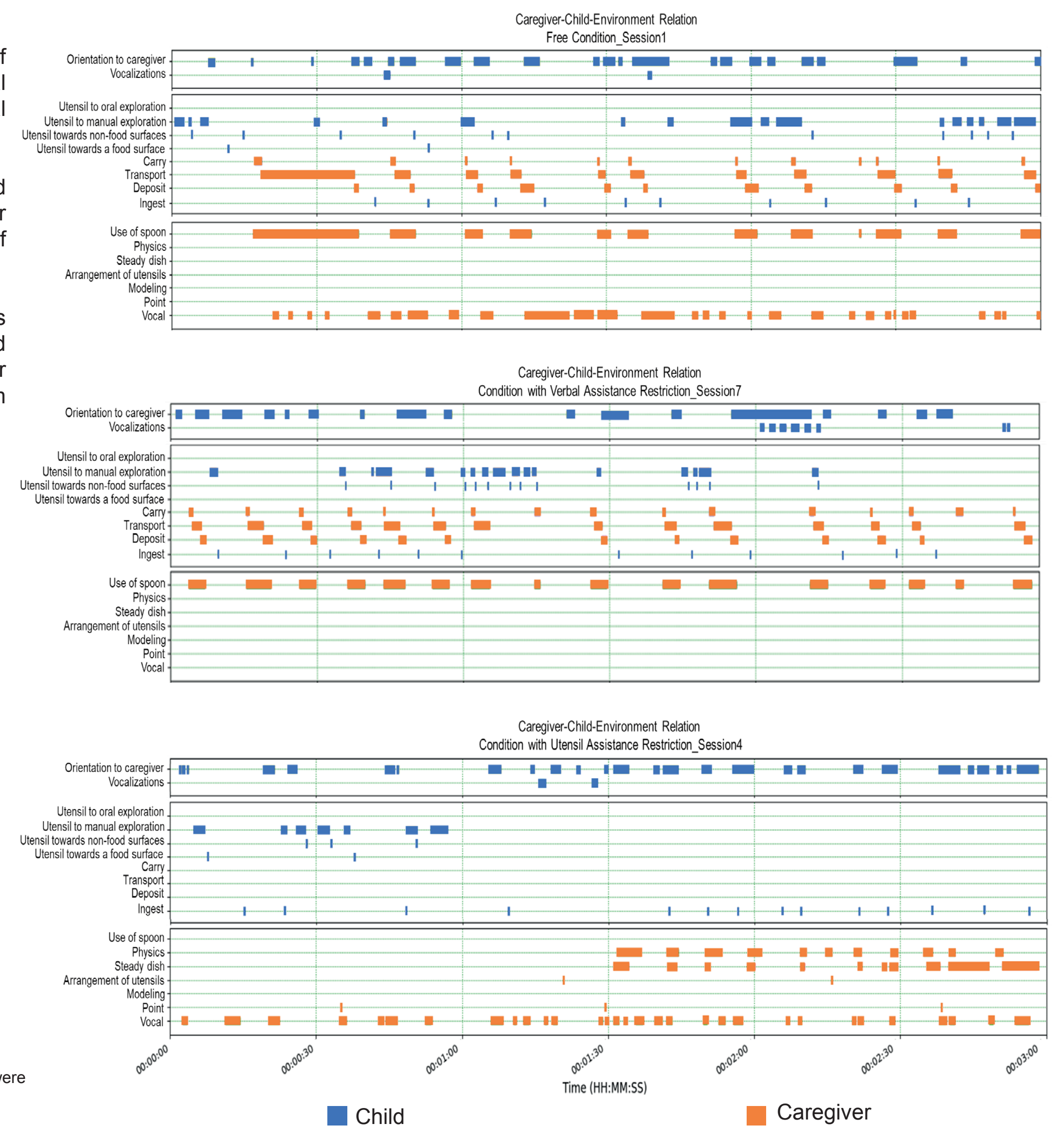


Design

Dyads	Experimental Conditions								
1	A	A	A	B	B	B	C	C	C
2	C	C	C	A	A	A	B	B	B
3	C	A	C	B	A	B	A	B	C
4	B	A	B	C	B	C	A	C	A

Note: A, Free Condition; B, Condition with restricted utensil assistance; C, Condition with restricted verbal assistance.

Results



Note: The results presented correspond to dyad 1.

Conclusions

In line with what Cappella pointed out (1981) and the expected results from our system perspective, changes were identified in caregiver-child-environment interactions when restricting verbal and utensil assistance from the caregiver.

When verbal assistance was restricted to the caregiver, the following compensatory behaviors of the system were observed: an increase in the child's vocalizations, a more limited presentation of utensils for manual exploration, and in most cases, these utensils were followed by utensils towards non-food surfaces. Correspondingly, the caregiver showed a higher frequency and consistency in feeding cycles throughout the session.

When the caregiver's use of utensils was restricted, compensatory behaviors were observed to achieve the feeding objective. The caregiver diversified assistance in the second half of the session, resulting in more consistent intakes by the child.

The results obtained show that: a) studying caregiver-child-environment interactions in a laboratory setting allows for a clearer identification of compensatory behaviors in the system when restricting the most relevant behaviors identified in longitudinal studies, and b) the observed compensatory behaviors account for the system's adjustment to meet the objective of the situation: feeding.

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ICPA 2023

Moving the Goalposts: The influence of Context on Behavioral Transitions in a Unilateral Manual Reaching Task

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Background

Hysteresis phenomena are a hallmark of complex systems and are formally observed when the relationship between the state of the system depends on the history of variation of some external, or control, parameter (Brilliant, 1958). It has been shown that hysteresis in transitions between behavioral modes can be exaggerated by incorporating (seemingly) functionally unrelated cognitive demands into the task (Lopresti-Goodman et al., 2009), suggesting that observed hysteresis may be affected by task constraints other than the immediate affordance boundary separating one behavior from another. The global landscape of affordances that may influence the dynamics of a behavior are not limited to the same behavioral scale as the immediate action. Factors such as goals, intentions, planned proceeding actions, or social contexts may all shift the topography of the affordance landscape and influence the dynamics of an action at the task level. The present investigation explores affordance-based transitions in behavior in the context of a relatively simple landscape of competing affordances.

Hypothesis: that both hysteresis effects and entropy trajectories would be influenced by the landscape of affordances. More specifically, the magnitude of the hysteresis effect and the pattern of entropy measures would vary as a function of the location of the goal

Method

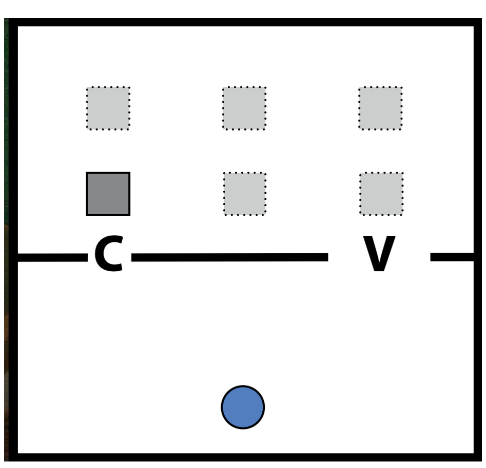

Figure 1: Birds-eye schematic of the virtual tabletop. Participants moved the circle to the goal location (medium gray filled square at top) by passing through one of the apertures. Lighter squares with dashed outlines represent other possible goal locations. C = critical aperture; V = variant aperture

Twenty right-handed undergraduate students (11 women) participated for course credit. Participants completed a 2D bimanual reaching task to move an object from a start location though a choice of either constant or variable apertures, to a goal location. Virtual targets and obstacles were projected onto a table, where participants moved a physical Polhemus tracker through the space. Explicit decisions and x,y coordinates of the tracker were recorded.

Results

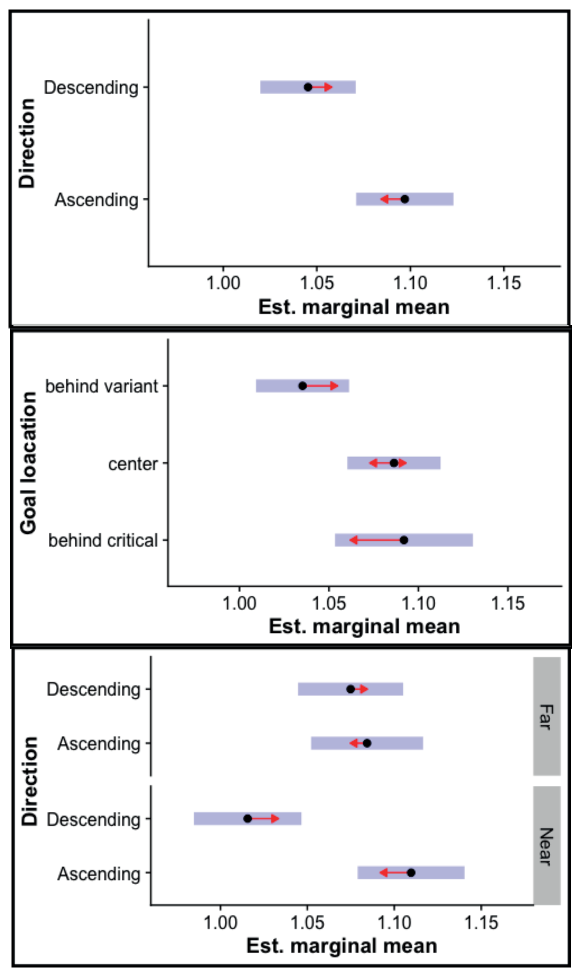

Figure 2: Estimated marginal mean differences in transitions as (top) a function of direction; (middle) a function of goal location, (bottom) the interaction between goal distance and direction.

Linear mixed effects modelling revealed effects for presentation direction, $F(1, 129.69) = 16.18$, $p < .001$; goal location, $F(2, 135.45) = 7.66$, $p < .001$; and an interaction between direction and goal distance, $F(1, 124.74) = 11.10$, $p = .001$. Mean transition points were (1) **lower in blocks of descending trials than for ascending trials;** and (2) **lower when the goal was located behind the variant aperture** compared to when it was behind the critical aperture or in the center of the table.

Entropy values were submitted to a linear mixed effects model, revealing an interaction between trial-to-transition and direction, $F(8, 1300) = 2.32$, $p = .018$. During ascending blocks, entropy values remained relatively stable with a slight decreasing trend over trials ($F = 1.29$, $p > .05$, *n.s.*). **For descending blocks there were significant changes in entropy over trials** ($F = 2.21$, $p = .024$). Neither goal location nor goal distance interacted with trial-to-transition (*ps* > .05)

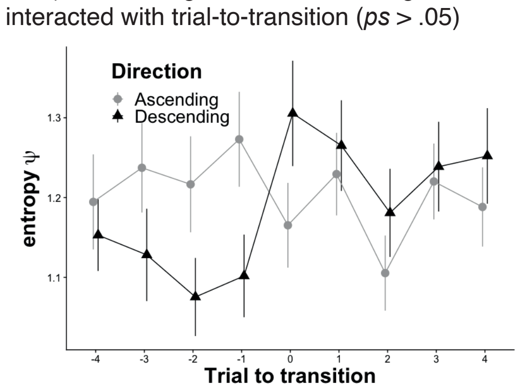

Figure 3: Entropy measures as a function of trial order. Trial 0 represents the transition trial.

Discussion

We suspect that the differences in the pattern of entropic fluctuations reflect an asymmetry in the presentation of available affordances (restricting vs providing). Here we may consider dual afforded routes as wells whose depth varies as a function of their basin size. During descending trials, this basin is initially deeper reflecting its larger π-value. but grows shallower; "pushing" the behavior out of the variant basin and into the constant basin. During ascending trials, behavior starts in a moderately stable basin of attraction. As the variant opening grows wider, its basin grows deeper, but importantly, this change has less direct impact on the current behavior. As the variable opening becomes sufficiently large, the behavioral mode will gradually shift (fall) into the new pattern as it is more attractive. As the behavior is not being pushed out of its original pattern, it is less likely to be an erratic shift, and more of a gentle transition to a new state.

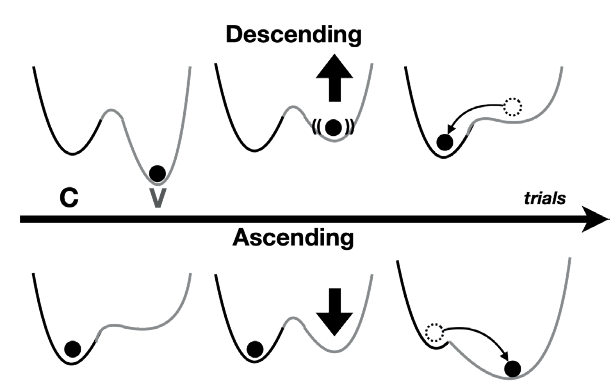

Figure 4: Schematic of potential attractor landscape of the Critical and Variant apertures, demonstrating how the landscape changes over trials

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Acoustic versus Vibrotactile Stimulation in a Sensory Substitution Device

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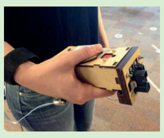
ICPA 2023

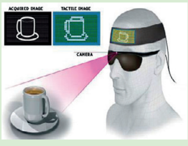
Perception & Action Research Group

Introduction

Sensory Substitution Devices (SSDs)



- Electronic devices
- Enhance the capabilities of a sense (touch or audition) to detect information typically accessed by vision
- Provide information to solve daily tasks
  - Navigation avoiding obstacles
  - Objects' recognition
  - Grasping objects?



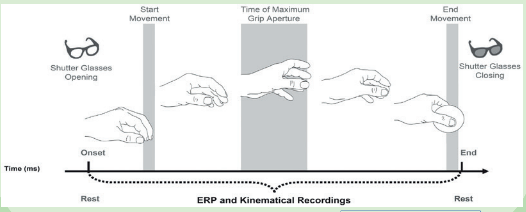
Grasping task

Grasping is a daily sensorimotor function

Eye – arm – hand coordinated movement

Many cues are implied (vision, muscles, etc.)

Many types of grasping (object's affordances)



Jeannerod (1984))

Information

1. What info do we need to grasp an object?

- Distance towards the object ~ increments of stimulation intensity
- Size and/or edges of the object active exploration or sensing

2. Which sensory modality should we use?

- Touch ~ spatiotopic / underused / already tested
- Hearing ~ better resolution / overused?
- Combination (?) ~ redundancy / overloaded

3. Ecological psychology

- Information is amodal (Gibson, 1979)
- Not so many unisensory cues in the environment, but high-order variables
- Global array (Stoffregen & Bardy, 2001)

Method

General purpose

- Evaluate the suitability of different sensory modalities in terms of performance for grasping tasks using a SSD
- Determine whether combining multiple sensory modalities in a SSD would have a detrimental effect on performance

Participants

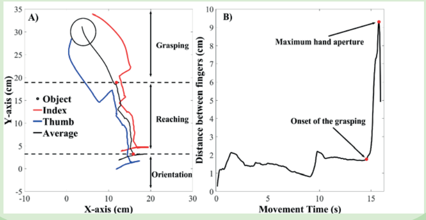
30 blindfolded participants
10 mins of familiarization
1 hour session

Independent Variables

1. **Sensory modality groups** (between subj)
   - Sound
   - Vibration
   - Cross-Modal
2. **Properties of the object** (within subj)
   - Orientation (150° / 120° / 90°)
   - Distance (30 / 25 / 20 cm)
   - Diameter (8 / 6 / 4 cm)

Dependent Variables

1. **Proportion of correct answers**
2. **Proportion of time dedicated to each movement phase**
3. **Maximum hand aperture**



The Sensory Substitution Glove

Polyester glove (easy and stable grasp)

Two vibrotactile motors (index and thumb).
The vibration intensity ranged from 3 to 10 V

Acoustic stimulation
200 Hz pure tone, range from 45 to 84 dB

Directly connected to a computer

6 reflective markers (MOCAP-system)

Results

Magnitude estimation task

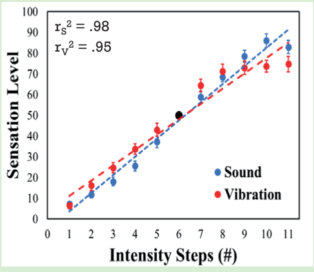
Two sensory modalities (Sound vs Vibration)

Intensity: 10 stimuli (1 reference)

	1	2	3	4	5	6	7	8	9	10	11
V	3.1	3.79	4.48	5.17	5.86	6.55	7.24	7.93	8.62	9.31	10
dB	45	48.89	52.77	56.66	60.55	64.33	68.33	72.22	76.11	79.99	83.88

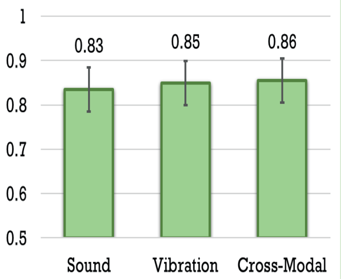
ANOVA

Sensory Mod. ($p > .05$); Intensity ($p < .05$); I* S ($p < .05$)



Hit rate

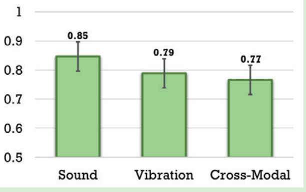
- Overall performance: **0.84**
- Equivalence test:
  Sound = Vibration = Cross-Modal



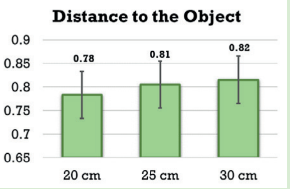
- Repeated measures ANOVA

Proportion of time dedicated to each phase

- Overall proportion of time: **0.80** (reaching)
- Equivalence test:
  Sound > Vibration > Cross-Modal

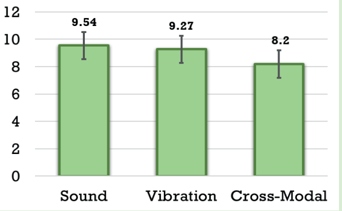


- Repeated measures ANOVA

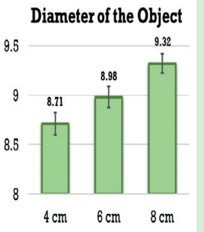


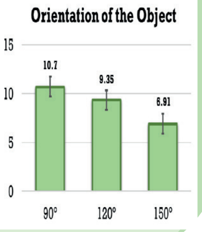
Maximum Hand Aperture

- Overall max hand aperture: **9 cm**
- Equivalence test:
  Sound = Vibration > Cross-Modal



- Repeated measures ANOVA





Discussion & Conclusions

- **Good overall performance**
  - The properties of the object did not have a significant effect
  - Results consistent with previous research (visual models and de Paz et al. (2023)
- **Multisensory integration**
  - Sound was the worst group (*)
    - Functioning?
    - Not directly linked to the movement?
  - Cross-modality was not detrimental, but neither was it beneficial
  - Vibration was the preferred stimulation (survey)
  - The equivalence between groups indicated that the environmental info es amodal and it can be accessed through multiples sources of stimulation

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Interpersonal Coordination during Steady-State Isometric Force Production: Complementary or Compensatory?

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Background

Success in joint actions often demands a high degree of motor coordination and precision between multiple actors—actors must complement one another's movements and efforts to best complete the shared task. While much work has been done investigating the coordination of movements (kinematics, e.g. Ramenzoni et al., 2011; Romero et. Al, 2015), to date comparatively little has investigated the coordination of effortful force production during a joint task. However, many real-world tasks depend upon the successful coordination of both produced movements and forces.

Recently, Grover et al (2022) investigated the *intrapersonal,* synergistic coordination of forces across limbs within individual actors as it was related to task performance. They found that actors' performance in a precision force stabilization task was predicted not only by the degree of synergistic compensation between limbs—as measured by variance along the uncontrolled manifold (UCM, Latash et al., 2008), but, more importantly, the regularity of the structure of variability of compensation—as measured by sample entropy (SampEn, Richman and Moorman, 2000). Here, we extended these findings to joint action, by investigating the degree and structure of synergic compensation during an interpersonal force production task. Our primary objectives were (1) to investigate the nature of interpersonal synergies in a force stabilization task as related to the amount of required force production; and (2) to determine whether the dynamics of compensation similarly predict joint task performance in an interpersonal force stabilization task.

Method

Participants: Thirty healthy dyads (43 F and 17 M), aged 18 to 38 years were recruited to participate.

Apparatus: standard pinch gauge dynamometer, two FS20 low-force compression load cells, Arduino/ Processing code, computer monitor.

Procedure: Participants sat next to each other in a chair in front of the monitor. Prior to the experiment, participants' MVC was measured; The max MVC value produced over two trials between each dyad (40.06 ±11.57 N) was used to scale the target force (10% & 30% of MVC). During the study, participants were asked to produce a stable force for 30 seconds per trial. In each trial, participants tried to produce and maintain a total force (FTOT) as close to the target force (FTARGET) displayed on the 17" monitor as possible with real-time visual feedback (see Figure 1). There were a total of 10 trials with random task conditions at 10% and 30% MCV for target force.

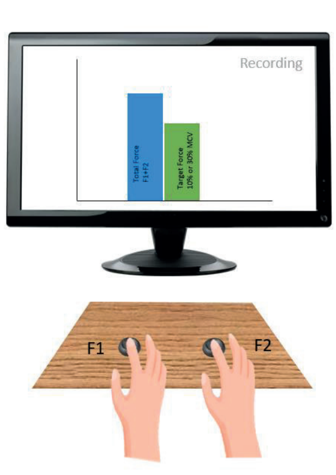

Figure 1: Schematic of the joint finger force production task.

Results

The UCM approach was used to quantify the degree of synergy between the dyads performing steady-state isometric force stabilization task. To begin, we calculated the amount of variability within the UCM, or V_{UCM}. Following Grover et al, we extended the UCM method by computing the projection lengths of finger-force deviations from their mean state along the UCM. This allowed us to generate time series of finger-force variability along the UCM. We analyzed the regularity of these timeseries using sample entropy ($SampEn_{UCM}$). We submitted values of RMS error of deviations from target performance to a mixed effects model including overall V_{UCM}, $SampEn_{UCM}$, and the force demand Condition as predictors.

Table 1: Significant model results.

Fixed Effects	Estimate	95 % CI	p
Condition	0.67	0.39 – 0.95	< .001
V_{UCM}	0.35	0.29 – 0.41	< .001
$SampEn_{UCM}$	0.67	0.43 – 0.92	< .001
Condition × $SampEn_{UCM}$	0.33	0.10 – 0.56	< .01

Marginal R^2 0.772
Conditional R^2 0.848

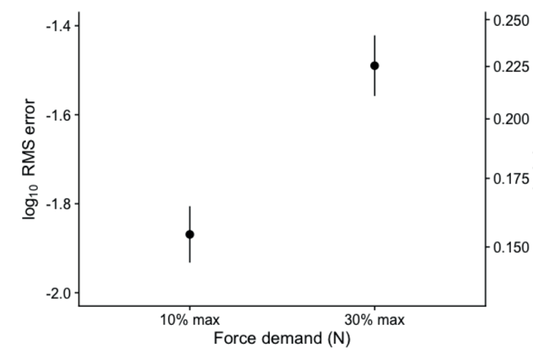

Figure 1: RMS increases with force demand condition

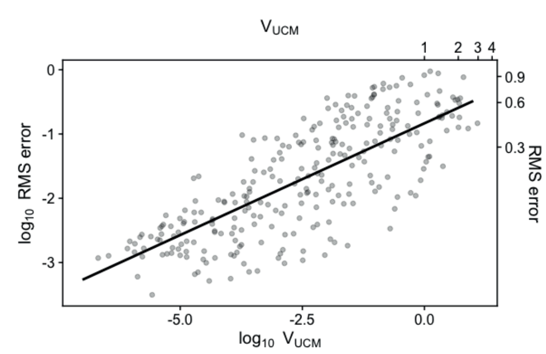

Figure 2: Relationship between RMS error and V_{UCM}

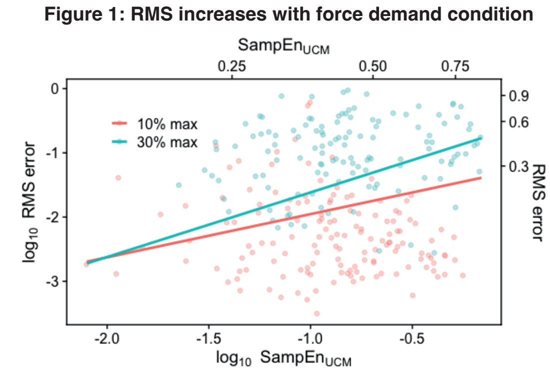

Figure 3: $SampEn_{UCM}$ by Condition interaction

Discussion

This study aimed to determine the degree to which the task demands and the dynamics of synergistic compensation between actors inform about performance in a shared force production task. Our results indicated that joint task performance typically suffered (1) in conditions that demanded actors produce a greater amount of their maximum force, and (2) during trials where there was greater irregularity in the structure of compensatory variance (as measured by V_{UCM}). These two factors interacted with one another such that increasing irregularity of V_{UCM} had a more profound impact on joint task performance during trials of greater force production demands. Together these results are consistent with previous work investigating similar task demands in intrapersonal coordination of force production (Grover et. Al, 2022). Notably, increased overall V_{UCM} had a deleterious effect on joint task performance. This result was also consistent with previous work and raises the question of whether greater compensatory variance is always "good", but rather should be understood in the context of ongoing task demands. Here, it appears that a "strategy" that minimized the amount of compensatory variance between members of the dyad while maintaining more regularity in the fluctuations of variance along the UCM maximized dyadic performance in the force production task. Future work may investigate if these findings generalize to more functional tasks (both intra- and interpersonal) such as walking, postural control, and object manipulation in typical and clinical settings motor systems.

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Transfer of Learning in Perception with Haptic Substitution Devices

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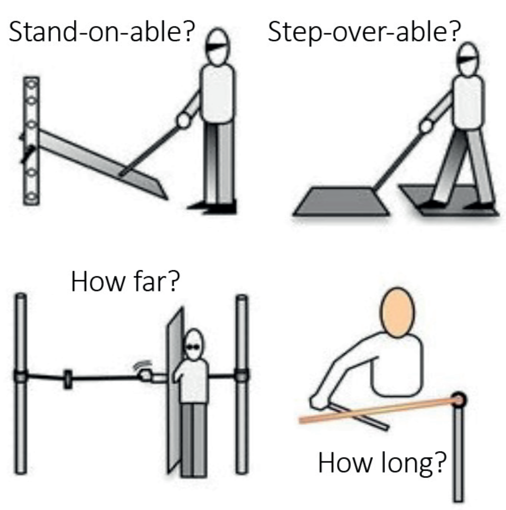
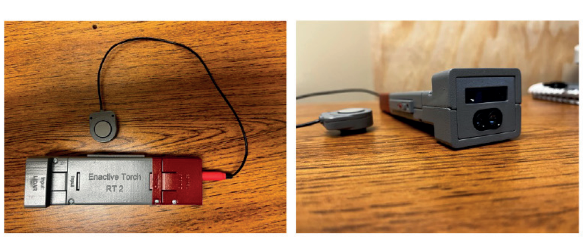
INTRODUCTION

People can perceive many properties of an occluded surface when exploring that surface with a wooden rod…



…and when exploring that surface with an Enactive Torch



If the stimulation patterns that support perception of surface properties is invariant across medium…

…then calibration of perception of a given surface property ought to transfer from rod to torch, and vice versa

METHOD

Pre-Test
Test Modality: Torch & Rod
(N=60)

Practice Modality: Torch (n=30) → Practice: Inflated Feedback (n=15); Practice: No Feedback (n=15)

Practice Modality: Rod (n=30) → Practice: Inflated Feedback (n=15); Practice: No Feedback (n=15)

Post-Test
Test Modality: Torch & Rod

METHOD (continued)

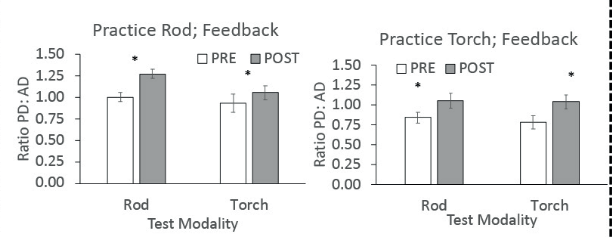
Why inflated feedback?
(1) increase the potential for recalibration
(2) differentiate recalibration from change

How did we assess calibration?
(1) ratios of perceived to actual distance
(2) slopes and intercepts of regression lines

RESULTS

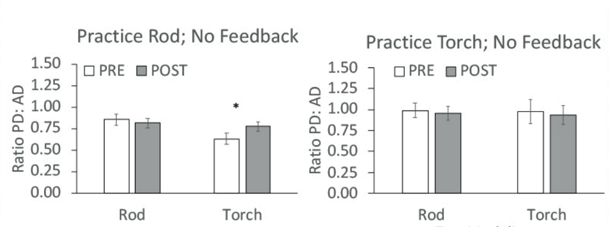
With Inflated Feedback, ratios increased from Pre-Test to Post-Test in all conditions…

…showing both calibration and transfer of recalibration



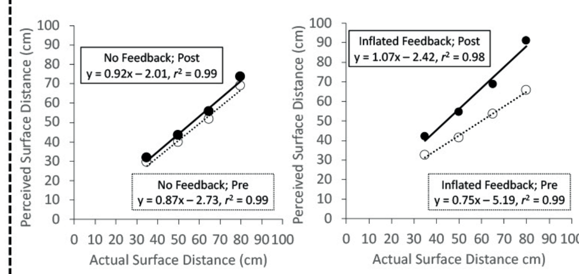
With No Feedback, ratios increased from Pre-Test to Post-Test in only one condition…

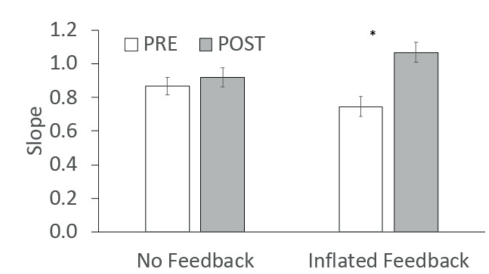
…showing transfer of recalibration in the form of self-training



RESULTS (continued)

With Inflated Feedback, slopes increased from Pre-Test to Post-Test in all conditions…





…again, showing both calibration and transfer of recalibration

Moreover, intercepts did change from Pre-Test to Post-Test…

…suggesting a rescaling of perceived distance to stimulation and not a post-hoc adjustment of perceived distance values…

DISCUSSION

The stimulation patterns that support perception of surface distance are likely to be invariant across medium

Relationship between Animal and Surface → Lawfully generates → Invariant Mechanical Stimulation Pattern

Invariant Mechanical Stimulation Pattern → Specifies uniquely → Relationship between Animal and Surface

Study of the rhythmic entrainment between speech and gestures in a conversational task

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Introduction

Social interactions involve a complex interplay of verbal and nonverbal cues, with rhythmic entrainment of bodily movements emerging once perceptual coupling is established. For example, to show agreement, the listener can produce a backchannel with soft vocalizations ("yeah") or quick gestures (nodding). While most studies focus on either motor behavior or language dynamics independently, very few have investigated the bi-modal (verbal and nonverbal) dynamics of social feedback.

Objective: Find rigorous research methods to enhance our comprehension of the bi-modal dynamics observed between participants within a conversational task.

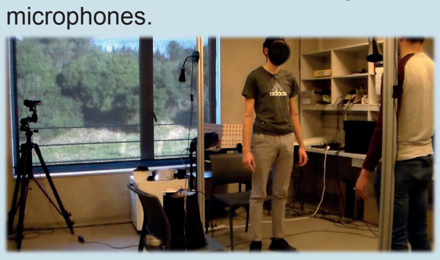
Methods

Experimental Setup :

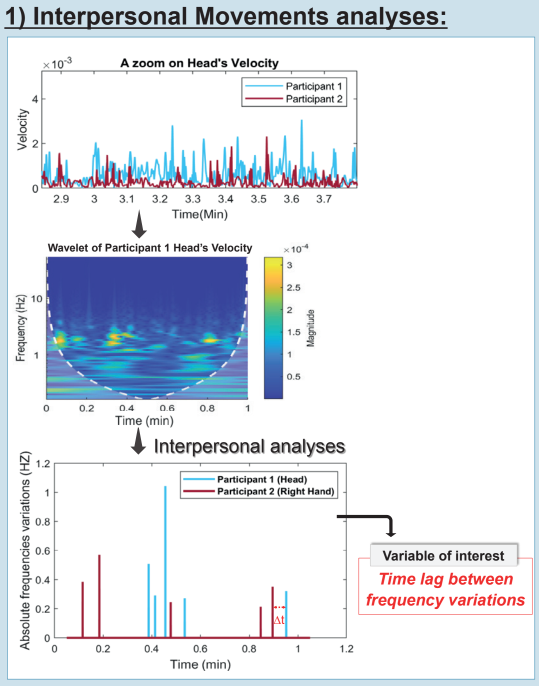
Dyads performed a conversational task where they had to answer 2 structured and 2 freeform questions (while standing or seating):

- *C1: seated & structured*
- *C2: seated & freeform*
- *C3: standing & structured*
- *C4: standing & freeform*

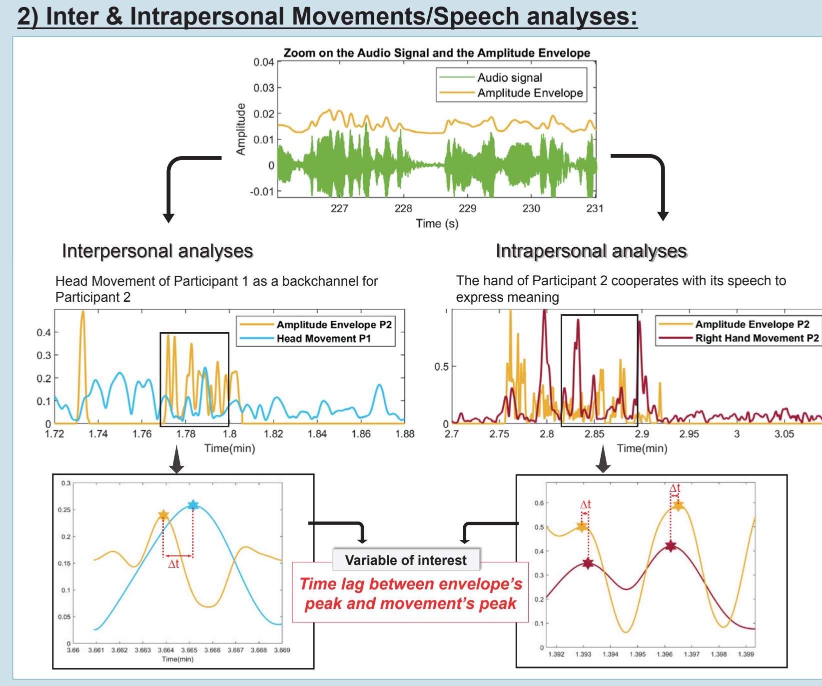
Movements of specific body parts were motion captured using the Optitrack technology.
Voices were recorded using lapel microphones.



1) Interpersonal Movements analyses:



2) Inter & Intrapersonal Movements/Speech analyses:

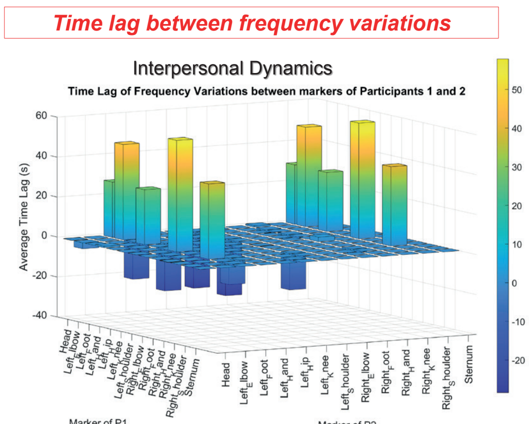


Results

The results were analyzed on moments where gestures were detected, employing an individual velocity threshold for selection

1) Interpersonal Movement analyses:

Time lag between frequency variations

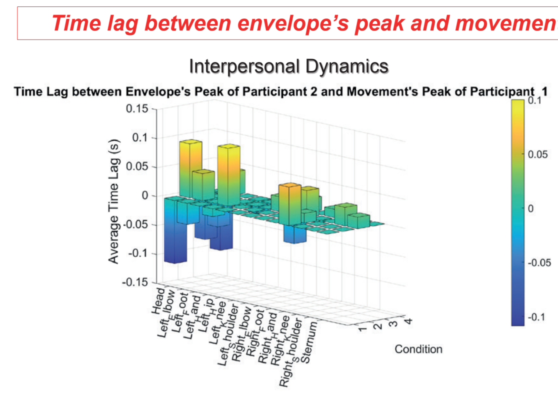


Markers with the minimum lag:

- -*C1*: P1's Left Shoulder & P2's Head → **0.0416 sec**
- -*C2*: P1's Left Hand & P2's Head → **0.0172 sec**
- -*C3*: P1's Left Foot & P2's Right Shoulder → **-0.0667 sec**
- -*C4*: P1's Right Hand & P2's Left Hand → **0.0054 sec**

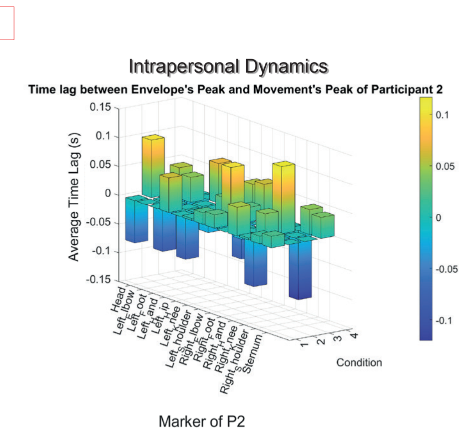
2) Inter & Intrapersonal Movements/Speech analyses:

Time lag between envelope's peak and movement's peak



Marker with the minimum lag:

- -*C1*: Left Hand → **-0.0133 sec**
- -*C2*: Right Hand → **0.0167 sec**
- -*C3*: Right Hand → **-0.0044 sec**
- -*C4*: Right Hand → **0.0144 sec**



Marker with the minimum lag:

- -*C1*: Left Knee → **0.0033 sec**
- -*C2*: Right Shoulder → **-0.0133 sec**
- -*C3*: Head → **-0.02 sec**
- -*C4*: Left Hip → **0.0033 sec**

Discussion and Conclusion

Time Lag in Interpersonal Analyses:

In interpersonal movement analyses, the average time lag spans -25 to 55 seconds. However, in interpersonal movement/speech analyses, it remarkably narrows, ranges from -0.1 to 0.1 seconds. This discrepancy can be attributed to the occurrence of backchannels, where one participant engages in nonverbal communication through gestures (nodding for example) while the other participant is speaking.

The importance of an accurate gesture discrimination method:

During interactions, individuals often engage in non-communicative movements (small oscillations while standing), which exhibit frequency variations. Although we employed a gesture detection threshold, non-communicative movements could explain the extremely weak minimum time lag found for interpersonal analyses. Therefore, it is crucial to implement a highly accurate gesture discrimination method that can differentiate communicative gestures related to the interaction from common movements.

Extending this methodology, along with a precise gesture discrimination method, will allows us to gain a deeper understanding of how both verbal and nonverbal cues interact to shape our social interactions.

This study was funded by the Agence Nationale de la Recherche (ANR) project ENHANCER #ANR-22-CE17-0036-03

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Sex differences in active tilt in a virtual driving game

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Driven to Discover

Introduction

Motion sickness is common when virtual locomotion (walking, driving, or flying) is presented via head-mounted displays (HMD). Many methods have been proposed to prevent or reduce motion sickness in this setting. One such proposal is for software to tilt the visual scene in the direction of left/right turns. The hypothesis is that a tilted visual scene could help to reduce the extent to which users tilt their own heads (as they normally do in physical vehicles; Fig. 1). The potential value of such an intervention rests on the assumption that people actually tilt their heads during turns in head-mounted virtual reality. Yet no existing research has evaluated actual head tilt among HMD users. Accordingly, an assessment of active head tilt among HMD users was the primary motivation for our study. Our second motivation relates to sex. In HMD-based virtual reality, motion sickness is more common among women than men. In addition, patterns of postural activity that are related to motion sickness differ between women and men. For these reasons, we compared women and men.

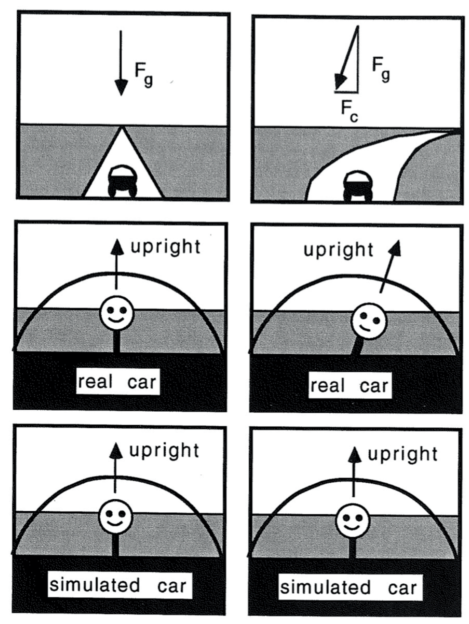

Fig. 1. Forces acting on the body during straight and curved physical driving (top). Body control in physical driving (middle). Hypothetical body control in virtual driving (bottom).

Method

Seated young adults (22 women, 19 men) drove a virtual car using a head-mounted display (Oculus). In a between-participants design, 20 participants drove a "Gran Prix" course that had many turns, while 21 drove an "Indy car" course that had few turns (Fig. 2). Participants controlled the vehicle using a steering wheel and foot pedals (accelerator and brake). Each participant completed a single trial, lasting 15 minutes. Using a magnetic tracking system (Polhemus), we evaluated the kinematics of the head and torso during virtual driving, extracting 3 dependent variables (Fig. 3).

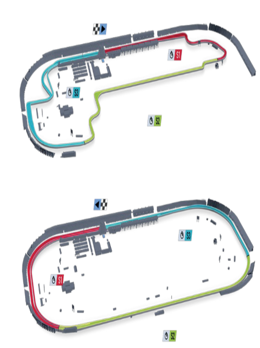

Fig. 2. Tracks for virtual driving.
Top: More turns. Bottom: Fewer turns.

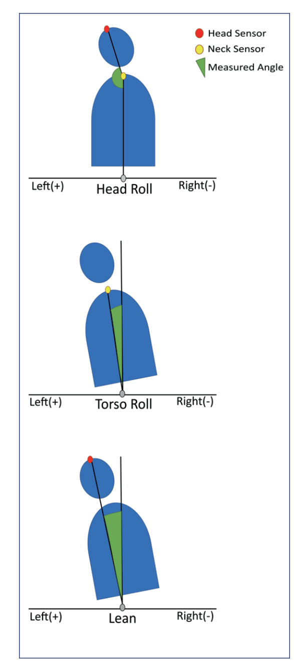

Fig. 3. Operational definition of tilt of the head (top), torso (middle), and body (bottom).

Results

As expected, driving was faster with fewer turns (Fig. 4). Women drove more slowly than men (Fig. 5). Overall tilt increased across the 15-minute driving sessions (Fig. 6), consistent with generalized effects of exposure time on movement during VR exposure. There were no main effects of Condition, or Sex on movement. However, the Condition × Sex interaction was significant for tilt of the torso, and for overall lean (Fig. 7).

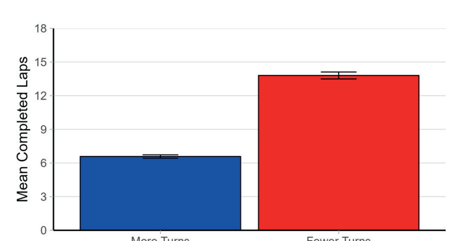

Fig. 4. Driving speed (laps completed in 15 minutes) as a function of Condition.

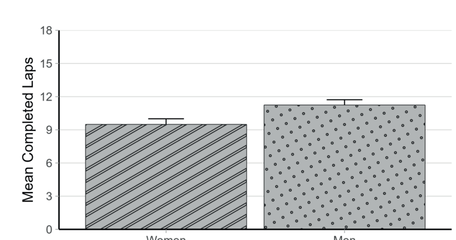

Fig. 5. Driving speed (laps completed in 15 minutes) as a function of Sex.

Discussion

The results demonstrate that adults actively tilted their own bodies while driving a virtual vehicle presented via an HMD, and that they varied the magnitude and direction of tilt in response to variations in conditions (tracks). Interestingly, our results suggest that participants tilted the body (i.e., the torso, as well as overall lean), but did not tilt the head relative to the torso. Importantly, these effects were observed only among male participants. That is, men varied their tilt as a function of track conditions, but women did not (Fig. 7). These sex differences may be related to sex differences in cybersickness (women are more susceptible than men), and may indicate that sex should be taken into account in the design of mitigation techniques. In particular, mitigation strategies that rely on "virtual head tilt" may have differing effectiveness for men and women.

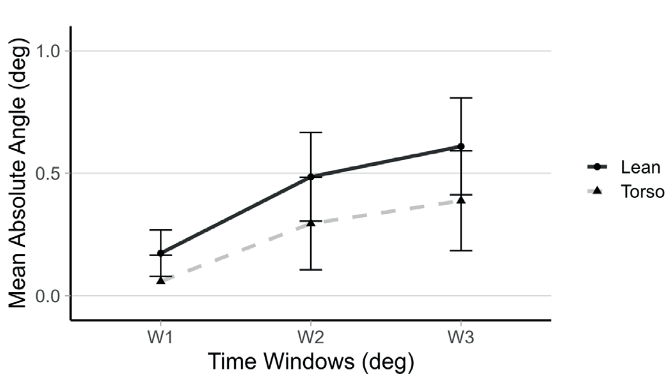

Fig. 6. Mean absolute tilt as a function of time during the 15-minute driving session for the head, the torso, and the body. W1, W2, W3: First, middle, and final 2 minutes, respectively.

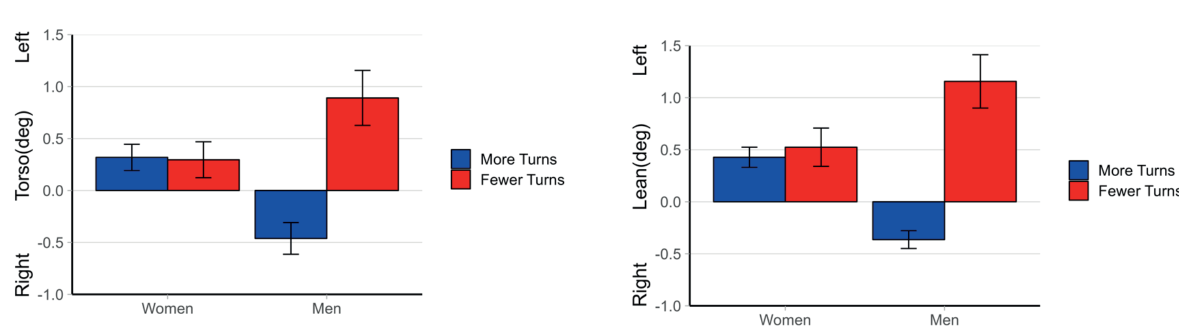

Fig. 7. Mean angle of the torso (left) and overall lean (right) during virtual driving.

Thomas A. Stoffregen, George Bailey, and Danilo Arruda were supported by the National Science Foundation (CHS-1901423). Eugenia Garza was supported by a University of Minnesota University Research Scholar award.

Perception of affordances for receiving serves in virtual volleyball: Effects of serve height in women and men

School of Kinesiology
University of Minnesota
Driven to Discover

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apaL

Introduction

Many affordances scale to body dimensions, such that perception seems disparate when scaled extrinsically, but universal when scaled intrinsically (Fig. 1). We investigated the perception of affordances for different ways to receive a serve in volleyball, where the importance of body scale is modulated by dynamic variables. Generally, players employ one of two techniques (Fig. 2): 1) raise the arms and receive the ball with the fingertips or 2) lower the arms and receive the ball with the lower forearm, or the heel of the hands. In a head-mounted virtual environment (Fig. 3), participants viewed approaching serves, and responded to each serve by attempting to field it as they would in a physical volleyball game. We tracked the location of the hands for each serve. We classified participants' responses as being either overhand or underhand.

Few studies have investigated possible sex differences in affordance perception. Anecdotal evidence suggests that, in volleyball, women are more likely to use the underhand technique. We asked whether any sex difference would be related to or independent of sex differences in body dimensions (height, and maximum vertical reach).

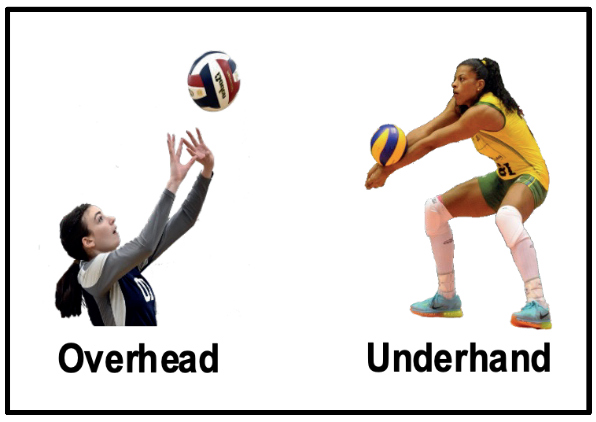

Fig. 2. Techniques to receive serves in volleyball

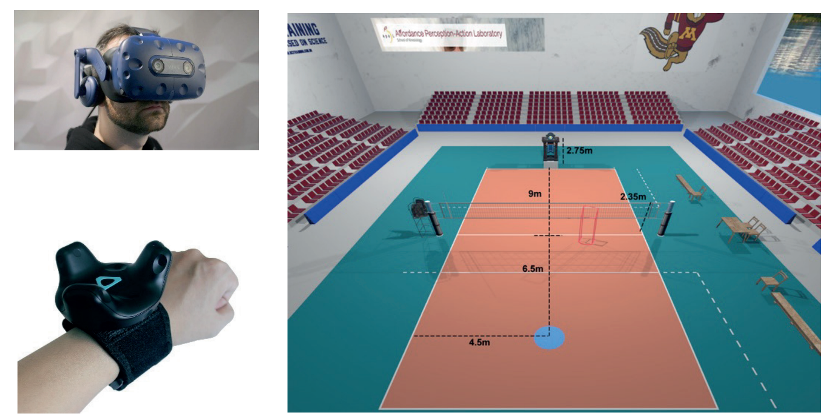

Fig. 3. Head-mounted display, hand tracking device, and virtual volleyball court.

Methods

Participants were experienced, competitive volleyball players, mean age 20.75 years. There were 20 men (mean height 1.80 m) and 17 women (mean height 1.64 m); the difference in mean height was statistically significant. Each participant wore an HMD (Oculus) and responded to 30 serves. Through software design, we manipulated the height (within participants) at which each serve arrived, with 6 values for each participant (see Fig. 5A), and 5 trials for each height.

Results

Participants' responses were categorical (Fig. 4). The results are summarized in Fig 5. We separately analyzed the proportion of underhand serve receives as a function of a) serve height in meters, b) standing height, and c) maximum vertical reach. The main effect of serve height was significant in all analyses. When scaled in meters, the 50% transition did not differ by sex, but this difference was significant when serve height was scaled by standing height, or by maximum vertical reach. The two intrinsic scaling conditions did not differ from each other.

Fig. 4. Representative responses.

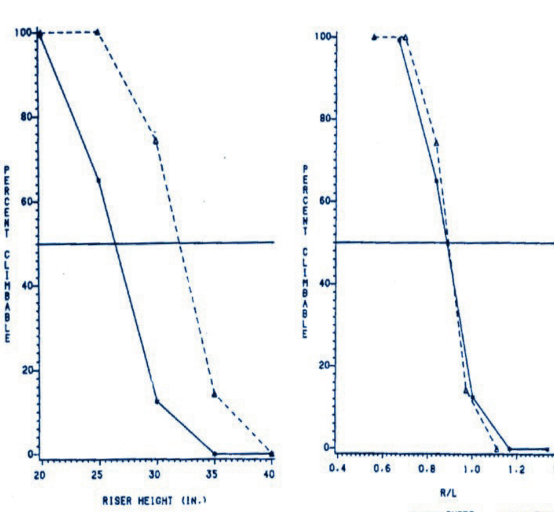

Fig. 1. Warren's (1984), classic effects of extrinsic and intrinsic scaling.

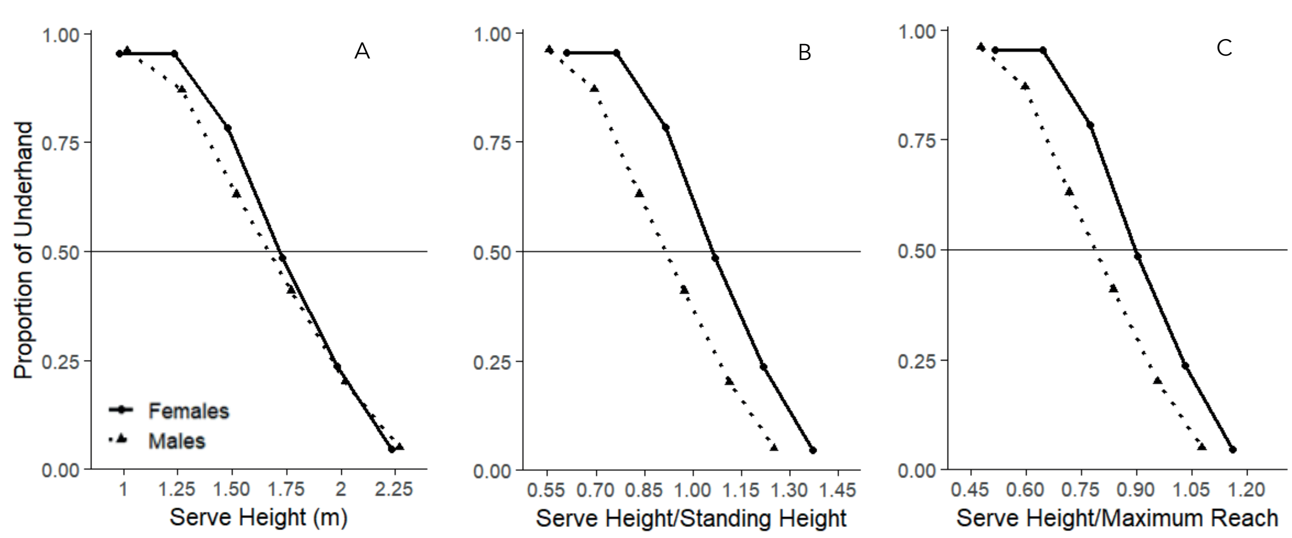

Fig. 5. The proportion of underhand serve receives as a function of serve height and sex. A. Serve height in meters. B. Serve height as a proportion of standing height. C. Serve height as a proportion of maximum vertical reach.

Discussion

Rather than replicating classic effects of body scale on affordance perception (Fig. 1), when including sex as an independent variable we found the opposite pattern (Fig. 5). When scaled intrinsically, the transition between techniques differed by sex in ways that were independent of sex differences in body dimensions. Our results demonstrate the perception of affordances for receiving serves in virtual volleyball, and suggest that sex should be analyzed as an independent variable in affordance research. Women and men differ in height, but our results suggest that affordances for receiving volleyball serves may be more strongly influenced by other sex differences.

Calibration of nested affordances when navigating through apertures on an e-scooter

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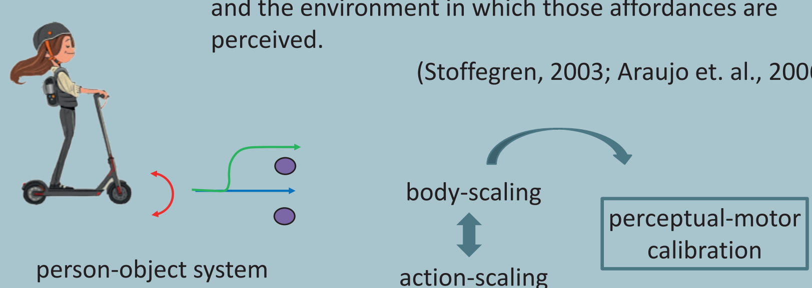
Introduction

Nested affordances: affordances for a given behaviour are nested within other affordances and within the goals and the environment in which those affordances are perceived.

(Stoffegren, 2003; Araujo et. al., 2006)



Aim: To investigate how different person-object systems calibrate to changes in aperture width and its relation to action capabilities.

Methodology

Participants

- Group 1: HBw=Sw
- Group 2: HBw>Sw (+ 10cm)
- Group 3: HBw<Sw (- 10cm)

Aperture conditions

- From MAC-1 ratio to MAC+8 ratio, in increments of 0.05

Experimental task

- To approach the aperture at a comfortable speed (8 km/h) and to cross through it avoiding the collision

1)

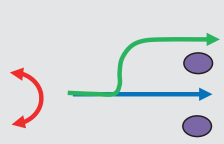
Figure 1. The experimental bicycle with the cargo bag attached to the frame.The approaching and stopping zones of the cycle path until the obstacle (white foam cuboid). Initial distances placed at 21.6m and 37m to the obstacle were used for low-speed and high-speed conditions, respectively.

MAC test

- Maximum action capabilities (MAC) will be measured to establish the minimum passable aperture width for each participant.

Modes of action

- **Facing** (+ braking)
- **Turning** (+ braking)
- **Escape**



Data analysis

- Rate of successful trials (%)
- Performance (Prob. Success) by modes of action (Franchak & Adolph, 2014)

Results

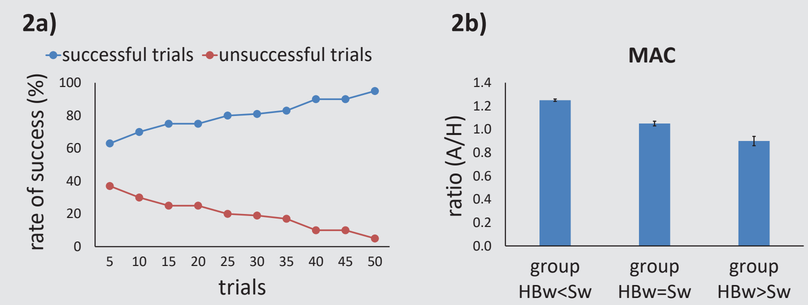


Figure 2. a) percentage of success across trials; **b)** ratio aperture-handlebar width (A/H) per experimental group during the maximum action capabilities test (MAC).

Figure 3. Performance (Prob. Success) by modes of action for **a)** group HBw=Sw; **b)** group HBw<Sw; **c)** group HBw>Sw. HBw, handlebar width; Sw, shoulder width; MAC, maximum action capabilities test.

Conclusions

- The handlebar width changed the participants' action capabilities and how they exploited the modes of action to overcome the obstacle.
- These observations seem to indicate that body- and action-scaling interplay to determine action capabilities and support calibration to changes in aperture widths.

Funding

This work is being funded by Normandie Region CPER-FEDER (ID: RIN Percycle)

Normandie Université

FEDER
Fonds européen de développement régional

Nested affordances may explain how we remember and fulfill intentions — *without* memory.

Ecological Prospective Memory: Grounding Prospective Control within Nested Affordances

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PROSPECTIVE MEMORY:

Setting an intention in the present and successfully executing the necessary actions to fulfill that intention in the future

TRI-CUE MODELS:

- Traditional cognitivist approaches to prospective memory (PM) propose three unique, discrete types of cues available for successful execution [1-4]: **time-based ( ), event-based ( )**, and **location-based ( ).**
- TCM approaches have proposed multi-process approach to recognizing these cues that includes both **attentional monitoring ( )** and **spontaneous retrieval ( )** [5].

SPATIOTEMPORAL SPECIFICATION MODEL:

- We propose an ecological alternative: the **spatiotemporal specification model (SSM)**. The cues proposed by TCM are parts of an inseparable whole. Every moment has a time, location, and action (i.e., event) that specifies it uniquely in the world. That reality must be reflected in PM.
- We build this theory the ecological concept of **nested affordances**—opportunities to act that become available due to a previous action changing the landscape of possible opportunities.
- We argue for thinking of nested affordances as an **exploit-to-detect-and-exploit method** -- a strategy to act in a particular way in the present that *cascades* into future opportunities for intended actions (See Fig 2.).
- Since remembered affordances are action-scaled like perceived affordances [6], we argue that an ecological account of remembering can account for the persisting awareness of objects and events occluded from view. (See Fig. 3.)

Fig. 1: The three components of an event necessarily and together specify the intention to be executed.

Fig 2: We can exploit the current structure of the environment to reveal more information to be detected and exploited in the future, even if we cannot predict what it might be. For example, a person's ability to build a fence changes dramatically with tools: Instead of stacking stones by hand, a hammer, nails, and wood afford the opportunity to build a tall fence that may, in turn, afford other opportunities for action—like letting their dog outside without a leash. Thus, acting in the present cascades into future opportunities for intended actions.

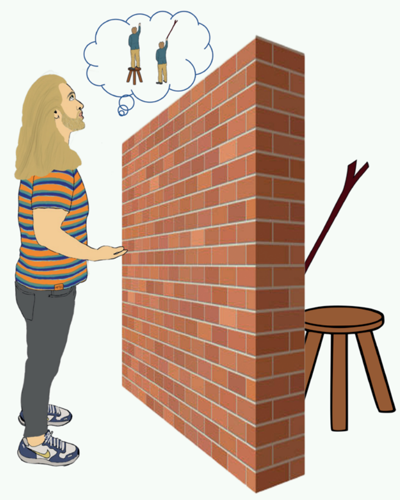

Fig 3: A person's self-reported maximum reaching height increases when an implement that would increase their reaching ability was present and after it had been removed from their view [6]. An ecological remembering can therefore account for the persisting awareness of affordances even when the objects are no longer visible.

RESEARCH PROPOSALS:

- **Compare TCM and SSM.**
  - Contrast PM fulfillment of a naturalistic intention using artificially cues proposed by TCM with a spatiotemporally specified PM (e.g., a navigation task on a university campus varying the specificity and saliency).
- **Habit Formation through Ecological PM.**
  - Manipulate the saliency of where and when to accomplish an intention of developing a reading habit (e.g., read for 30 min. each day).

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Stochastic Resonance Influences Heaviness Perception

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CONTRIBUTORS: Allison A. Grunkemeyer and Aaron D. Likens

Introduction

- Heaviness perception is the ability to use haptic feedback from effortful touch to determine the weight of a wielded object [1].
- The inertia tensor provides information about how mass is distributed in a rigid body **(Figure 1)** [2].
- Recent studies have provided evidence that adding noise to a weak stimulus can enhance a person's ability to detect it [2].
- Introducing a subthreshold stimulus embedded with noise may, in some cases, improve sensations gained from limb movements [1].

We hypothesized that subthreshold noise of various statistical structures and mass will influence accuracy in perceiving heaviness of a wielded object.

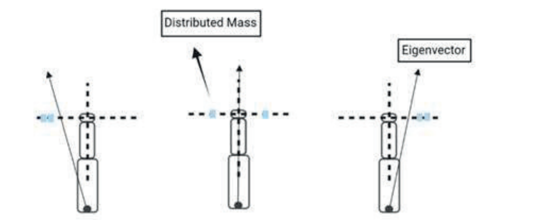

Figure 1. Effect of varying mass loads on eigenvectors.

Methodology

- 10 adults (> 19 years) participated in this study.
- Participants were seated for the duration of the trial with a haptic device fastened to their wielding arm, as seen in **Figure 2.**
- Subjects wielded an occluded object with varying masses.
- Subthreshold stimuli were introduced via a haptic device with different signals of colored noise.
- Noise (none, pink, white) × mass (0, 50, 100, 150 g)

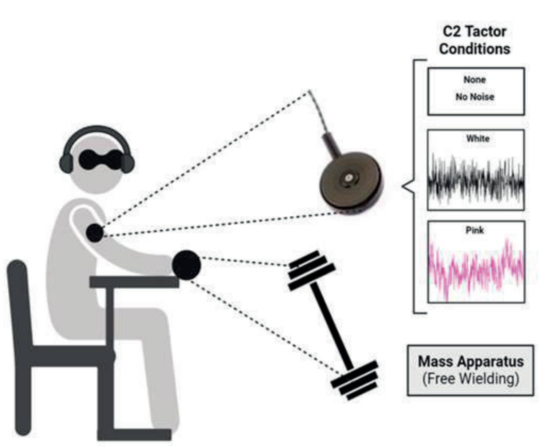

Figure 2. Experimental set up. Mass apparatus conditions include 0, 50, 100, and 150 g. Active markers (PhaseSpace Inc.) were applied to the participants' wielding arm and the apparatus.

Data Analysis

- Percent error based on the physical scale markings **(Figure 3)**.
- ARFIMA modeling to quantify presence of long-range correlations in displacement time series **(Figure 4)** [3].
- For statistical analysis, we computed 2 two-way ANOVAs via Linear Mixed Effect Models to determine the effects of mass and noise on percent error and *d*.

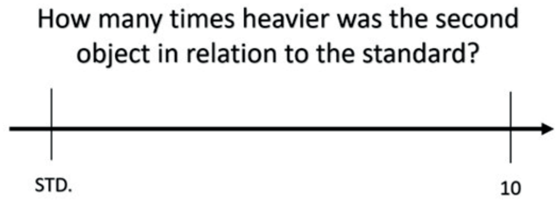

Figure 3. Visual scale provided for the participants.

Results

- Noise and mass had a significant interaction effect on percent error.
  - $F(6,85) = 2.72$, $p = 0.02$
- Percent error decreased at the largest mass level for pink and no noise and increased for white noise **(Table 1)**.
- Neither mass nor noise revealed any main effects or interactions on movement dynamics.
  - $F(6,95) = 0.46$, $p = 0.84$
- Presence of long-range correlations in all displacement time series **(Table 2)**.

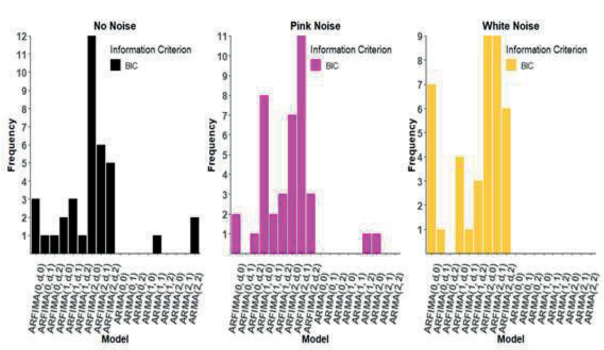

Figure 4. Frequency of model "wins" (i.e., rank order = 1) by condition.

Table 1. Simple contrasts illustrating the relationship between error and mass per condition.

contrast	*Mass*	*estimate*	*SE*	*df*	*t*	*p*	
none - pink	0	-2.74499	25.71771	83.62872	-0.10674	0.993739	
none - white	0	32.12261	24.76886	83.29278	1.296895	0.400931	
pink - white	0	34.8676	24.39328	83.22265	1.429394	0.330589	
none - pink	50	-10.6175	24.18397	83.15399	-0.43903	0.899345	
none - white	50	13.36269	23.52914	83.02978	0.567921	0.837512	
pink - white	50	23.98021	24.22794	83.1537	0.989775	0.585358	
none - pink	100	21.09061	23.67186	83.05848	0.890957	0.647505	
none - white	100	13.9829	23.76087	83.09073	0.588484	0.826666	
pink - white	100	-7.10771	23.94322	83.03008	-0.29686	0.952612	
none - pink	150	-0.77417	25.04881	83.33689	-0.03091	0.999474	
none - white	150	-59.3336	25.26425	83.26598	-2.34852	0.054718	.
pink - white	150	-58.5595	23.7723	83.07007	-2.46335	0.041471	*

Table 2. Analysis of 3D Euclidean Distance series during wielding with different noise types.

		Noise Condition		
	Model Selection	None	Pink	White
Mean ARFIMA weight	BIC	0.683	0.686	0.718
ARFIMA as the best model	BIC	**34/37**	**37/39**	**40/40**

Discussion

- As a general summary of the results, we found that percent error decreased at the largest mass in the no noise and pink noise conditions.
- White noise appeared to degrade one's ability to perceive weight at the largest mass.
- Our results suggest that introducing subthreshold noise influences one's ability to perceive the weight of an occluded object.
- It is likely that the direction of influence depends on the statistical structure of the subthreshold noise and the underlying signal **(Figure 5)**.

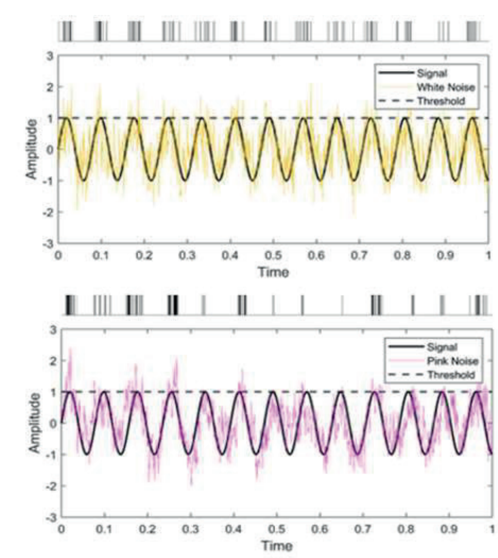

Figure 5. Noise enhanced information in a threshold system. The system involves the signal (solid line), noise (colored line), and threshold (dashed line). The signal in the top panel is a sinusoidal wave superimposed with white Gaussian noise. The bottom panel is the same sinusoidal wave but superimposed with pink Gaussian noise. Superimposed Gaussian noise with varying statistical structures elevate the signal above threshold, illustrated in the spike train above each graph.

Conclusion

Current results suggest that the effects of noise and mass on the accuracy and movement dynamics of wielding patterns may improve spatial recognition of occluded objects. Future directions include:

- Investigate broader mass range
- Investigate optimal noise structure
- Investigate different populations and pathologies

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Acknowledgements

This research was supported by an UNO GRACA to AG, and NASA Nebraska Space Grant FY23 Fellowship to AG.

The influences of visual angle in visually-guided eye movements on postural control

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Background

The effects of the visually-guided eye movements on body sway have been the focus of studies since the 1980s (White et al. 1980). As the advancement of eye-tracking technology, the purpose of this study is twofold. First, it aims to verify whether eye movement large than 20˚ horizontally elicit head rotation (Hallett, 1986; Stoffregen et al. 2007). Second, it aims to compare the difference between the effect of fixation and horizontal visually-guided eye movements on body sway.

Methods

Participants

Thirty-two healthy young adults (*M* = 21.34 yrs., *SD* = 1.69 yrs.) participated and they had normal or corrected-to-normal vision. The experimental protocol was approved by the Research Ethics Committee for Human Behavioral Sciences of National Cheng Kung University

Apparatus and Material

The sensors of the magnetic motion tracker (Flock of Birds, FOB., Ascension Technologies, Inc., Burlington, VT) were attached to the participants' head (above the safety helmet of the bicycle) and torso (seventh cervical vertebrae). Eye tracking system (Tobii Pro Nano) was used to record the eye movements of the participants. The experimental setup is as Figure 1.

Procedure

The FOB system recoded the displacement and rotation of the participant's head at 60 Hz. The eye movement system was fixed 65 cm in front of the participant, slightly below eye level, and measured the eye movement of the participant at 60 Hz. The visual task is a video clip generated by i-Movie and is projected on a 54.5 x 31.2 cm screen. Participants were required to stand and fixate (0˚) or track the red target, which was approximately 1.15 degrees in size (Stoffregen et al., 2006) and moved at visual angles of 11, 24, and 36 degrees from the left to the right at 0.5 Hz on the screen. The red target was presented in the center of the screen and at the participants' visual eye height level.

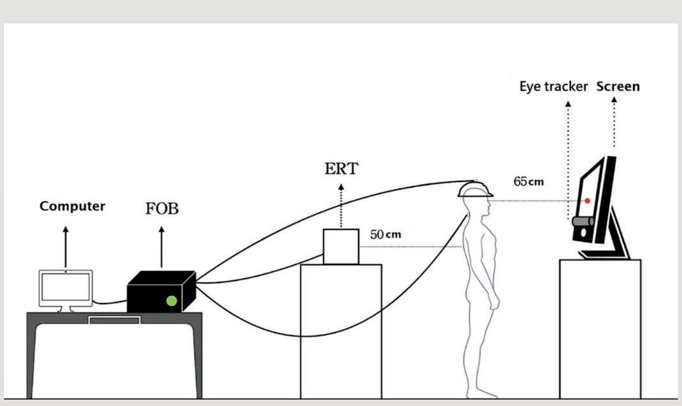

Figure 1. The experimental setup.

Results and Discussion

Head rotation

Results of one way ANOVA on the velocity of the head movement in the yaw (left/right head turn) direction among four conditions indicated a significant effect, $F = 2.80$, $p = .045$, post-hoc analysis showed that velocity of the head movement in 24° visual angle were greater than 0° and 11˚ (see Figure 2).These results verified that eye movement large than 24° horizontally elicit head rotation. This would induce vestibular ocular reflex (VOR) and affect the results of the eye movement. Therefore, in the following analysis, we only compared the differences between 0˚ and 11˚ visually-guided eye movement

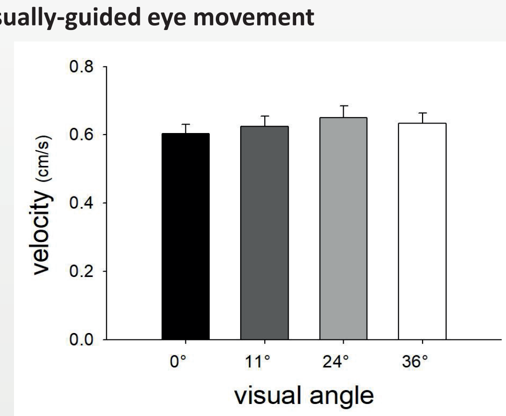

Figure 2. The velocity of head movement in the yaw direction, illustrating statistically significant effect among visual angles. The error bars represent the standard error of the mean.

Linear Body movement in 2 visual tasks

Results of paired sample t-tests on the positional variability (SD of the displacement) of the head and torso movement in the AP axis between 0° and 11° visually-guided eye movement was significant, $t(30) = 3.26$ and 2.39, $p = .003$ and .024, respectively. The position variability was greater in fixation as compared to the 11° horizontal visually-guided eye movements (see Figure 3). Without head rotation, the effect of horizontal visually-guided eye movement on body sway was reduced as compared to fixate at a point. For velocity of the head and torso movement in the AP and ML axis between 0° and 11° visually-guided eye movement paired sample t-tests were not significant, $p > .05$.

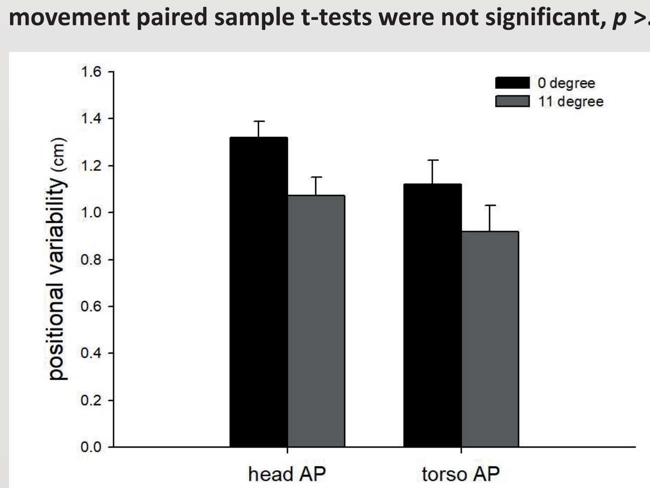

Figure 3. The positional variability of the head and torso movement in the AP axis, illustrating statistically significant effect between visual angle 0˚ and 11˚. The error bars represent the standard error of the mean.

Eye movement in 2 visual tasks

Results of paired sample t-tests showed the difference between 0° and 11° visually-guided eye movement were all significant at $p < .001$. In the number of fixation, $t(31) = -14.16$, number of fixation in the 11° was greater than 0° visually-guided eye movement . In fixation duration, $t(31) = 5.81$, fixation duration in the 0° was greater than 11°. In number of saccade, $t(31) = -11.41$, the number of saccade in the 11° was greater than 0˚. In saccade duration, $t(31) = -11.41$, saccade duration in the 11° was greater than 0°.

Conclusion

This study verified that eye movement large than 20 degrees horizontally elicits faster head rotation (Hallett, 1986). Additionally, 11 degrees of horizontal eye movement induced more stable body sway as compare to eye fixation at a fixed point which supports the functional role between eye movement and postural control (Stoffregen et al., 2007).

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The present study was supported by the Ministry of Science and Technology, Taiwan (MOST 111-2410-H-017-015)

Developing a flow-based notation to describe architectural and urban experiences

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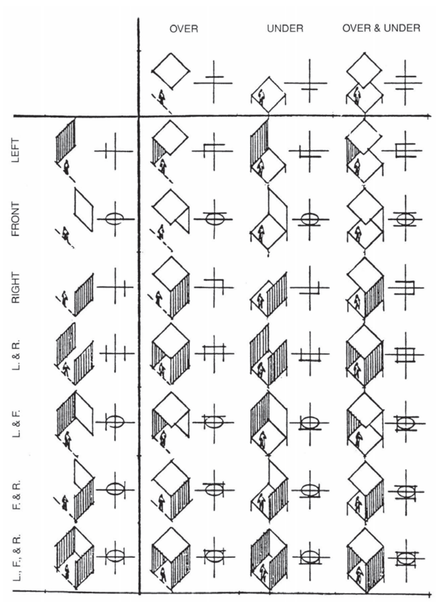
BACKGROUND & PURPOSE

For architectural and urban planning, various methods have been proposed to describe environmental experiences; in particular, "notations" score sequential experiences during locomotion.

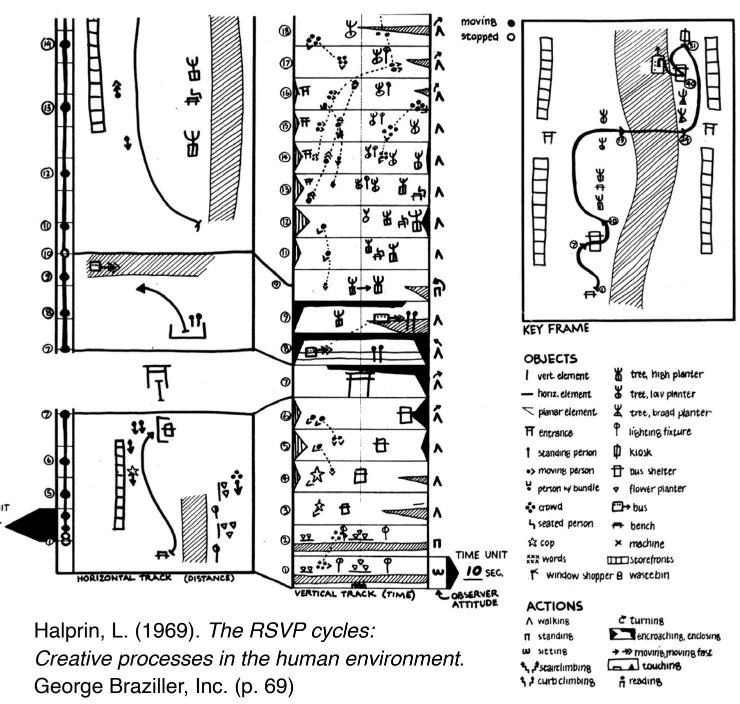
Gibson's ecological theory of perception emphasizes the role of optical flow as a source of information for perceiving the environment and controlling actions.

This study, using a technique of image processing, developed a notation based on optical flow to quantitatively describe environmental experiences.



Thiel, P. (1997). *People, paths, and purposes: Notation for a participatory envirotecture.* University of Washington Press (p. 247)

Notation of surface layout



Halprin, L. (1969). *The RSVP cycles: Creative processes in the human environment.* George Braziller, Inc. (p. 69)

"Motation" of shopping street

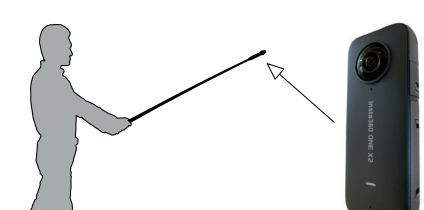
METHOD & EXAMPLE

An observer walked a route while holding a panoramic video camera at eye level and thereby recorded the environment from all directions except the view from behind the observer's body.

An algorithm processed the video data to estimate optical flow by detecting multiple vectors as the displacements of pixels between two sequential image frames.

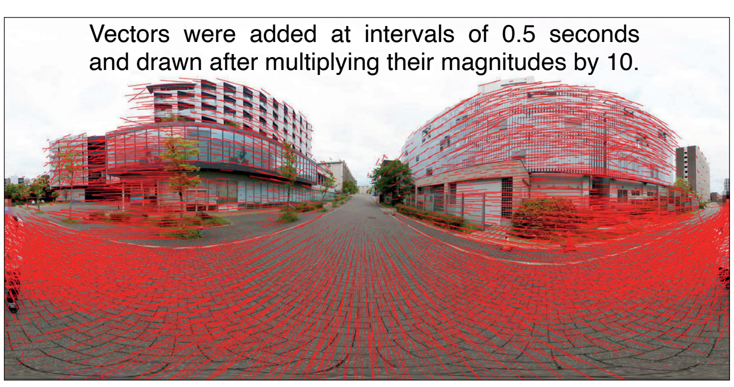
The vectors' magnitudes were converted to angular velocities and averaged for each direction (front, right, left, upper, and lower) as an index of flow's intensity.

The present example showed that the average angular velocity reflected the distance to environmental surfaces, the richness of environmental textures, and the direction of locomotion.

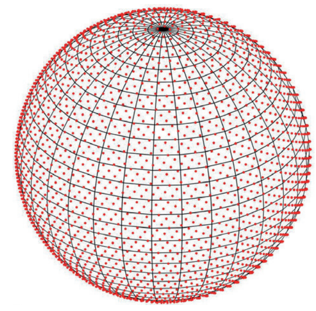


Insta360 ONE X2
5760×2880 pixels, 30 fps

Recording the environment

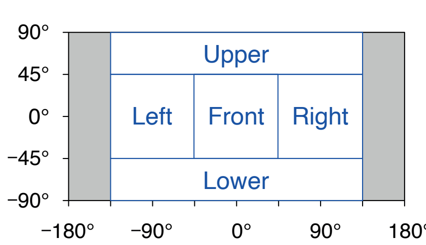


Detecting optical flow with the Farneback algorithm

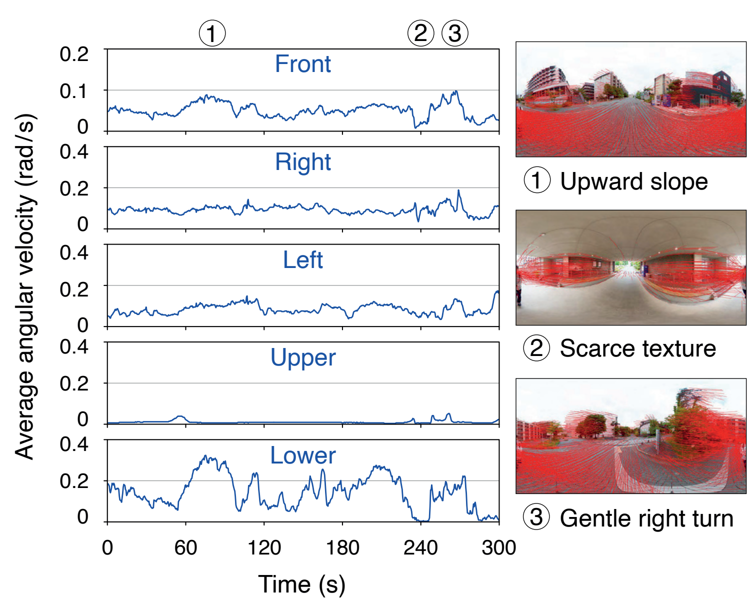


A total of 4001 points were uniformly distributed with the Fibonacci lattice.

Initial points of flow vectors



Analyzed five directions



Changes in the intensity of optical flow along a route

Lévy-like visual search and hazard detection performance in older drivers

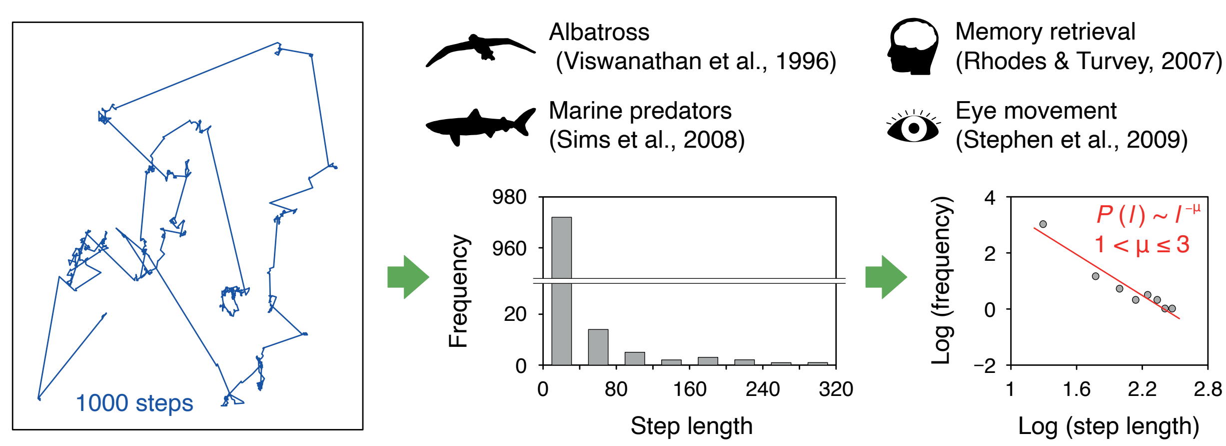
Makoto Inagami[1], Hirofumi Aoki[1], Kan Shimazaki[1,2], Aiko Iwase[1,3], Yuto Susuki[1,3], & Hiroko Terasaki[1]

[1] Nagoya University, [2] Kindai University, & [3] Tajimi Iwase Eye Clinic (Japan)

BACKGROUND & PURPOSE

A variety of foraging animals exhibit a movement pattern known as Lévy flights or Lévy walks, which enables an efficient search for foods under certain conditions.

This study applied such phenomena to the visual search of older drivers, and examined the presence of a Lévy-like pattern and its effect on the detection of potential hazards.

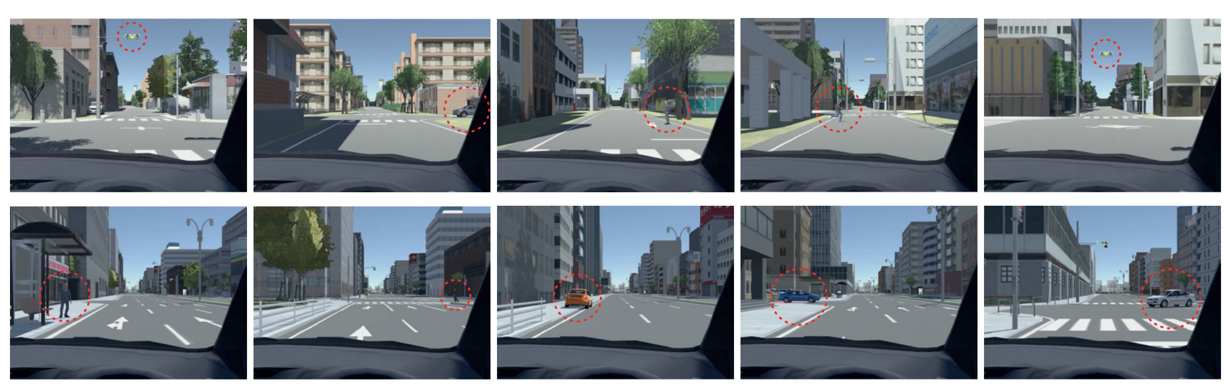


Simulated Lévy flights and examples of previous studies

EXPERIMENT

A head-mounted display, equipped with an eye-tracking system, was used to present two driving scenarios, in which ten hazards appeared along the way.

The driver's car traveled automatically, and participants ($N = 100$) scanned the traffic environment as they do in their everyday driving.



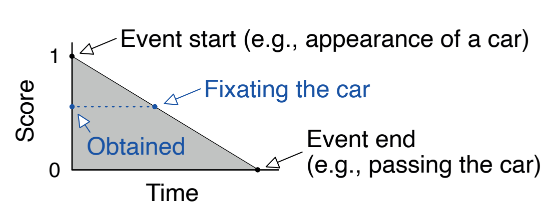
Two driving scenarios and ten potential hazards

RESULTS & DISCUSSION

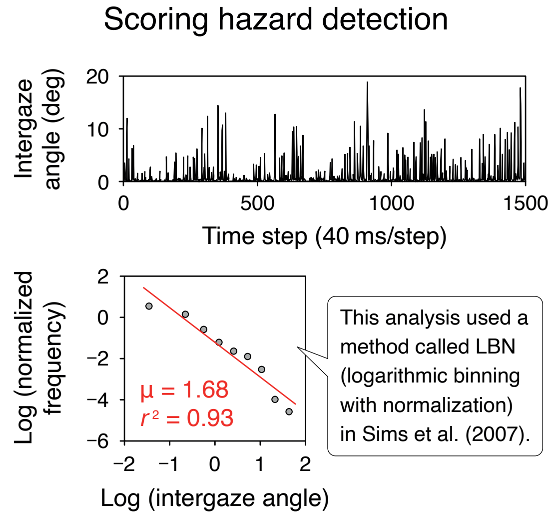
By analyzing the head- and eye-tracking data, we scored the detection of the hazards, and also obtained the frequency distribution of the amount of change in the gaze direction (i.e., intergaze angle).

The results showed that all participants exhibited Lévy-like gaze movement, but its properties (μ and r^2) were not related to the score of hazard detection.

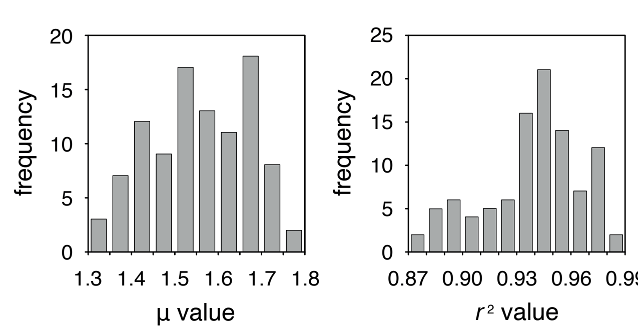
This suggests that older drivers have acquired an efficient search pattern, but their performance depends more on other skills, such as predicting hazards.



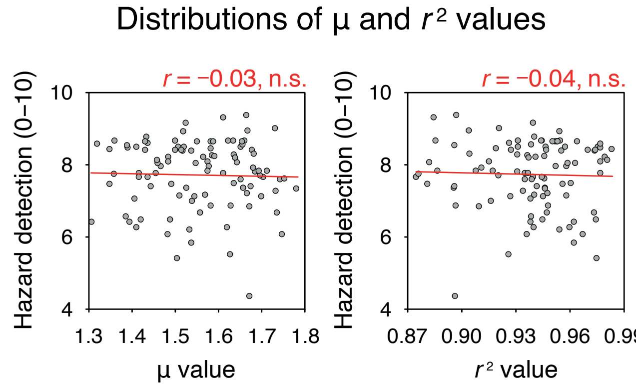
Scoring hazard detection



Analyzing gaze movement



Distributions of μ and r^2 values



Relationships with hazard detection

Concurrent Schedules of Reinforcement Impact Affordance Boundaries in a Grasping Task

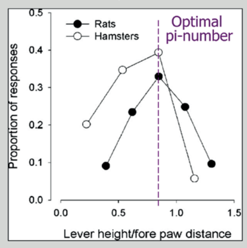
Robert W. Isenhower, Catalina E. Apodaca, and Kenny U. Ruiz
Department of Psychology, Rider University

Introduction

Affordances—possibilities for action scaled to organisms' action capabilities (Gibson, 1979)—have an important role within the experimental analysis of behavior (EAB; Killeen & Jacobs, 2017).

Research in EAB demonstrates that action-scaled constraints—such as ratios of lever height to fore-paw distance—guide free operant behavior in unconditioned lever-pressing in rats and hamsters (Cabrera et al., 2013).

Additionally, affordance constraints guide choice between equal concurrent schedules of reinforcement. Levers close to the optimal pi-number afford lever pressing with faster bout initiation and faster within-bout responding (Jiménez et al., 2019).



Previous research with humans has found that grasping behavior (i.e., grasping an object with one hand vs. two hands) conforms to predictable affordance boundaries based on a ratio of hand-span to object length. This transition occurs at approximately two-thirds of the participant's handspan (Lopresti-Goodman et al., 2009) and involves a choice between two concurrently available action modes.

The current study utilizes a similar grasping task in order to examine human behavior as influenced by:

1) **Unequal concurrent schedules of reinforcement**
2) **Affordance constraints defined by the organism-environment system**

$O\text{-}S^d \rightarrow R \rightarrow Sr$

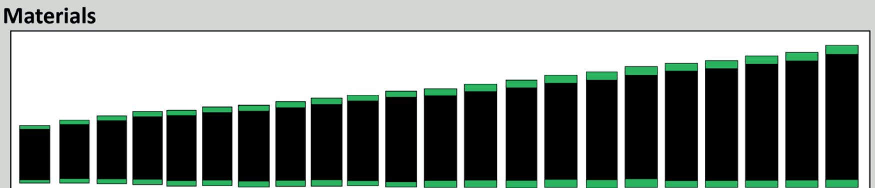
We expected the "organism-discriminated" operant, as defined by the specific "motivational, perceptual, anatomical, and biomechanical properties of the organism" (Killeen & Jacobs, 2017), to affect responding under unequal concurrent schedules of reinforcement. This influence should be captured in the pi-number of transition between 1H and 2H grasping.

Method

Participants and Setting

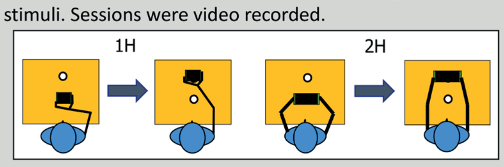
Six right-handed Rider University students (5 undergraduate, 1 graduate; 4 female, 2 male; age 20-25) participated. Sessions took place in a 3 m x 4 m research room with one-way mirror.

Materials



22 stimuli ranging in size from 2.9 cm to 23.1 cm in 0.96 cm increments.

A hand-held tally counter was used to keep track of points. A computer was used to record data and program reinforcement. A small desk with two dots 30 cm apart aligned along the midsagittal plane was used to present stimuli. Sessions were video recorded.



Design

- A-B-A-C withdrawal/reversal design
- A: Baseline (BL1, BL2), no reinforcement or feedback
- B & C: conc VR 2 VR 6 (or conc VR 6 VR 2) schedules for 1H or 2H grasps

Procedure

Planks were presented to participants on a table one at a time in a random order. Participants were instructed to grasp (only by touching their green ends) and move the planks from the dot closer to the dot further and do so using either one or two hands (Task adapted from Isenhower et al., 2005).

In the A phase (BL1, BL2), no other instructions, reinforcement, or feedback was provided. In B and C phases, participants were told that they could earn points based on the way they move the objects, with a goal to maximize points. Points were delivered on concurrent (conc) VR/VR schedules. In B and C phases, 1H responses produced points on a VR 2 schedule, and 2H responses produced points on a VR 6 schedule, or vice versa. Order of 1H and 2H was counterbalanced across participants.

Sessions comprised 22 trials. Three sessions of each condition were run before moving to the next condition. Average session time was 3 min 28 seconds.

Participant hand span was measured so that pi-numbers of transition could be calculated—see procedures in Isenhower et al. (2005) and Lopresti-Goodman et al. (2009).

Response Measurement and Interobserver Agreement (IOA)

A response was defined as the participant picking up an object with one or two hands (as above) and moving it from the point closer to them to the point further away.

A second independent observer collected data on 50% of sessions. IOA was calculated trial-by-trial. A trial with agreement was when both observers agreed on 1H or 2H.

Percent agreement = (trials with agreement / total trials) X 100.

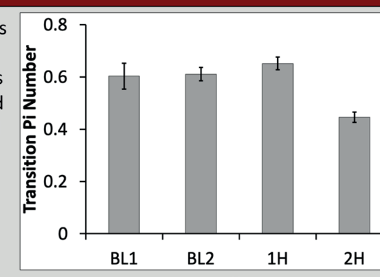
Overall, there was 99.0% (range = 86.4-100%) agreement in responses.

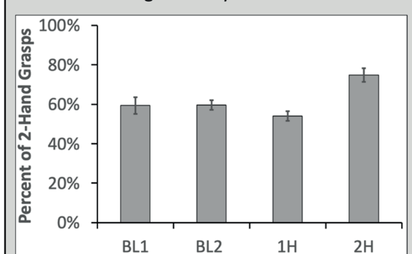
1865 RIDER UNIVERSITY

Results

A one-way ANOVA revealed differences between conditions on the transition pi-number, $F(3, 23) = 8.51$ $p < .001$, $\eta^2 = .56$. Post-hoc analyses confirmed that the 2H condition was significantly different from BL1 ($p < .01$), BL2 ($p < .001$), and 1H ($p < .001$). The denser schedule of reinforcement for 2H behavior resulted in a lower transition pi-number than the other conditions.

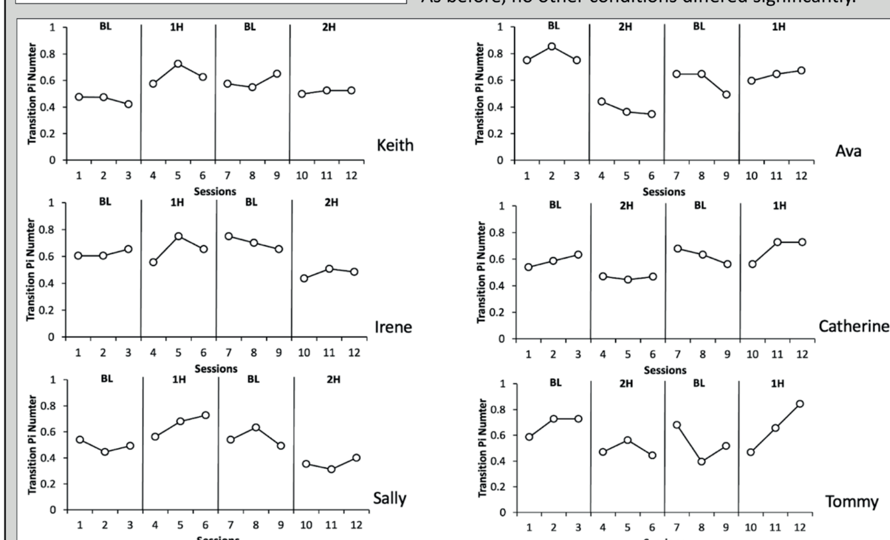
1H was not significantly different from BL1 or BL2. BL1 and BL2 were not significantly different from each other.





A second one-way ANOVA revealed differences between conditions in terms of the percentage of 2-hand grasps per session, $F(3, 23) = 7.47$ $p < .01$, $\eta^2 = .53$. Post-hoc analyses confirmed that the 2H condition was significantly different from BL1($p < .05$, BL2 ($p < .05$), and 1H ($p < .001$). The denser reinforcement of the 2H behavior resulted in a greater percentage of stimuli lifted with 2H compared to baseline and 1H.

As before, no other conditions differed significantly.



Average pi-number of transition between 1H and 2H grasping across conditions for the individual participants. Half the participants (left) were exposed to 1H first; half (right) were exposed to 2H first.

Discussion

The denser schedules of reinforcement for 2H grasps resulted in lower pi-numbers of transition with proportionally smaller objects lifted with 2H, and an increased probability of responding with 2H. Motivational properties (points) in addition to "perceptual, anatomical, and biomechanical properties" systematically affected affordance actualization.

Transition pi-number for 1H grasps did not differ from BL1 or BL2 at the group level. This may be due to task asymmetry: It was possible to grasp every stimulus with 2 hands but only some stimuli with 1 hand. However, two participants, Keith and Sally, showed an effect of the 1H manipulation.

There were no differences between BL1 (before the first operant contingency was applied) and BL2 (after the first contingency was removed), indicating that the influence of the contingency was transient.

Within-participant variability in BL1 was relatively small. Between-participant variability was relatively large.

The typical VR/VR pattern—responding exclusively to the schedule with the lowest response requirement (Cuvo et al., 1998)—was not observed. Leveraging affordance constraints in applied settings may be an effective tool to change the probability of free-operant behavior.

Future Directions

- Use a modified stimulus set where every object can be moved with 1-hand
- Use a restricted range of stimuli (all low pi-numbers or all high pi-numbers) to examine affordance boundaries (optimal vs. critical) more systematically
- Control for effector size with small/large hand span groups
- Include an equal schedules condition in a parametric analysis of other concurrent schedules
- Use concurrent VI/VI schedules to look at matching behavior

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Attractive stepping-stones landscapes: Preference for stone-height variation appears to be age independent[1]

Amy M. Jeschke, Rob Withagen, Frank T.J.M. Zaal, & Simone R. Caljouw
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Background

Dimensions of playgrounds and outdoor fitness areas tend to be standardized (Fig. 1).
Yet, research studying stepping-stones landscapes revealed:

1. People of all ages prefer non-standardized landscapes[2,3,4] (Fig. 2)
2. Children especially prefer variation in stone-height[5]

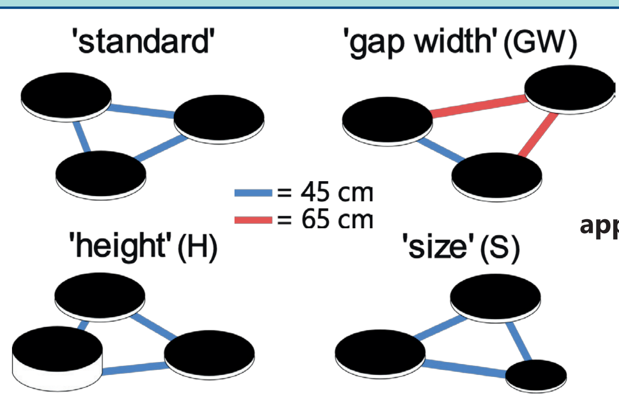
But what kind of variation attracts adults the most?

Fig. 1. Standardized configuration

Fig. 2. Non-standardized configuration

Method

Experiment 1



Group	N	Age (y)	Max. Jump (cm)*	TUG (s)*
Young adults	26	22.2 (2.1)	116.9 (12.9)	7.3 (0.8)
Older adults	25	70.8 (5.4)	98.3 (11.2)	8.3 (1.4)

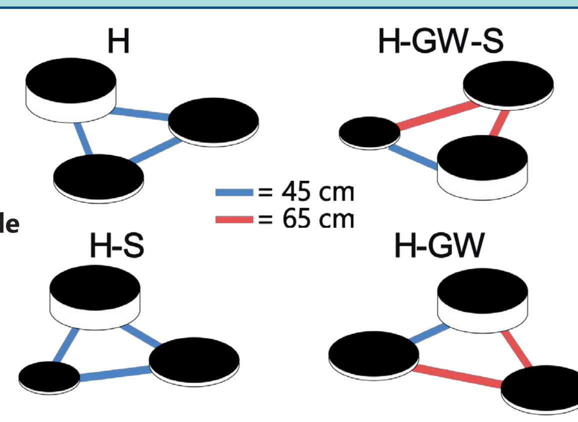
*$p < .05$

1. Three minutes of "play"

2. Judging the configurations on fun, aesthetic appeal, challenge, and risk using a 9-point Likert scale

3. Max jumping distance and Timed Up & Go test (TUG)

Experiment 2

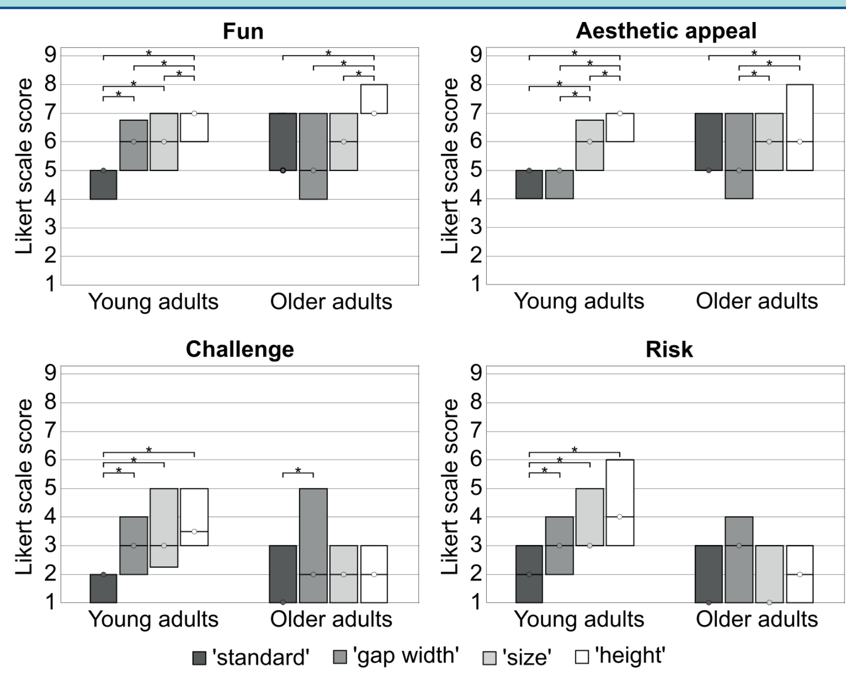


Group	N	Age (y)	Max. Jump (cm)*	TUG (s)*
Young adults	25	21.5 (2.0)	117.4 (12.2)	7.1 (0.6)
Older adults	28	70.1 (5.6)	94.1 (12.9)	8.6 (1.4)

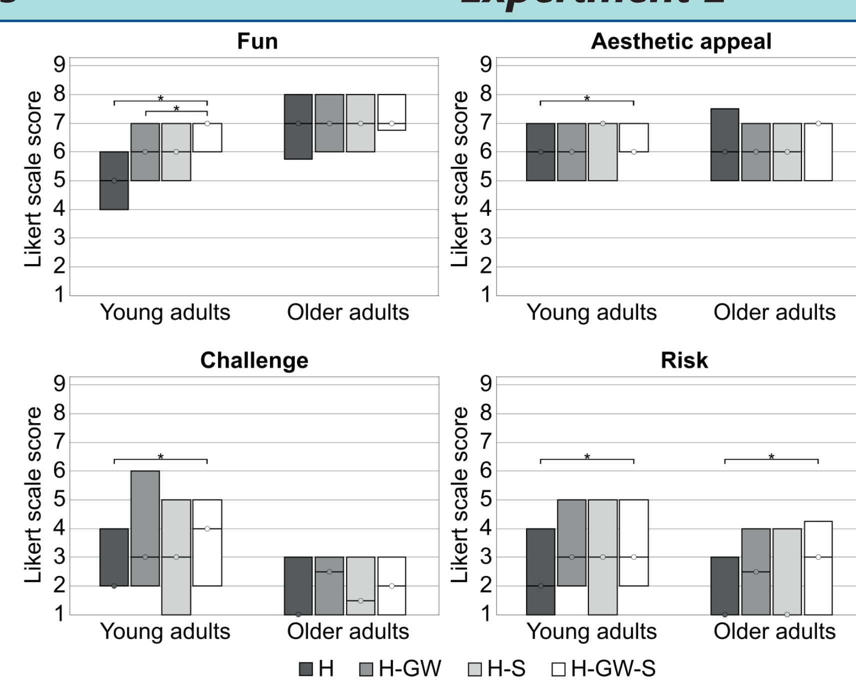
*$p < .05$

Results

Experiment 1



Experiment 2



In addition, using Kendall's tau-b, we found for nearly every configuration and age group sig. positive correlations ($\alpha = .05$) between scores on:

1. Fun & aesthetic appeal

(only for young adults the p-values for 'gap width', 'size', and H-GW were respectively .052, .195, and .058)

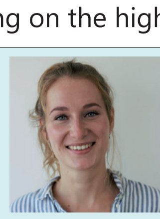
2. Challenge & risk

Discussion

The preference for stone-height variation in a stepping-stones landscape appears to be age independent

- Why are people generally attracted to variation in stone-height?
  - One may prefer the aesthetic appeal of the height configuration. Yet, no correlation found between fun and beauty for children[4]. Is the reason for the height-preference different among the various age groups?
  - Or is it governed by a factor that we have not examined thus far? People of all ages might appreciate the change of perspective or the "kinetic joyride" when stepping on the higher stones.

university of groningen



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[1]**Jeschke, A.M., Withagen, R., Zaal, F.T.J.M, & Caljouw, S.R. (in revision). Attractive stepping stones landscapes: Preference for stone height variation appears to be age independent. *Ecological Psychology.***
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Fractal Analysis of Pilot Pupil Size During Virtual Reality Piloting Tasks

Department of Psychology, College of Arts and Sciences, University of Cincinnati
Corinne Jorgenson, Dieter Vanderelst, Nikita Kuznetzov

Introduction

For this analysis, we explored the fractal properties of pilots' pupil diameter during piloting tasks of varying difficulty. We examined two groups of pilots: those with experience piloting actual or simulated aircraft, and those with no experience piloting actual or simulated aircraft. Specifically, we hypothesized that the fractal properties of experienced pilots' pupil dilation/contraction would approach 1/f noise, where the pupil dilation/contraction patterns of inexperienced pilots would show a breakdown in fractal scaling, especially for more difficult tasks.

Method

Participants: Data for this analysis was provided by the Department of the Air Force - MIT Artificial Intelligence (AI) Accelerator's CogPilot Data Challenge 2.0 (Rao, et al, 2022). This challenge aims to explore quantitative performance measurements and multimodal physiological data to assess a student pilot's competency. CogPilot provides data on 35 subjects (Ss) piloting a simulated aircraft. Each Ss flew three attempts at each of four levels of difficulty, such that there is a data set of 35x4x3 (35 subjects, 4 levels of difficulty, 3 runs per level of difficulty).

Procedure: Subjects piloted a virtual aircraft while connected to various sensors. The levels of difficulty (1-4) corresponded with increasingly more challenging weather conditions. Higher values are more difficult. The difficulty levels simulated visual flight rules (VFR, the simplest condition), instrument flight rules (IFR, the most challenging condition), and two intermediate levels.

For this analysis, we divided the pilots into two groups. The first group, inexperienced pilots, were those Ss who had less than 948 hours (the mean of total fixed wing experience) of actual and simulated fixed wing flight experience. The second group, experienced pilots, were those who had greater than 948 hours of actual and simulated fixed wing flight experience.

The data were prepared prior to analysis. Blinks (recorded by the hardware as -1) were removed from the dataset. Outliers above 3 SD above the mean were also removed. Additionally, data from just the right eye was used for analysis. Because the literature (e.g., Seijas, et al, 2007) supports significant symmetry in ocular dominance, choosing one eye allowed us to preserve fine-grain variations that may have been lost by averaging the size of both pupils at every time point.

While choosing a method for fractal analysis is nontrivial (Stergiou 2018), we took methodological precautions guided by Stergiou, et al, 2018 to determine DFA as the best method. Due to the length of the data, Stabilogram Diffusion Analysis (SDA) analysis was excluded as a candidate method. Visual inspection of Ss 33's data established that the data likely had fractal properties and met the necessary qualifications to be nonstationary fractional Brownian motion (fBm), as shown in Figure 1. These findings supported using detrended fluctuation analysis (DFA).

Results

Due to computational and recording errors, 66 runs were excluded from analysis. DFA was performed on the remaining 354 runs. Participants in the low experience group (n = 214) had a mean Alpha of 1.16 (SD = 0.05), while participants in the high experience group (n = 140) had a mean Alpha of 1.15 (SD = 0.05). A Welch two-sample t-test was conducted to compare the mean Alpha values between the two groups. The results revealed a significant difference between the low experience group and the high experience group ($t(301.84) = 3.13$, $p = .0019$, 95% CI [0.006, 0.026]).

Figure 1: Time series data of Ss 33's right eye pupil diameter

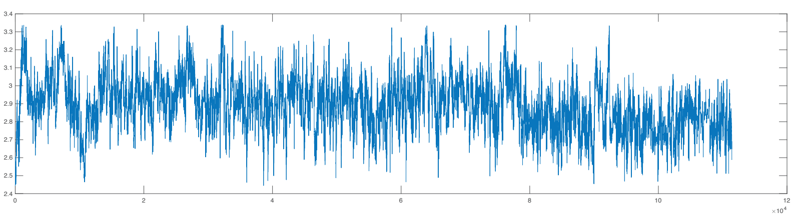


Figure 3: Ss 33 DFA results

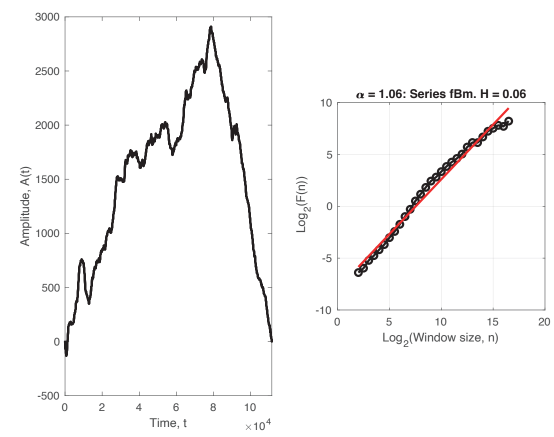
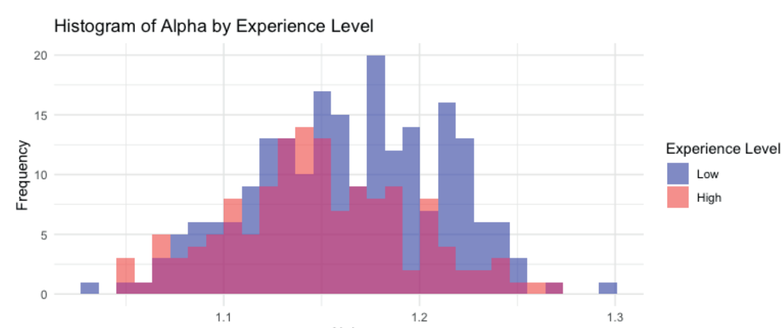


Figure 3: Histogram of Alpha values by experience level



Discussion

This analysis unveiled many interesting findings worthy of further investigation. We hypothesized that the fractal properties of experienced pilots' pupil dilation/contraction would approach 1/f noise, where the pupil dilation/contraction patterns of inexperienced pilots would show a breakdown in fractal scaling, especially for more difficult tasks. Results were consistent with this hypothesis.

The literature supports that there is a link between pupil diameter and cognitive load, since pupil diameter is controlled in part by the autonomous nervous system. During cognitive tasks that demand increased mental effort, the diameter of the pupil tends to increase. This analysis further shows that it is evident that there are differences in the fractal scaling properties of experienced pilots' pupil size during flight tasks compared with inexperienced pilots.

Further analyses could unveil correlations between these findings and the pilots performance data. Regression models may reveal relationships between performance data and resulting statistics from nonlinear analysis of pupil dilation data.

University of CINCINNATI

Diagonal couplets in four-legged human gait to climb stepping-block using two poles

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This research is supported by KAKENHI #20H00572, #20H04090

Background and objective

Trekking poles can be functional limbs for mountain climbers in climbing steep slopes while carrying heavy loads. When using these two additional limbs while climbing, distinct patterns of coordination emerge among the four limbs—the two hand-held poles, and the legs—depending on the step height. We hypothesized that such functional patterns of coordination have topological structures resembling some quadrupeds. To test this hypothesis, we referred to the classification model of the gait of various quadrupeds using **duty factor** and **diagonality.** (See: Fig. 1 for details.)

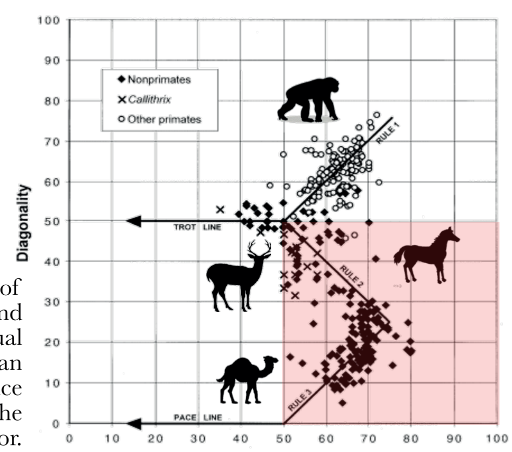

Fig. 1: Classification of quadrupeds by duty factor and diagonality. Individual differences in each species can be explained by the difference in function of the ratio of the diagonality to the duty factor. e.g., primates: $y = x$, horses: $y = 100 - x$, camels: $y = x - 100$ etc. cited from Cartmill(2002).

Method

Participants: Ten right-handed males (Age: 20.09 ± 2.01 yrs., Height: 169.36 ± 10.02 cm).

Task: Asked to climb a step (20 cm, 40 cm, or 60 cm) using both poles, one held in each hand. Participants were asked to perform the task with/without a 10 kg weight carried in a backpack.

Independent measure: Step Height (20 cm, 40 cm, 60 cm) and Weight (0 kg or 10 kg). Five trials of each, were conducted for 6 levels.

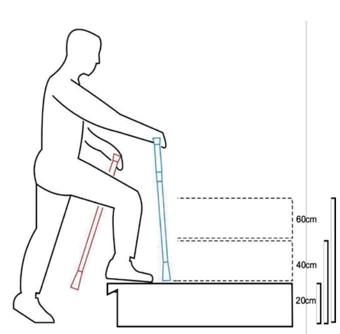

Fig. 2: Step climbing task. At the start of the experiment, the moment when any of the four points are in contact with the ground.

Data analysis

- The number of gaits in the red range in Fig. 1 (i.e., duty factor > 50% and diagonality < 50%) were calculated and tested for significant difference using 3 Step-Heights x 2 Weights-Carried (ANOVA.) (Fig. 4).
- The gait in this range, seems to resemble the gait of four legged animals which is qualitatively different from that of primates.
- Further tested for better data-function fit. (Fig. 5).
    - $y = 100 - x$: Horses, Deer
    - $y = x - 100$: Camels

Duty factor and diagonality calculation

A cycle of climbing action (C) was calculated as follows:

$$C = td - to$$

where, to denotes the time of the first limb to takeoff and td denotes the time of the last limb touchdown. Duty factor and diagonality were calculated by following equation.

$$\text{Duty factor} = \frac{C - (H_{td} - H_{to})}{C} \times 100$$

$$\text{Diagonality} = \frac{H_{td} - F_{td}}{C} \times 100$$

H_{to} and H_{td} denote the timing of the takeoff and touchdown of the hind limb. F_{td} denotes the same for ipsilateral forelimb touchdown.

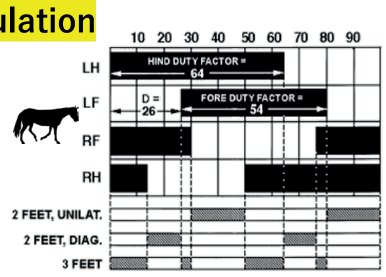

Fig. 3 : The definition of duty factor and diagonality was introduced by Hildebrand (1965). Duty factor is the duration of the stance phase of one foot calculated as a percentage of the gait cycle, and diagonality is the percentage of the time in which hindfoot touchdown precedes the forefoot takeoff relative to the step cycle. In this example, duty factor of left hind leg is 64% and diagonality of left limbs is 26%.

Results

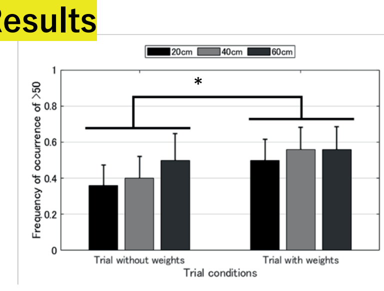

Fig. 4: The percentage of the tasks where duty factor was greater than 50% and diagonality was less than 50% for each condition. * denotes significant difference between groups. The values were significantly higher in the 10 kg weight condition compared to the 0 kg ($F(1, 9) = 7.367$, $p = 0.024$).

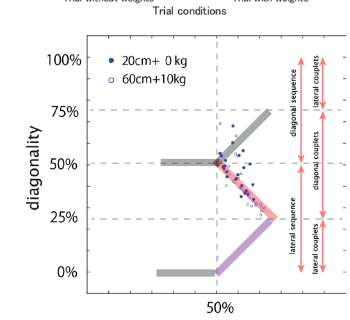

Fig. 5: Individual differences among the trials in diagonality as a function of duty factor. Data (20 cm + 0 kg and 60 cm + 10 kg, for example) with duty factor greater than 50% were distributed along the function $y = 100 - x$ similar to the difference among the species with relatively short legs with respect to trunk (i.e., horses).

Discussion

- Four-legged gaits with trekking poles are characterized by diagonality from 25% to 50%. They are labeled as "lateral sequence - diagonal couplets" on the Hildebrand diagram (Hildebrand, 1976) cited by Cartmill (2002). This coordination pattern is identical to the feature of the gait pattern of animals with short legs relative to the length of the trunk (e.g., horses or deer).
- Human participants adopted a strategy of moving forward by shifting their own center of mass (CoM) forward when relying on poles, like the gait of horses that loads heavy weight onto the forelegs, qualitatively different from primates.
- This observation suggests that hikers effectively advance by propelling their own CoM forward and inhibiting unnecessary mediolateral variance of the CoM by using diagonal couplets, unlike the long-legged quadrupeds, such as, camels.

2023/06/27-30 Four-legged human gait Koshimizu et al.

Against free energy, for direct perception

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School of Kinesiology
University of Minnesota
Driven to Discover

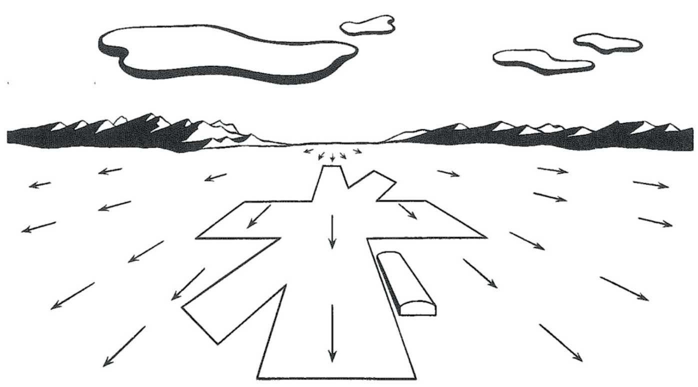

Figure 1. Optic flow

Gibson (1966, 1979) claimed that perception is direct. In Gibson's conception, physical law dictates determinate relations between properties of physical reality (including higher order properties relating to biological and psychological systems) and patterns in ambient energy arrays. Gibson claimed that these determinate relations are unique (i.e., 1:1), such that physical reality is specified in patterns of ambient energy. Gibson argued that optic flow specifies self-motion (Figure 1). Others have argued that the necessary 1:1 specification exists solely in the Global Array (Figure 2).

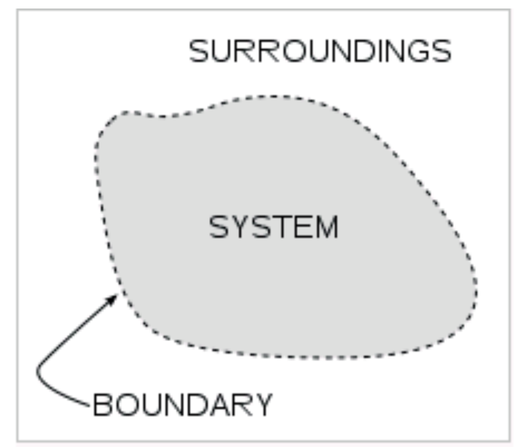

Figure 3. Bounded systems

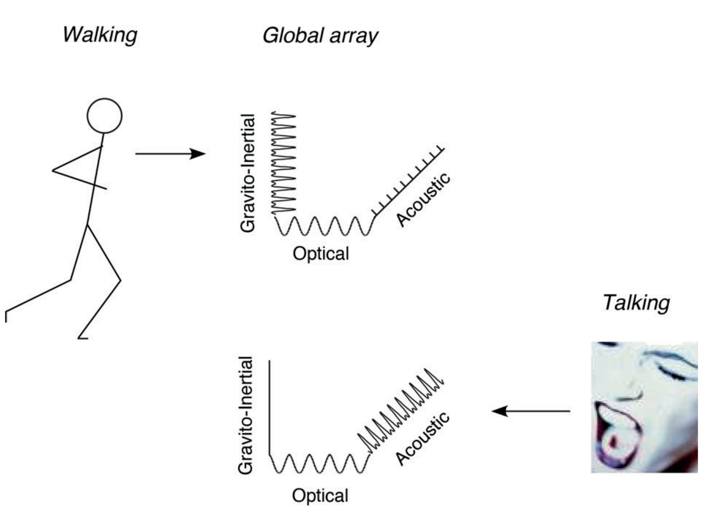

Figure 2. The Global Array

The Free Energy Principle (FEP) derives from 19th century physics. Friston has argued that the FEP is a foundational organizing principle in biophysics and cognitive science. The physics that underly the use of the FEP in the behavioral sciences mandate a categorical boundary between organism and environment (Figure 3). Information cannot cross the boundary, in either direction. Thus, Friston's FEP mandates that perception must be inferential (Figure 4). Under Friston's FEP, Gibson's arguments about lawful specification must be either physically incorrect, or simply irrelevant. That is, it is claimed that Friston's FEP takes precedence over any arguments about specification (e.g., Bruineberg et al., 2022).

The success of Friston's FEP depends, in part, on the underlying 19th century physics. Those physics require that time be mathematically modeled as being discrete, as in the "timeline", in which time is a linear quantity that can be divided into discrete, bounded units of arbitrary length (Figure 5). This conceptualization is common, but not universal. Bergson (1922) argued that the traditional discretization of time negates the essential nature of time as duration. Bergson argued that concepts of time in terms of discrete, bounded units cannot be correct. If Bergson is correct, then the FEP cannot be correct and, similarly, Friston's extension of it to the biological and psychological domains cannot be correct. It follows that there need not be a categorical boundary between organism and environment. Thus, Bergson's arguments can be understood as providing a fundamental basis for and justification of Gibson's claim that direct perception is based upon lawful specification.

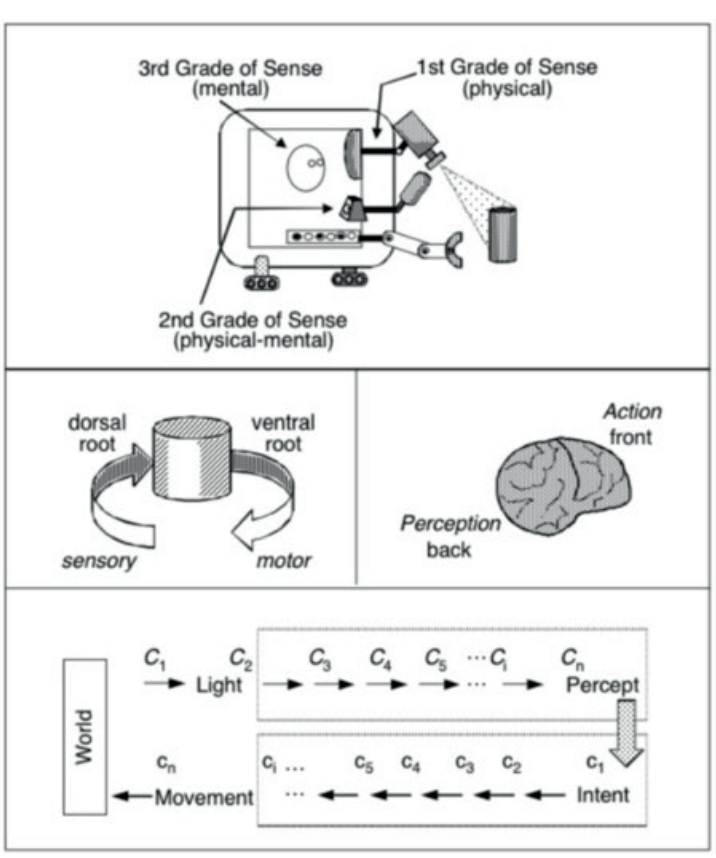

Figure 4. Inferential perception

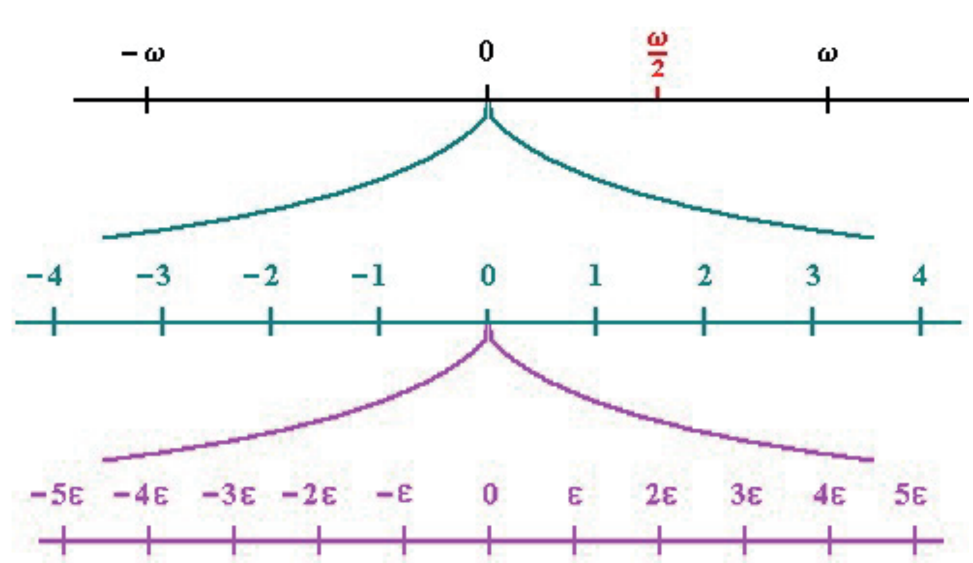

Figure 5. The infinitely divisible timeline

Stoffregen, T., & Heath, R. (2022). Against free energy, for direct perception. *Behavioral and Brain Sciences*, *45*, E212, 59-60.

AN ECOLOGICAL APPROACH TO MOLYNEUX'S PROBLEM

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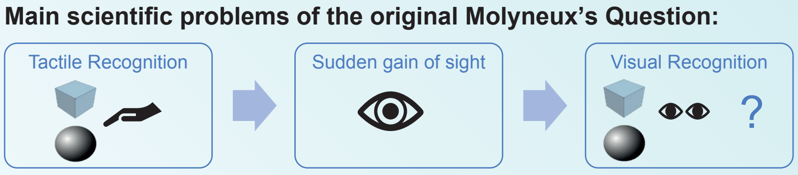
Abstract

Molyneux's Problem is a thought experiment on whether a **congenitally blind person**, that can identify a **sphere** and a **cube** by touch, could visually **recognize them after gaining sight**. Despite numerous empirical attempts to solve the problem, no conclusive answer has been reached (Held et al., 2011; Miller, 2011). In this study, we offer a theoretical analysis of the problem and propose an experiment that involves an object recognition task using a **vibrotactile device**, akin to Molyneux's original experiment. This approach will allow us to test a "reverse Molyneux" hypothesis and potentially contribute to a deeper understanding of the problem.

Introduction

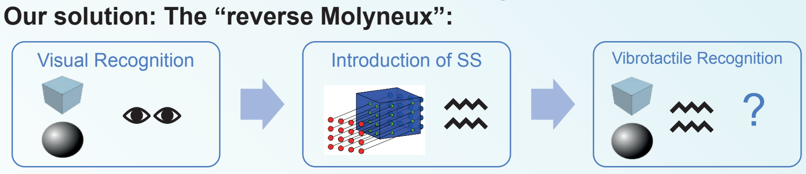
Due to the methodological limitations to experimental solutions proposed for Molyneux's Question, we aim to offer a methodological framework that is experimentally plausible using sensory substitution (SS).

Main scientific problems of the original Molyneux's Question:



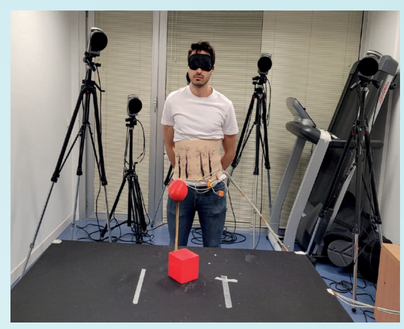
- Vision is completely functional, and it happens suddenly.
  - That is, it is possible to use it from that very moment without any kind of adaptation, it's also in 3D and it's calibrated.
- But perceptual systems do not work like this.
  - We learn how to control eye movements, how to focus on distant and proximate objects, how to calibrate depending on the lighting of the scene, etc.
  - The sudden full use of a sense produce an intense pain.

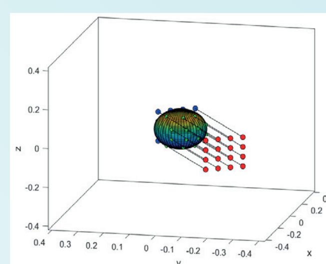
How to make this conditions experimentally plausible?
Our solution: The "reverse Molyneux":

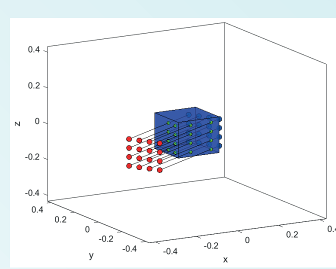


- Users adapt extremely quickly to this SS device
  - It functions in 3D
  - It is already calibrated for the environmental conditions
  - It is not painful

Method







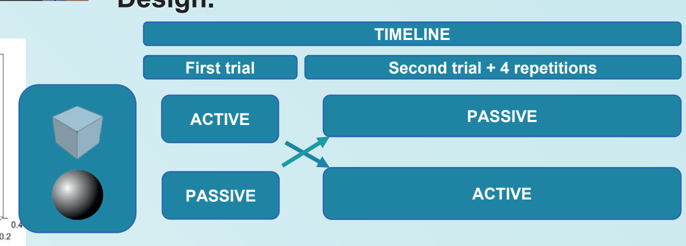
Participants. blindfolded sighted.

Apparatus. A vibrotactile SS waistband.

4x4 matrix of vibrating motors.

Motors vibrate as a function of the distance to the first encountered object.

Design.



Procedure.
Participants are asked to answer whether the object is a cube or a sphere.

No information is given about the functioning of the device

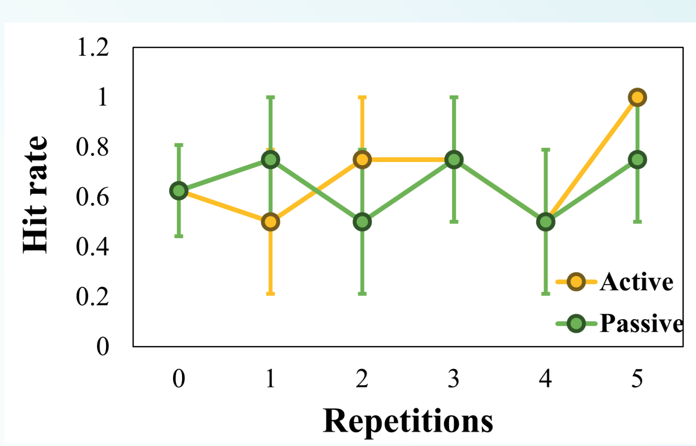
In the active condition they are free to move.

Data Analysis.
Hit ratio / Response time / Exploratory patterns

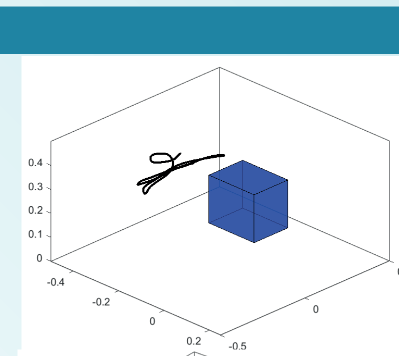
Results

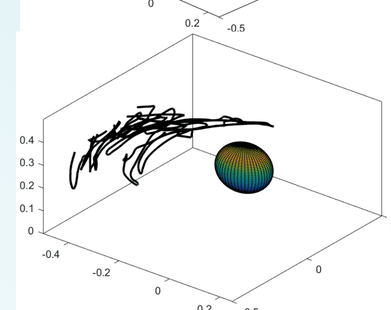
Hypothesis.
Hit rate:

- First trial: Participants would be unable to recognize figures "at first sight" above chance.
- Active vs. passive: Participants would have a learning effect only in the active condition.



Results of 4 participants of a pilot study intended to optimize the functioning of the device





Conclusions

The current design might solve the adaptation problem of the Molyneux problem.
Exploratory movement would inform on the relevant information for detecting the geometrical figures

References

Held, R., Ostrovsky, Y., de Gelder, B., Gandhi, T., Ganesh, S., Mathur, U., y Sinha, P. (2011). The newly sighted fail to match seen with felt. *Nature Neuroscience, 14*(5), 551-553.

Miller, G. (2011). Formerly blind children shed light on a centuries-old puzzle. *Science Now, 10.*

ICPA 2023

Space differentiation occurs in 6-8 old-month infants: A new view of the Spatial Orientation Paradigm

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Lab Psi Com
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Introduction

- One instance of differentiation of space (Gibson & Pick, 2000) is found in infant's spatial orientation, which is the ability to identify the fixed location of an event despite observer's movement in space (Acredolo, 1978).
- The evidence of such ability in pre-locomotor infants (6-8 months old) under visually homogeneous or heterogeneous environments is inconsistent (Acredolo, 1978; Acredolo & Evans, 1980; McKenzie et al, 1984; Rieser, 1979).
- The contradictory evidence may be due to the use of measures that only focus on "correct responses" and are not sensitive enough to capture small changes in the process of spatial differentiation.
- If differentiation imply, in addition of the specificity of response (Gibson & Gibson, 1955), the active process of detecting the permanent properties of the environment (Gibson & Pick, 2000), the analysis of this process may help us to resolve some controversies in the area.

Objective

- To analyze the process of differentiation of space of pre-locomotor infants, through the recording of moment-to-moment infant's activity, using a variation of the Spatial Orientation Paradigm (Acredolo, 1978) under a visually homogeneous or heterogeneous environment..

Method

Participants Six pre-locomotor infants between 6 and 8 months-old.

Figure 1
Experimental setting

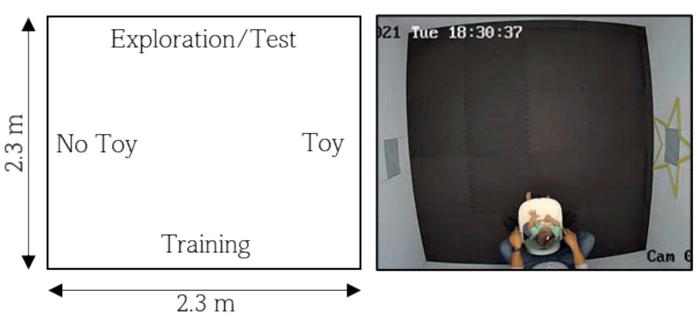


Table 1
Experimental design

Group	Exploration	Training	Test
Homogeneous	No events	Sound-Toy	Sound
Heterogeneous			

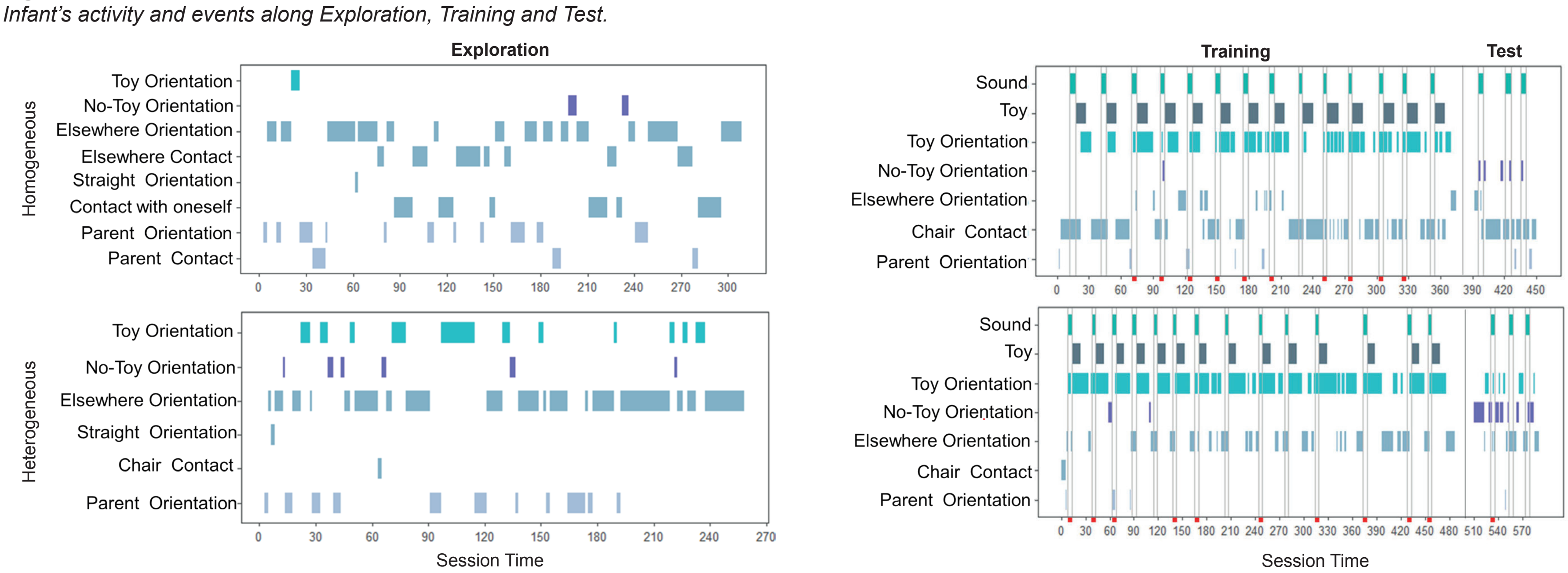
Note. 3 participants in each group. Heterogeneous environment: A yellow star frame around toy-window. Homogeneous environment: No yellow star frame.

Procedure

Exploration. Infant in exploration position for 5 min.
Training. Infant in training position. 14 trials sound (5 s) followed by toy (10 s) in a fixed location.
Test. Infant in test position. 3 trials sound (5 s).

Results

Figure 2
Infant's activity and events along Exploration, Training and Test.



Note. One representative infant of each group is show. The upper panels (Exploration, Training and Test) correspond to Homogeneous group, the bottom panels correspond to Heterogeneous group.

Conclussions

- The activity continuously displayed by infants is differentially organized according to the differences in the environment (homogeneous vs. heterogeneous) and the presence or absence of relationships between events (exploration vs. training- test).
- Recording and analysis of the moment-to-moment infant's activity shows differences not captured by traditional records in the area, based on infants' correct and incorrect responses during test trials.
- Specifically, under heterogeneous environment infants display more inspection and comparison of the relevant locations and corrections of the direction of his responses (in test). This results permit us to affirm that infants under this condition exhibit spatial orientation, against Acredolo's (1978) report.
- This differences in the infant's activity correspond with different process of active detecting of the permanent properties of the environment, it is, distinct process of differentiation of space.

References and Contact

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ICPA 2023

EuroMov Digital Health in Motion

IMT Mines Alès École Mines-Télécom

Moving with someone happy makes you happy

01 INTRODUCTION

- While interacting with someone, we tend to mimic their emotional expressions and catch their emotions[1]. This **emotional contagion** is socially beneficial by increasing liking, affiliation, empathy, and prosocial behavior[2].
- **Quantifying the emotional body movements** of individuals in interaction and their **influence** on their partner's movements and feelings could provide a better understanding of emotional contagion and open up avenues to possible ways of cognitive behavior therapies.

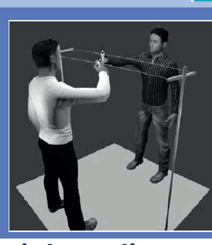
Objective :
To investigate emotional contagion (mimicry and feedback) of joy and sadness in dyads through changes in arm movements

02 METHODS

N = 15 dyads

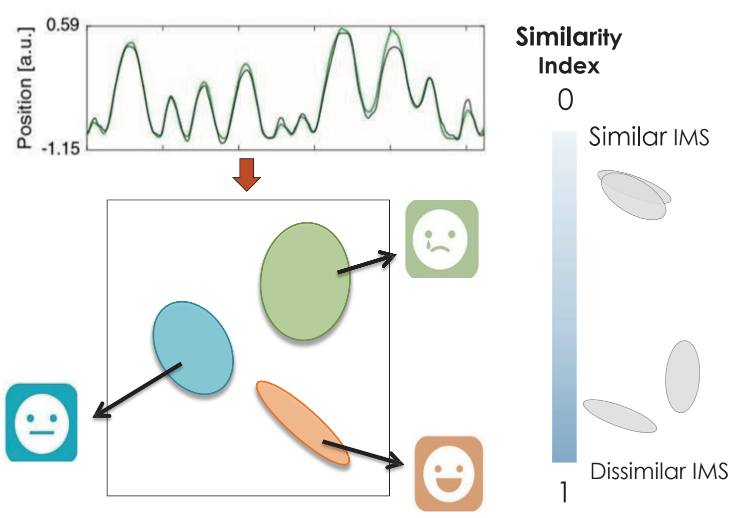
Emotion elicitation
Autobiographical recall paradigm
Joy *Sadness* *Neutral*

Mirror Game[3]

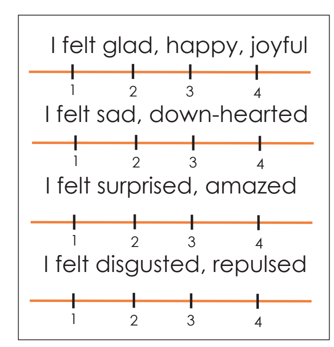


Dyadic interactions
Congruent emotions **VS** Incongruent emotions

Individual Motor Signature (IMS) - Mimicry



Felt emotions - Feedback

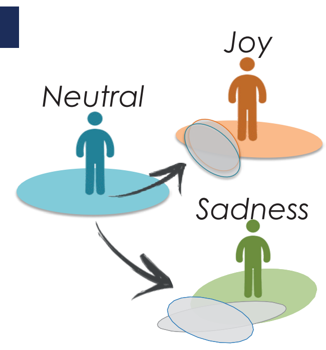


- 1st measure: before interaction
- 2nd measure: after interaction

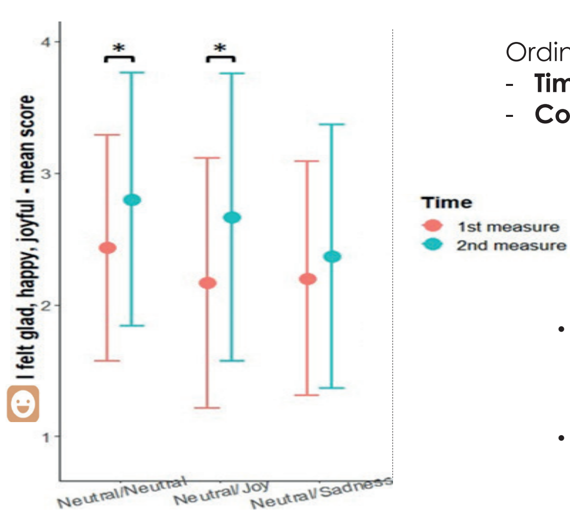
03 RESULTS

Individual Motor Signature change

	Mean congruent Index	Mean incongruent Index	*p*	Effect size
Neutral > Joy	0.0595	0.0472	**< .05**	0.35
Neutral > Sadness	0.0520	0.0397	**< .05**	0.53



Emotion change



Ordinal Cumulative Link Mixed Model (CLMM):
- **Time** (1st vs. 2nd measures)
- **Condition** (congruent vs. incongruent interaction)

- Significant increase in felt **joy** after the interaction with a joyful participant and also after the interaction with a neutral participant.
- Significant decrease in felt **sadness** after the interaction with a neutral and a joyful participant.

04 DISCUSSION

- As each IMS represents an idiosyncratic way of moving, we demonstrated that **neutral members** engaged in similar motor behaviors to their **joyful and sad partner** during the interaction.
- Changes in emotional feeling from a neutral state were not obvious to assess after a 5-minute speechless interaction despite the evidence of emotional mimicry.
- **Emotional mimicry and feedback** are not automatically appreciated together during a body-engaging experimental study[4].

05 CONCLUSION

- People can mimic emotional uni-dimensional arm movements in addition to face, voice, and posture, opening the field of possibilities in the study of **emotional contagion**.
- Our study is the first step in quantifying the **emotional behavior** of moving individuals during **dyadic social interactions**, leading to potential avenues of cognitive behavior therapies.

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Contribution of Variability in Joint Coordination During Novel Motor Learning

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Introduction

Novel **motor learning** entails the **search** within **joint space** to find new **coordination patterns** in order to perform the task.

Search is characterized as systematic task specific changes in patterns over time [1]. The search for a new movement solution depends on the amount and structure of motor variability at the task level [2].

However, finding a new movement solution requires **variability** in the joint space to search and form joint coordination patterns that fit the task at hand.

Research Gap

Motor learning studies widely report benefits of practice variability as improvement in task performance. Limited studies have evaluated the underlying search processes at play during learning to find new coordination patterns.

Moreover, the variability of practice effect is primarily studied as pre – post designs and the focus has not been on the acquisition phase. Therefore, we examine the role of practice variability in the learning process at the joint level.

Research Question

Are there differences in the search for a new coordination pattern in arm joints between blocked and variable practice when learning a novel task?

Methods

Task: Virtual Lateral Interception

Groups:
1.Blocked (on arrival position)
2.Variable

Participants: 8 (4 per group)

No. of Trials: 480 trials (Feedback was provided on successful trials)

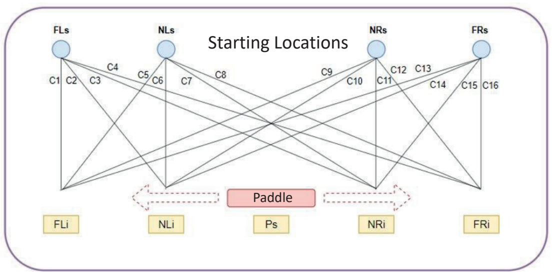
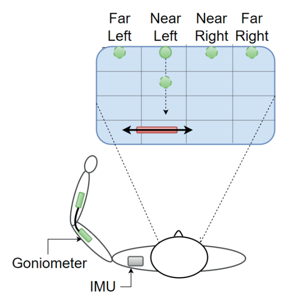


Fig 1. Experiment Design: Lateral interception task ("Ball Catching") with 16 different ball trajectories from 4 starting locations (FLs, NLs,NRs and FRs) to 4 arrival positions (FLi, NLi,NRi and FRi)

A **redundant mapping** of joint angles is used to control an avatar (paddle) on the screen (the red bar in the figure above).



Mapping → Calibration → Experiment

P = Elb + ScaY + ScaZ

Ball Catching

P = Position of paddle
Elb = Normalized left elbow flexion-extension angle
ScaY = Normalized Protraction-Retraction of left scapula
ScaZ = Normalized Rotation of left scapula

Fig 2. Experimental Setup: The task is performed in virtual reality using signals from shoulder and elbow movement.

Task Level Results

1. Is there a difference in change of end effector error over practice between blocked and variable group?

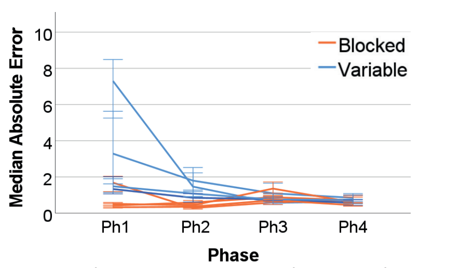


Fig 3. Change in error across learning phases. Faster learning in blocked practice as compared to variable.

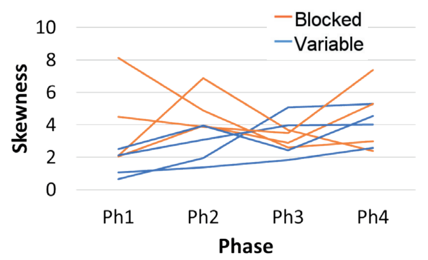


Fig 4. Difference in skewness of error distribution between groups indicate differences in learning strategies.

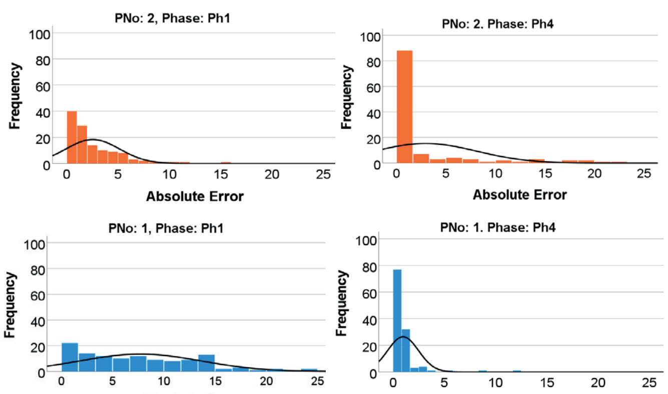


Fig 5. Error distribution comparison between first and last phase of learning.

Representative plots for a single participant from blocked (PNo.2) and variable (PNo.1) group .

Dissimilarity between variable and blocked practice show different search strategies employed.

Joint Level Results

2. Does the search over practice within joint space differ between blocked and variable practice?

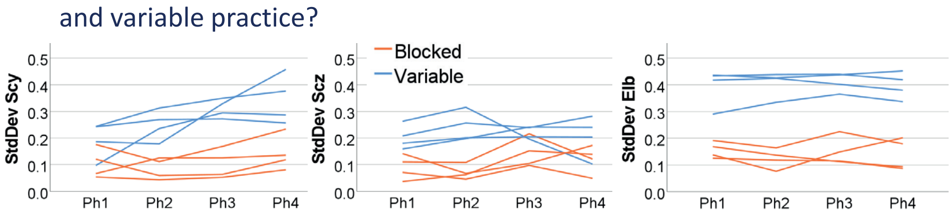
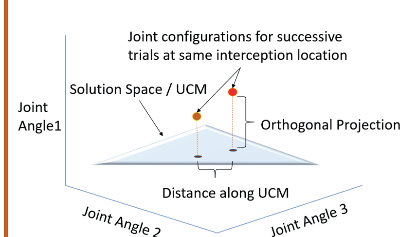


Fig 6. Standard deviation of joint configuration at interception across learning phases. Higher standard deviation in all joints for variable practice indicates more search behavior in this group in comparison to blocked practice.

Joint Projection Analysis Results



Orthogonal projection and distance along UCM are parameters to track the changes in joint space with respect to the task goal.

They are used to quantify the search behavior.

Fig 7. Graphical representation of the projection analysis for joint configuration at interception

3. Do the joint configurations at interception locations differ between blocked and variable practice?

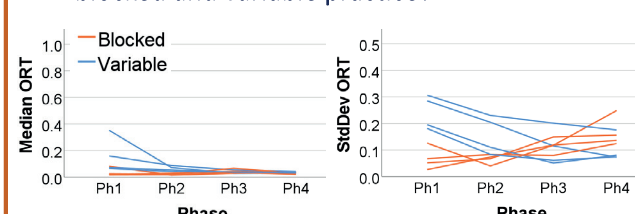


Fig 8. Orthogonal Projection at interception location. Reduction in orthogonal projection shows that all participants learn joint configurations that allow successful interception of the ball.

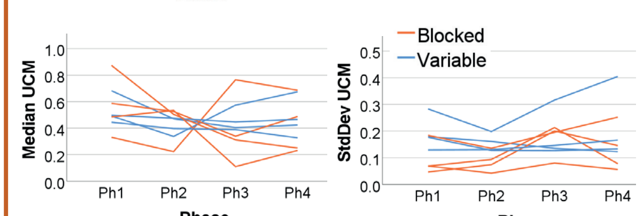


Fig 9. Distance along UCM at interception. High values in phase 4 implies differences in joint configuration even though task is performed successfully.

Variable group performs the task with more varied configurations than blocked as indicated by higher standard deviation even in the last phase of learning.

Discussion

- Participants learn to co-ordinate their movements through practice and learn to perform the task irrespective of practice schedule. However, there are distinct learning patterns between blocked and variable practice.
- Despite the low error in most part of the practice, participants still explore coordination patterns within the solution space.
- Participants in variable practice search more than the blocked practice group within the joint space across all phases.
- In later phases of practice, the variable group continues to explore more within the solution space.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 956003

Response-force Requirements on Food-maintained Responding in Rats

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BACKGROUND

Response force is a fundamental dimension of behavior. Yet, little is known about its significance for learning. Research shows that conditioned behavior decreases in frequency with increasing response force requirements in different species, such as rats pressing a lever (Notterman & Mintz, 1965), pigeons pecking a key (Chung, 1965), and mice pressing a disk with the snout (Zarcone et al., 2007). These findings have been interpreted as increasing force requirements being aversive. Overall, these works suggest that the simple regression model can describe this relation:

$$Y = \alpha + \beta \cdot X, \quad (1)$$

where *Y* are response rates, *X* are force requirements, and parameters *α* and *β* are the intercept and slope of the regression line, respectively.

However, studies that measured criterion force and subcriterion force responses in operant tasks with different response force requirements (Pinkston & Moore, 2020; Zarcone et al., 2009), found that higher force requirements increased total response emission (i.e., the sum of criterion and subcriterion responses), which is not consistent with the punishment hypothesis.

The present work evaluated these findings from an ecological (i.e., Gibsonian) perspective, manipulating force requirements not from an extrinsic metric, but in intrinsic terms. That is, from the animal's biomechanical properties.

A second aim was to explore a different model than the linear to describe the relationship between biomechanical properties and operant learning performance. This is important if empirical evidence that measured subcriterion responses suggests that high force response requirements are not aversive. The model assessed whether describes in a more precise way this relation was the simple binomial logistic regression:

$$logit(Y) = ln\left[\frac{\pi}{1-\pi}\right] = \alpha + \beta \cdot X. \quad (2)$$

Taking the antilog of Eq. 2 on both sides, derives an equation to predict the probability of the occurrence of criterion responses as follows:

$$\pi = \frac{e^{\alpha+\beta \cdot X}}{1+e^{\alpha+\beta \cdot X}}, \quad (3)$$

where *π* is the probability of criterion responses, *α* is the *Y* intercept, *β* is the regression coefficient, *e* = 2.71828 is the base of the system of natural logarithms, and *X* is the force requirement.

METHOD

Subjects

Six male Wistar rats maintained at 85% of their free-feeding body weights. Rats were housed individually in polycarbonate cages with free access to water in a temperature-controlled colony room on a 12:12 h light/dark cycle.

Aparattus

Procedure

Before the beginning of the experiment, rat's grip strength was measured using a dynamometer for rodents (Bioseb, model GT3, Vitrolles, France).

Rats obtained food pellets by lever pressing according to a fixed-ratio 1 schedule of reinforcement. Experimental sessions were conducted at the same time daily and lasted until the delivery of 49 food pellets or the elapsing of 30 minutes, whichever occurred first.

In conditions that lasted 5 sessions each, lever force (mass) requirement for food delivery was increased in intrinsic metric (i.e., according to a percentage of each rat's grip strength, see Table 1).

Table 1. Experimental design.

Block 1	1.5%	3%	6%	9%	12%
Block 2	3%	6%	9%	10%	13%

RESULTS

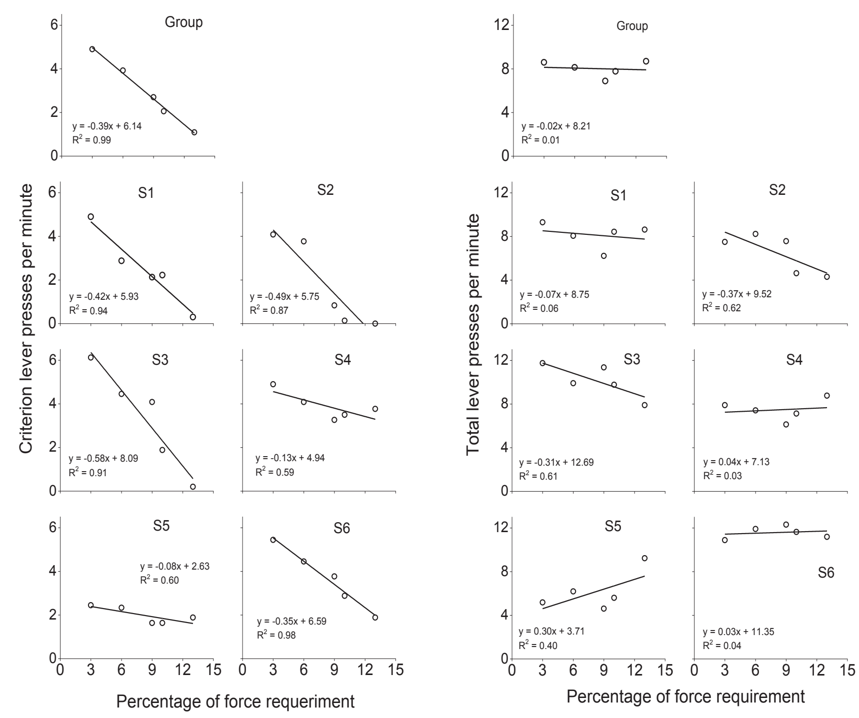
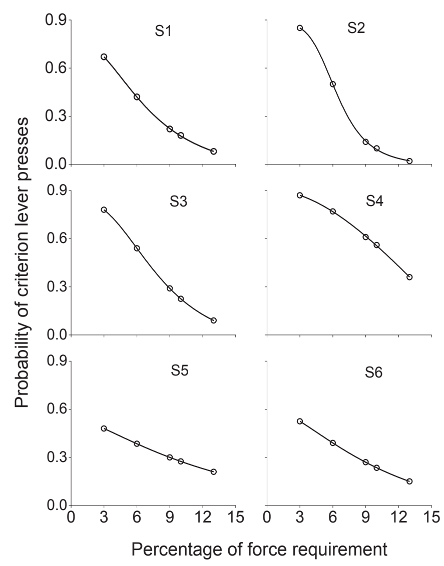


Table 2. Results of simple binomial regression analysis.

Rat	Inter-cept	Force	Devian-ce	AIC	Likeli-hood ratio	Wald Z	Nagel-kerke R^2	C	D_{xy}	Gamma
S1	1.66***	-0.32***	Null > residual	758.62	<0.0001	<0.0001	0.26	0.77	0.55	0.65
S2	3.47***	-0.58***	Null > residual	415.82	<0.0001	<0.0001	0.51	0.89	0.78	0.87
S3	2.35***	-0.36***	Null > residual	672.35	<0.0001	<0.0001	0.31	0.79	0.57	0.67
S4	2.70***	-0.25***	Null > residual	548.65	<0.0001	<0.0001	0.18	0.71	0.42	0.51
S5	0.30	-0.13***	Null > residual	891.71	<0.0001	<0.0001	0.05	0.62	0.24	0.30
S6	0.65**	-0.18***	Null > residual	1028.4	<0.0001	<0.0001	0.10	0.68	0.35	0.43

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



CONCLUSIONS

1. Criterion lever-press rates decreased with increasing lever force requirements. The linear regression model (Eq. 1) described the data well.
2. Linear regression lines showed that total lever-press rates tended to remain constant (slopes close to 0) across lever force requirements. This result contradicts a punishment interpretation of criterion response decrements and suggest that higher force requirements are more analogous to intermittent schedules of reinforcement.
3. The simple binomial logistic regression model (Eq. 3) showed that the likelihood of emission of force criterion responses decreased with increasing force requirements.
4. The sigmoidal relationship predicted by the binomial logistic model between lever press rates and lever force requirements suggests that linearity is not the case over the full range of lever force requirements.
5. These findings indicate that preorganized properties of behavior (the organism's biomechanical abilities) present before operant conditioning takes place, contribute to modulate instrumentally conditioned behavior.

Role of Emotion on Potential Affordance Detection in Different Environments

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UCONN UNIVERSITY OF CONNECTICUT

Introduction

- Positive emotional states are theorized to create a broadening effect, captured as the expansiveness of one's cognitions, actions, and perceptions (Fredrickson & Branigan, 2005)
- Little is known about how an individual's current affective state influences responsiveness to an environment
  - In other words, could the "broadening effect" lead to more sensitivity to detecting action possibilities (i.e., affordances; Gibson, 1979)?
- Explore whether the type of environment matters
  - Natural versus built environments? (Brymer et al., 2020)
  - Public versus own territory? (Meagher, 2020)

Predictions

H1: Positive affective states will sensitize individuals to their environment, leading them to list more total activities that they could do in an environment.

H2: Those who imagine themselves navigating outdoor environments will generate larger and more socially-oriented lists than those assigned to indoor environments (Brymer et al., 2020; Jäger & Rüsseler, 2016), or the opposite will occur (see the territoriality hypothesis; Meagher, 2020) because private spaces provide more *hosting*-relevant affordances.

Method

- Video stimuli pretested in pilot study, confirming effectiveness of video manipulation
- Experimental designs conceptually replicate Fredrickson and Branigan (2005)

Experiment 1

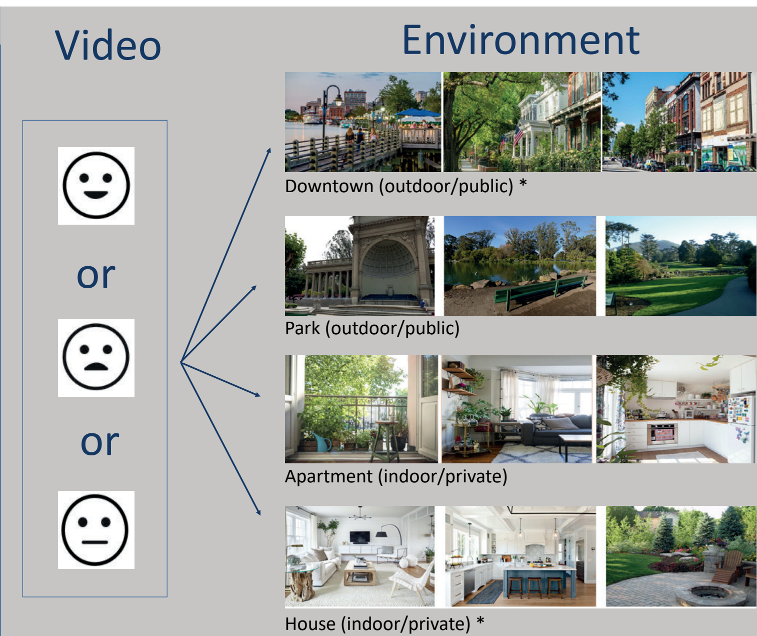
Between-subjects design; *N* = 298 (194 women)

- Randomly viewed one video (i.e., evoking a positive, negative, or neutral emotion state)
- Imagined being transported to *one of four* possible depicted environments
- Asked to indicate what activities they could do there by completing the prompt "*I could…*" up to 20 times

Experiment 2

Between-subjects design; *N* = 203 (147 women)

- Randomly assigned to view a short video (i.e., positive or negative)
- Imagined being transported to *one of two* possible depicted environments (indoor v. outdoor, see asterisks)
- Asked to complete the prompt "*I could…*"



Then answer: ***I could …*** prompts

* Used in Experiment 1 and Experiment 2

Results

Experiment 1

ANOVA: Video (Positive, Negative, Neutral) x Environment (Downtown, Park, Apartment, House)

- **No main or interactive effects of video** on the total number of thoughts generated (Figure 1)
- **Planned contrast** examining outdoor environments (+1 +1) versus indoor environments differed (-1 -1) **was significant** $F(1, 286) = 3.981$, $p < 0.05$
  - More thoughts listed for indoor environments (M = 12.92, SD= 0.46) than outdoor environments (M = 11.63, SD = 0.46)
- **Main effect of environment** on number of social action urges (i.e., activities listed involving others; Figure 2)
  - Reported more action urges in outdoor versus indoor environments
- **Main effect of video** on complexity (i.e., number of compounds listed)
  - Positive video significantly differed from negative and neutral conditions

Experiment 2

ANOVA: Video (Positive, Negative) x Environment (Downtown, House)

- **No main or interactive effects of IVs** on the total number of thoughts generated nor on complexity
- **Main effect of environment** on number of social action urges (Figure 3)
  - More social items listed for indoor (M = 2.56, SD = 2.07) versus outdoor environment (M = 1.37, SD = 1.64)

Additional Linguistic Analysis

LIWC: (Tausczik & Pennebaker, 2010)

- Conducted analyses of social, actions (i.e., verbs), and perception content

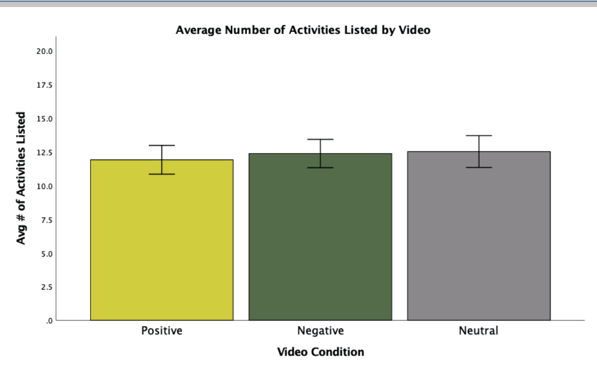


Figure 1: Contrary to H1, no main effect of video on total number of activities listed in Experiment 1.

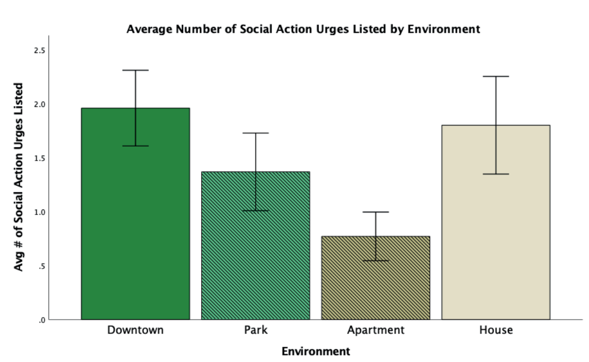


Figure 2: In Experiment 1, those who were transported to the apartment environment listed significantly fewer social action urges.

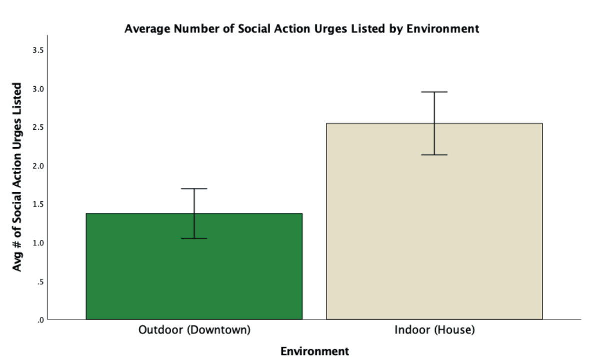


Figure 3: In Experiment 2, we found those transported to an indoor environment listed significantly more social action urges.

Discussion

Experiment 1

- Results did not support Hypothesis 1
- Regarding Hypothesis 2, initial evidence for territoriality perspective (Meagher, 2020)
- More "social action urges" reported in outdoor environments, however, people were depicted in the images—a confound removed in Experiment 2.
- Total number of activities evoked by indoor environments were greater
  - Contrary to Jäger and Rüsseler (2016), there was no difference in "social action urges" due to video conditions

Experiment 2

- Environment effects of Experiment 1 were not replicated.
- Once confound was removed, the results provided clearer support for the territoriality hypothesis (Meagher, 2020).
- As in Experiment 1, no support was found for the affordance extension of the "broadening" effect, despite using affect manipulations similar to past research (Fredrickson & Branigan, 2005)

Limitations

- Static images (with some dynamic change, i.e., "zooming in") were used instead of environments, a significant methodological flaw (Heft, 2007). Examining people's sensitivity to actual affordances will necessitate them being embedded in the actual environments.

In sum, the findings illuminate interesting possibilities for examining the salience of potential affordances in different environments, but no support for broadening hypothesis.

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The Effect of Ambient Lighting Conditions on Affordance Perception

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INTRODUCTION:

- The presence of a flat surface at a steep angle in front of an observer during quiet stance stabilizes posture and increases movement complexity (Hajnal et al., 2014)
  - What is the influence of light intensity?
- **Present Study**
  - Manipulated light (Low, Mid, High)
  - Manipulated angle (0° - 90° in 15-degree increments)
  - Affordance task: ”Can you stand on presented angle?”

HYPOTHESES:

- **H1**: The action boundary in the low condition should be < 30 degrees
- **H2**: The action boundary in the low condition will be lower than in the mid and high conditions
- **H3**: Reaction time should be slower in the low condition compared to the high and mid conditions
- **H4**: Body movements should be higher in the low condition compared to the high and mid conditions
- **H5**: Light intensity and body movements should interact and predict affordance judgments

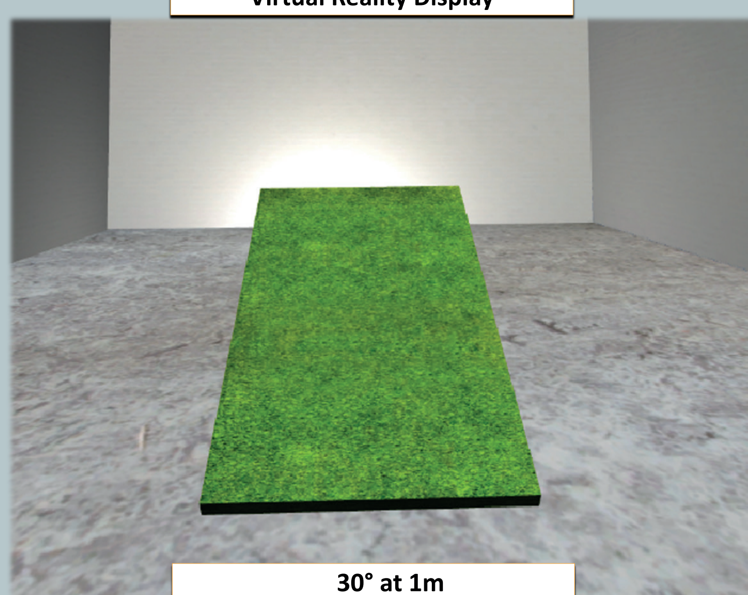
METHODS (n = 31):

- “Can you stand on the ramp at the presented angle?”
  - Yes/No responses
  - Response time
  - Head movements (Mean, CV, ETC)
  - Center of Pressure

“Light intensity

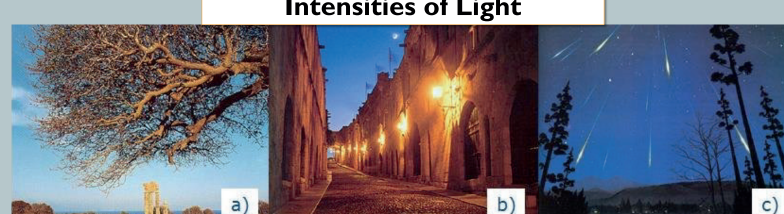
influences the **affordance perception** of stand-on-ability”

Virtual Reality Display



30° at 1m

Intensities of Light



A: Photopic
B: Mesopic
C: Scotopic

Link to lab website

Contact: t.overstreet@usm.edu

References:

Hajnal, A., Rumble, D., Shelley-Tremblay, J. F., & Liu, W. (2014). Optical push by geographical slant affects postural sway. *Ecological Psychology*, *26*(4), 283–300. https://doi.org/10.1080/ 10407413.2014.957999

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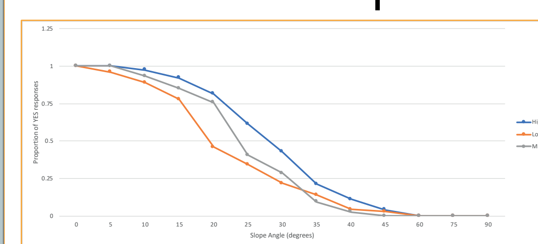
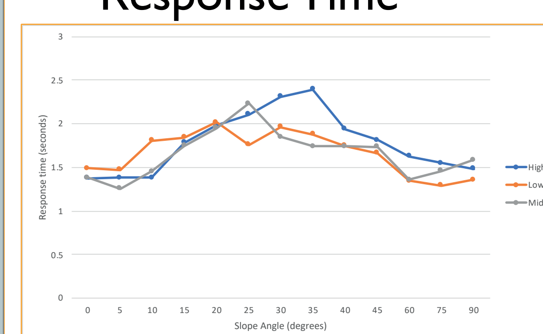
RESULTS:

- Perceptual judgements transition from yes to no as the angle increases from 0 to 90
- Answers were more conservative in the lowest light condition (**H1 & H2 confirmed**)
- Response time is longest at the transition point (~30) and in the **highest** light condition (**H3 not confirmed)**

Affordance Response



Response Time



DISCUSSION:

- **Upcoming analyses**
  - How is postural sway influenced by lighting conditions
  - Compare sway measurements between head and feet
- **Limitations**
  - VR Hardware
- **Future Studies**
  - Compare with real world equivalent
  - Population Comparisons
    - Old vs Young
    - Athletes vs Nonathletes
    - Motor control deficiencies

Cross Recurrence Quantification analysis of a ball retrieval task in Virtual Reality

Balagopal Raveendranath, Roshan Venkatakrishnan, Rohith Venkatakrishnan, Christopher C. Pagano & Sabarish Babu
Clemson University, USA

Introduction

- Human behavior is often coordinated with rhythmic environmental information.
- The actualization of affordances depends on the task relevant information as well as the end-effector.

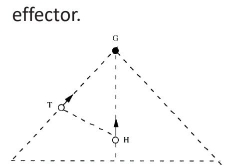


Figure 1. Tau coupling task used in Lee et al. (2001)[1]

Figure 2. Devices used in Venkatakrishnan et al. (2023)[2]

- According to the general τ theory, the τ of a gap could be perceived directly without perceiving either the gap size or its rate of closure[1].
- In Virtual Reality (VR) applications, different devices could be used to simulate end-effectors that could be used to interact with the environment[2].
- End-effector representations affect the perception of dynamic affordances in virtual environments.
- In a ball retrieval task in VR, participants were the most successful when a virtual hand was yoked to a hand-tracked glove[2].

Method

- N = 60 participants (4 males, age M = 22.48, SD = 4.69)

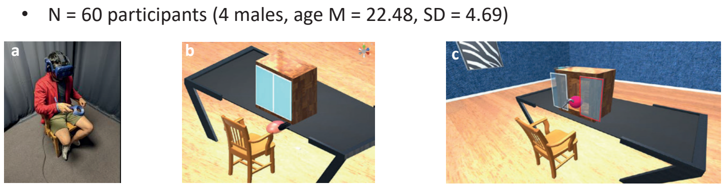


Figure 3. The experimental set up; a) Participant performing task, b) Scene prior to the start of a trial, c) A failed trial where the participant failed to retrieve the ball successfully.

- Participants sat on a wooden chair that physically co-located with a virtual replica.
- Sliding doors oscillated symmetrically at a constant speed in each trial.
- Oscillation speed ranged from 35 per minute up to 155 per minute.
- Participants retrieved a virtual ball from the virtual box without colliding with the doors.
- Each trial ended with a successful or failed retrieval.
- 3 virtual end effectors (between-participant) x 13 door frequencies (within-participant) x 2 ball sizes (within-participant) multifactorial design.
- The positions of the controller/glove, sliding doors were recorded throughout each trial.

a. Controller b. Controller-hand c. Glove

Figure 4. First person perspective of the three types of end-effectors used in the study.

Hypotheses

- As door frequency increases, participants will reduce the coupling between the end-effector and the sliding door to successfully retrieve the ball on the other side of the door.
- Participants will exhibit the least amount of coupling between the end-effector and the sliding door when the end-effector used is a virtual hand yoked to a hand-tracked glove.

Data Analysis

- Two distance to collision (DTC) time series were computed based on the position time series for the sliding door on the right and the controller/hand position.
- CRQA performed on the DTC for the controller/hand and that for the door.
- The shared phase space of the pairs of DTC time series was reconstructed using the method of time-delayed embedding.
- Average Mutual Information (AMI) was calculated over increasing time lags and the time lag where the first local minimum appeared was chosen for the reconstruction.
- Embedding dimension was determined by first local minimum of False Nearest Neighbors.
- The radius was allowed to vary within each DTC pair, so that the recurrence rate within each pair was exactly 5%.
- %DET, Average diagonal length and Longest diagonal length were used for this study.

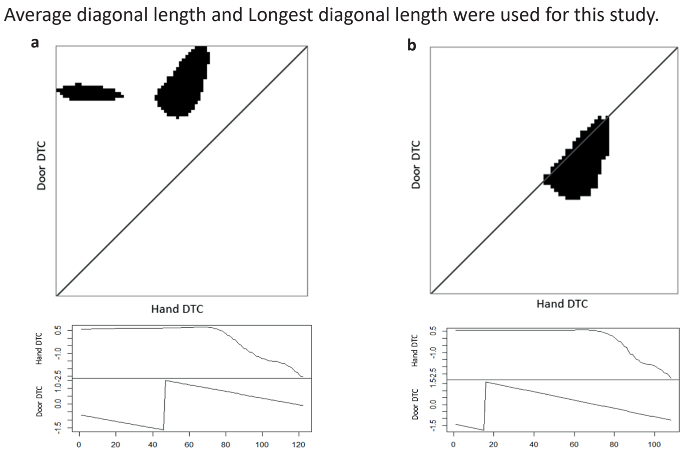


Figure 5. a) Sample cross recurrence plot and DTC time series for a successful, low frequency door oscillation trial for controller end-effector; b) Sample plot for a failed, low frequency door oscillation trial for controller end-effector.

Results

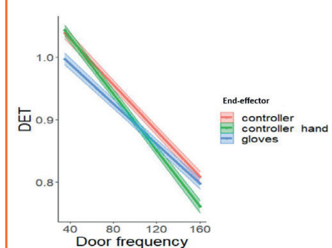


Figure 6. Door frequency x End-effector interaction for %DET

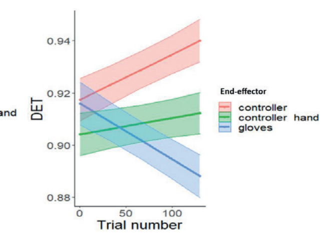


Figure 7. Trial number x End-effector interaction for %DET

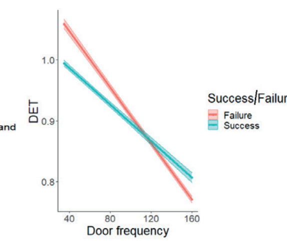


Figure 8. Door frequency x Trial outcome for %DET

- A linear mixed model was used to check the effects of the end-effector type, door frequency, trial number and trial success on **%DET**:
- Significant effect of end-effector type, $\chi^2 = 6.61$, $p = 0.036$, $sr^2 = 0.007$
- Significant effect of door frequency, $\chi^2 = 263.14$, $p < 0.001$, $sr^2 = 0.13$
- Significant effect of trial outcome, $\chi^2 = 42.6$, $p < 0.001$, $sr^2 = 0.001$
- The model explained 27.6% of variance in %DET.

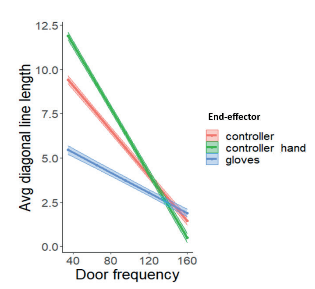


Figure 9. Door frequency x End-effector type for Avg diagonal line length

- A linear mixed model was used to check the effects of the end-effector type, door frequency, trial number and trial success on **the Avg. diagonal line length**:
- Significant effect of end-effector type, $\chi^2 = 278.18$, $p < 0.001$, $sr^2 = 0.07$
- Significant effect of door frequency, $\chi^2 = 161.59$, $p < 0.001$, $sr^2 = 0.14$
- Significant effect of trial outcome, $\chi^2 = 202.13$, $p < 0.001$, $sr^2 = 0.002$
- The model explained 49% of variance in Average diagonal line length.

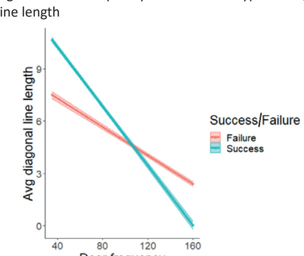


Figure 10. Door frequency x Trial outcome interaction for Avg diagonal line length

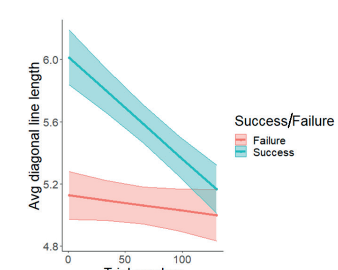


Figure 11. Trial number x Trial outcome for Avg diagonal line length

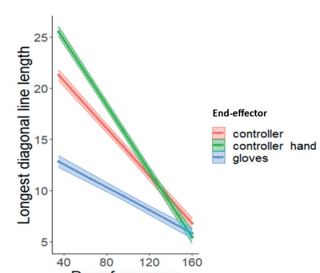


Figure 12. Door frequency x End-effector interaction for Longest diagonal length

- A linear mixed model was used to check the effects of the end-effector type, door frequency, trial number and trial success on **the Longest diagonal line length**:
- Significant effect of end-effector type, $\chi^2 = 158.94$, $p < 0.001$, $sr^2 = 0.08$
- Significant effect of door frequency, $\chi^2 = 176.17$, $p < 0.001$, $sr^2 = 0.10$
- Significant effect of trial outcome, $\chi^2 = 16.34$, $p < 0.001$, $sr^2 = 0.001$
- The model explained 38.5% of variance in Longest diagonal line length.

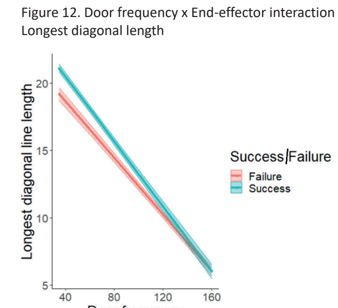


Figure 13. Door frequency x Trial outcome for longest diagonal line length

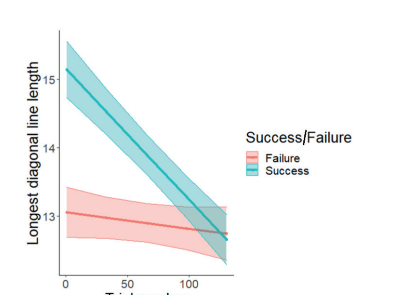


Figure 14. Trial number x Trial outcome for longest diagonal line length

Discussion

- As the door frequency increased, the coupling between the hand and the doors reduced significantly.
- The rate of reduction in coupling was higher for participants who saw the glove-yoked virtual hand as the end-effector.

References

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Effects of active-passive exploration and surface layout stability on haptic perception

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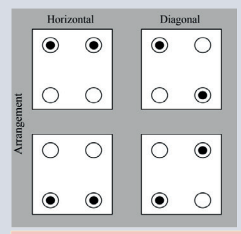
Introduction

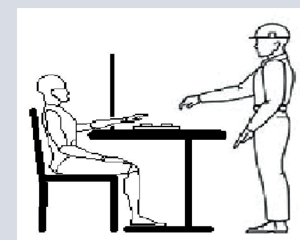
Research on active-passive touch has shown that perceivers who actively explore the environment detect information more accurately than those who explore it but in a passive way (Held, 1965). These studies have been performed under experimental settings in which the surface layout is stable. Little is known however about the effects of active-passive exploration on haptic perception when the surface layout is non-stable. In this study, we assessed the role of surface stability on detection of information by means of active and passive tactile exploration.

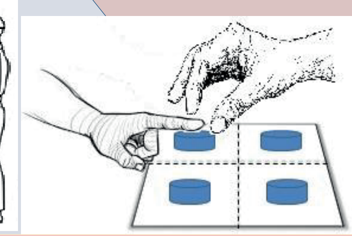
Method

For Experiments 1 and 2:

- Forty cards made of paper (15 cm x 15 cm) were used.
- Subjects were exposed to four marbles arranged as a square.
- They had to detect whether left marbles were horizontally or diagonally related to
- right marbles. At the middle of the session the relationship was reversed and subjects had to detect the novel relation.







Experiment 1

- Twenty four college students (83% women; *M*= 19.1 year-old, *SD*= 0.48) participated.
- In Phase 1 some subjects were exposed to horizontal relationships and others to diagonal relations.
- Some participants moved their hand freely (active explorers) and others their hands were moved by the experimenter (passive explores) reproducing the same movements performed by active explorers.
- In Phase 2 the relation between stimuli (marbles) was reversed and all participants (active and passive explores) were allowed to explore actively.

Experiment 2

- Sixteen college students (82% women; M= 20.4 year-old, SD= 2.95) participated.
- In Phase 1, in half of the trials, stimuli (marbles) had a horizontal relationship and in the other half they had a diagonal relation. Trials were presented in a random order, simulating a non-stable surface layout.
- Active and passive explorers were exposed to this condition before moving on to the second phase.
- In Phase 2, all trials were based on a horizontal or diagonal relationship. In this phase, all participants explored actively.

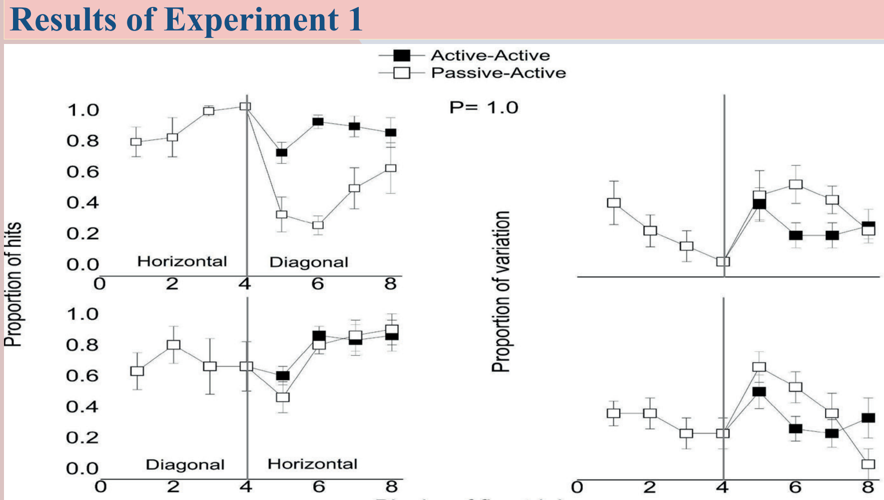
Design of Experiment 1

		Phase 1		Phase 2	
Group	Probability	Exploration	Relation	Exploration	Relation
1 (n= 6)		Active	Horizontal		Diagonal
2 (n= 6)	P=1.0		Diagonal	Active	Horizontal
3 (n= 6)		Passive	Horizontal		Diagonal
4 (n= 6)			Diagonal		Horizontal

Design of Experiment 2

	Phase 1		Phase 2		
Group	Probability	Exploration	Probability	Exploration	Relationship
1 (n= 4)		Active			Horizontal
2 (n= 4)	P=0.5			Active	Diagonal
3 (n= 4)		Passive	P=1.0		Horizontal
4 (n= 4)					Diagonal

Results of Experiment 1



Comparing performance before and after the relationship reversal:

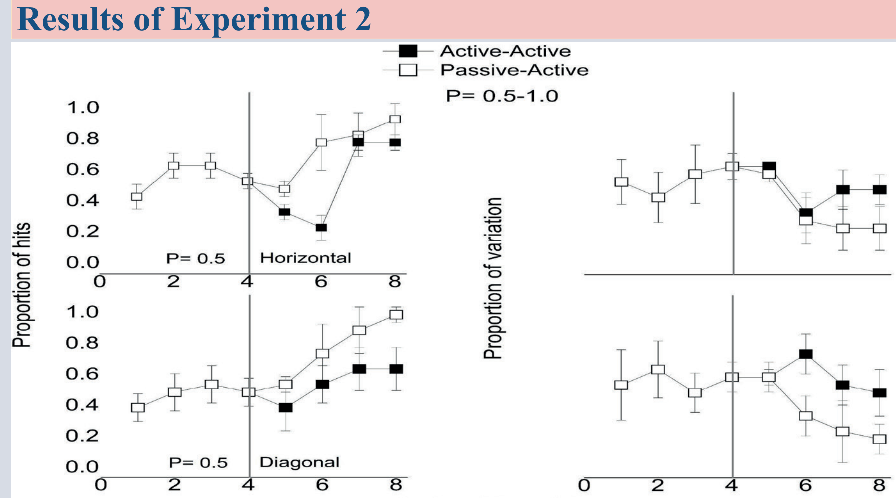
- In the horizontal–diagonal relationship (top panels):

For passive-active exploration, proportion of hits significantly decreased $t(df=119)=8.91$, p=.000, and proportion of variations significantly increased $t(df=227)=-3.92$, p=.000. Non-significant differences were found for active-active exploration in neither of these two measures.

- In the diagonal-horizontal relationship (bottom panels):

Non-significant differences were found for passive-active exploration nor for active-active exploration in neither of the two measures (hits and variations).

Results of Experiment 2



Comparing performance before and after the change of probability:

- In P= 0.5–1.0, horizontal relationship:

For passive-active exploration, proportion of hits significantly increased $t(df=80)=-2.41$, p=.018, and proportion of variations significantly decreased $t(df=75)=2.70$, p=.009. Non-significant differences were found for active-active exploration.

- In P= 0.5–1.0, diagonal relationship:

For passive exploration, proportion of hits significantly increased $t(df=79)=-4.18$, p=.000 and proportion of variation significantly decreased $t(df=75)=3.55$, p=.001. Non-significant differences were found for active-active exploration.

Conclusions

- Under a stable surface layout (Exp. 1), passive-active explorers showed less hits and more variations when they had to detect the change in relation from horizontal to diagonal than active-active explorers. These results suggest that passive-active explorers were less able to detect novel relations than active-active explorers, which is consistent with what has been reported by Held and Hein (1963).
- On the contrary, under a non-stable and then a stable surface layout (Exp. 2), we found opposite effects. That is, passive-active explorers showed more hits and less variations when they detected the novel relation (horizontal and diagonal) than active-active explorers.
- These findings are consistent with Gibson's (1966) assertion that: "An individual who explores… detects the permanent layout… isolates the information for permanence" (p. 264). Apparently, in active exploration individuals are more able to detect novel relations if the change in stimuli relations occurs in a context of a stable environment (Exp. 1). However, if detection of novel relations in a stable environment is made after being exposed to a non-stable environment, those who benefit are passive-active explorers (Exp. 2).
- Our results are also consistent with experiments reported by Held (1965), who emphasizes the role of sensory-motor couplings in perception. According to him, sensory-motor couplings are possible given that the environment is stable.

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How Affordances Affect Choice in an Environment with Variable Food Distribution?

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Universidad de Guadalajara

Research on choice behavior has shown that behavior allocation in two concurrent schedules is determined by characteristics of the reinforcing stimuli (i.e., food) that are contingent on responding such as their rate (e.g., Herrnstein, 1961). Different studies have manipulated food allocation and observed the resulting changes in response allocation with the following model:

$$\log\left(\frac{B_1}{B_2}\right) = S_R \cdot \log\left(\frac{R_1}{R_2}\right) + \log b, \tag{1}$$

where B_1 and B_2 are behavior allocations, measured in responses to alternatives 1 and 2, R_1 and R_2 are food rates obtained from alternatives 1 and 2, b is a measure of bias towards one alternative arising from factors other than food ratios, and S_R is sensitivity of behavior ratio to food ratio (Baum, 1974).

Choice behavior is also affected by affordance detection (Gibson, 1979), which results in the selection of actions according with the animal's abilities given by his own dimensional properties. As a result, if two alternatives furnish opportunities to obtain the same consequence (i.e., access to food), an animal will choose the alternative that better matches his own structure and capabilities. Former research show that rats' operant performance improves when response levers approximate to forepaw height (Jiménez et al., 2017), and that affordances offered by two levers with different heights organize lever pressing distribution (Jiménez et al., 2019).

Affordances are not only characterized by the animal's dimensions, but by the relation between the animal's biomechanical properties and the environment's surfaces force requirements (Cesari & Newell, 2000; Choi & Mark, 2004).

What happens when the choice alternatives differ in two dimensions: food distribution and force requirements to obtain food? Baum and Rachlin (1969) proposed that animals allocate behavior between two alternatives according to the relative value obtained, such that the ratio of behavior allocated between two activities equals the ratio of the values of the activities. Thus, generalizing this idea gives us the following equation:

$$\log\left(\frac{B_1}{B_2}\right) = S_R \cdot \log\left(\frac{R_1}{R_2}\right) + S_F \cdot \log\left(\frac{F_1}{F_2}\right) + \log b, \tag{2}$$

where B_1 and B_2 are behavior allocations, R_1 and R_2 are obtained food rates, F_1 and F_2 are the forces (masses) required by levers 1 and 2 to deliver food, b is a measure of bias towards one alternative arising from factors other than food and force ratios, S_R is sensitivity of behavior ratio to food ratio, and S_F is sensitivity of behavior ratio to lever force ratio (Hunter & Davison, 1982).

Accordingly, one aim of this experiment was to assess in rats how affordances provided by different lever forces (masses) affect choice in a situation where food allocation changed constantly and unpredictably.

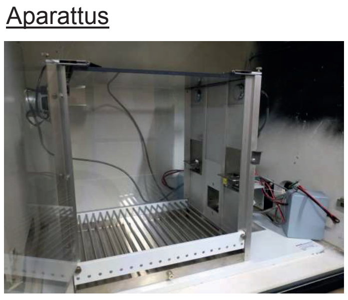
A second goal was to test whether the multiple linear regression (Eq. 2) provides an adequate model for describing behavior distribution in two alternatives.

METHOD

Subjects

Six male Wistar rats maintained at 85% of their free-feeding body weights. Rats were housed individually in polycarbonate cages with free access to water in a temperature-controlled colony room on a 12:12 h light/dark cycle.

Aparattus



Procedure

Rats obtained food pellets by lever pressing, the experimental situation arranged seven different food ratios or components within the session. Components were presented randomly, without replacement neither signaling. Across components, food was delivered according to different pairs of concurrent variable interval (VI) – VI schedules of reinforcement (see Table 1), a 2-s changeover delay (Herrnstein, 1961) separated both VI concurrent schedules.

Table 1. Experimental situation.

	VI in left (s)	VI in right (s)
Comp. 1	12	108
Comp. 2	12	36
Comp. 3	12	24
Comp. 4	15	15
Comp. 5	24	12
Comp. 6	36	12
Comp. 7	108	12

Each component lasted until the delivery of 8 food pellets, components were separated from one another by a 10-s blackout during which the chamber lights were extinguished and lever presses had no effect. Experimental sessions were conducted at the same time daily and lasted until the seven components were completed (56 food pellets were obtained) or the elapsing of 30 minutes, whichever occurred first.

Before the beginning of the experiment, rat's grip strength was measured using a dynamometer for rodents (Bioseb, model GT3, Vitrolles, France). In 4 conditions that lasted 15 sessions each, levers force (mass) requirement for food delivery was varied in intrinsic metric (i.e., according to each rat's grip strength, see Table 2).

Table 2. Design.

Rats 1, 2, and 3		Rats 4, 5, and 6	
Left lever	Right lever	Left lever	Right lever
3%	3%	3%	3%
3%	6%	6%	3%
9%	3%	3%	9%
3%	12%	12%	3%

RESULTS

Table 3. Sensitivity coefficients of the regression of **log criterion response allocation** on log food ratios (Eq. 1) across the different force ratios assessed. Log criterion responses only include lever presses with force equal or above force threshold.

Log (L/R) force ratio	M01	M02	M03	M04	M05	M06	Mean
0	0.16	0.37	0.21	0.53	0.26	0.09	**0.27**
0.3	0.22	0.62	0.22	1.35	0.64	0.16	**0.53**
0.47	0.94	1.18	0.28		0.19	1.36	**0.79**
0.6	1.37	0.83	1.52		1.05	0.88	**1.13**

Table 4. Results of regressing **log criterion response allocation** on log food and force ratios (Eq. 2). Sensitivity coefficients for food and force are the unstandardized weights obtained prior to the addition of the interaction term. R^2_{inc} refers to the increment in R^2 when the interaction value was applied.

Rat	Food	Force	Intercept	R^2	Interaction	R^2_{inc}
M01	0.74***	-1.49***	-0.11	0.83	-0.54**	0.01
M02	0.78***	-1.70***	-0.14***	0.93	0.28*	0.00
M03	0.77***	-0.90***	0.08	0.59	-1.18***	0.10
M04	1.03***	-3.24***	0.45**	0.80	2.72**	0.04
M05	0.58***	-1.20***	-0.13**	0.73	0.87***	0.07
M06	0.86***	-1.82***	0.07	0.88	-0.02	0.00
Mean	**0.79**	**-1.72**	**0.04**	**0.79**	**0.35**	**0.03**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5. Results of regressing **log overall response allocation** on log food and force ratios (Eq. 2). Log overall responses include lever presses above and below force threshold.

Rat	Food	Force	Intercept	R^2	Interaction	R^2_{inc}
M01	0.61***	-0.64**	0.01	0.62	-0.41*	0.02
M02	0.70***	-0.89***	-0.02	0.73	-0.23	0.00
M03	0.38***	-0.15	-0.03	0.47	-0.23	0.01
M04	0.69***	-2.35**	0.41	0.65	1.50	0.01
M05	0.39***	-0.14	0.05	0.58	0.47***	0.09
M06	0.21***	-0.26*	0.14	0.69	-0.12**	0.02
Mean	**0.50**	**-0.74**	**0.09**	**0.62**	**0.16**	**0.02**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CONCLUSIONS

1. Sensitivity (i.e., slopes) to food-ratio variations was positive. That is, subjects preferred the richer lever adjusting to the rapid changes within sessions in food distribution.
2. Sensitivity to food-rate ratios increased with increasing asymmetrically lever-force requirements.
3. For results of Eq. 2, response distribution changes were of lesser magnitude than changes in food ratios (slopes below 1.0).
4. Sensitivity to force-ratio variations was negative, indicating that across conditions subjects preferred the lower force lever.
5. For criterion response ratios, force slopes were steeper than food slopes, which suggest a larger control by force ratios than by food ratios. However, this finding is not supported with overall response ratios.
6. The model of multiple linear regression (Eq. 2) described the data better when criterion response ratios were introduced in the equation as the outcome variable than when overall response ratios were used as the outcome.
7. For most subjects, increments in R^2 values were negligible when adding to Eq. 2 the interaction term.
8. Across subjects, bias (i.e., the intercept) was close to zero (except for rat 4), which indicates that choice behavior was controlled by food and force ratios and not by other variables.
9. These results suggest that Eq. 2 that assumes the concatenation of choice-affecting variables (Baum & Rachlin, 1969) describes the data well. Such a model implies that food ratio and lever force requirement ratio have independent multiplicative effects on choice.

Does Upper-limb Exoskeleton Affect Pointing Accuracy?

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Introduction

- Exoskeletons are wearable devices that support or augment users' physical abilities by reducing the physical demands of repetitive tasks involving the use of heavy tools, etc.[1]
- Upper-limb exoskeletons support the back and arms and are commonly used in industry for occupational tasks, primarily overhead work.[2]
- Users can improve their performance through attunement, calibration, and exploration.[3]
- **The purpose of the study was to assess the effect of an exoskeleton on accuracy at a blind-pointing task.**

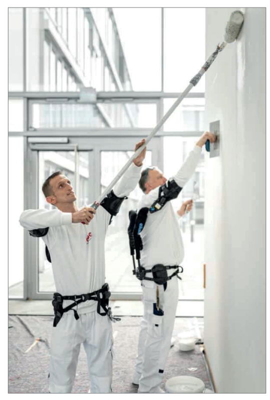
Figure 1. Upper-limb exoskeleton.[4]

Hypotheses:
1) Wearing an exoskeleton will decrease accuracy on a blind-pointing task.
2) Accuracy on a blind-pointing task will improve from pre-test to post-test, due to repeated calibration.

Methods

- *N* = 17 college students (9 Females, Age *M* = 20.76, *SD* = 4.80)
- Task: Start with hand at the side, follow a 40 BPM metronome to point six times alternating between two target points placed either on a vertical or horizontal line
- 3 phases: pre-test, calibration, post-test (8 trials per phase)
- Exploratory variables: Direction (vertical/horizontal); Movement (extension/flexion)
- Motion tracking data was collected via Qualisys motion capture system

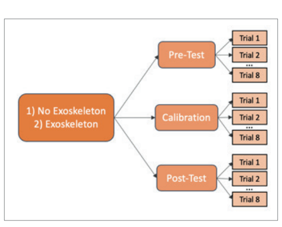

Figure 2. Flowchart depicting the research design.


Figure 3. On each trial, participants made vertical or horizontal reaches between two points on the poster.

Results

- Due to the repeated-measures design, variables had considerable nesting that produced multiple levels of variance.
- To account for this, Hierarchical Linear Modeling was used to assess the effects of condition, phase, direction, and movement on accuracy.
  - Participant ID was included as the random effect.
- Accuracy, the dependent variable, was determined by the distance between the actual target point and the touched target point.

Predictor	df_1	df_2	*F*	sr^2
Condition	1	3243	4.69*	.0001
Phase	1	3243	1.21	–
Direction	1	3243	84.90***	.003
Movement	1	3243	104.2***	.001

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 1. Results of the omnibus *F* test predicting accuracy.

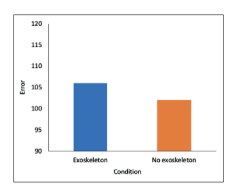
Figure 4. Plot showing the main effect of condition.

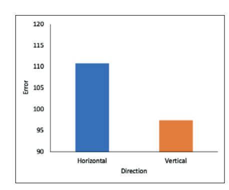
Figure 5. Plot showing the main effect of direction.

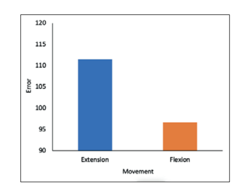
Figure 6. Plot showing the main effect of movement.

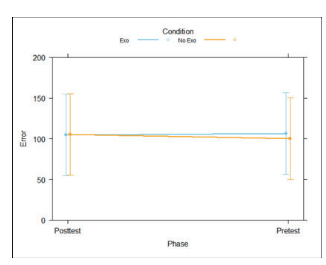
Figure 7. Plot showing the interaction effect between condition and phase.

No difference in posttest.
Difference in pretest, $p = .001$.
Pretest–Exo: $M = 106.60$
Pretest–No Exo: $M = 99.95$

No difference in vertical.
Difference in horizontal, $p < .001$.
Horizontal–Extension: $M = 125.30$
Horizontal–Flexion: $M = 96.27$

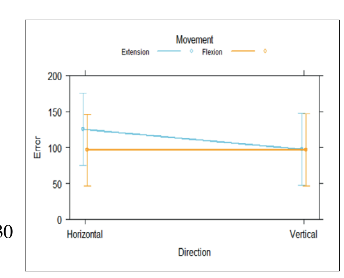
Figure 8. Plot showing the interaction effect between direction and movement.

Discussion

Condition, direction, and movement were significant predictors of accuracy.
- Less accurate when wearing an exoskeleton
- Less accurate when pointing along a horizontal line
- Less accurate during an extension movement

Though there was no difference between pre-test and post-test, there was an interaction between condition and phase.
- Accuracy was higher without the exoskeleton during the pre-test phase
- No difference in the post-test phase

The interaction effect between direction and movement suggests that accuracy is lower when pointing away from the body.
- Accuracy was lower when extending to point along a horizontal line
- No difference between movements when pointing along a vertical line

Wearing an exoskeleton decreased accuracy on the blind-pointing task.

Accuracy tends to decrease when performing tasks that are farther away from the body.

Future research will examine how including a weight can impact pointing accuracy when wearing an exoskeleton. Additionally, future work should consider varying the nature of the task as well as including a sample representative of the population of likely users in terms of age, occupation, etc.

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Travel support was provided by the Clemson Human Factors Institute.

Active patterns in relationship perception: a modified transposition task with multidimensional stimuli

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Introduction

- In standard transposition task (STT), relationship perception (RP) has been studied training subjects to respond to one stimulus of a pair according to a multidimensional relational criterion involving two relevant dimensions: "bigger and darker than" (Andrade et al., 2020; Reese, 1968).
- Under STT, correct responses and latencies are the only evidence to focus on, leading to mediational explanations of RP (e.g., abstraction process; Okamoto & Okuno, 1958). This perspective has been criticized for its simple stimuli array and because it neglects other factors like the role of behavioral active patterns (Andrade et al., 2020).
- Recently, León et al. (2021) found that in a multidimensional array with irrelevant dimensions (e.g., form, color) and a relevant one (e.g., size), mouse inspection over the screen was crucial to respond correctly. This pointed out the importance of spatial dimension of RP through inspection patterns and expanded the research scope with other possibilities of study how RP establishes.
- In order to further characterize the spatial dimension of RP, traveled distance and straightness index could be an adequate quantitative measures of it.

Objective

- In line with the above, the present work analyze active patterns in RP establishment when space is a relevant dimension under a multidimensional array in a modified transposition task based on Lazareva et al. (2018).

Method

Participants

- 14 human adults between 22 and 28 years old.

Experimental setting

- One session per day was performed via remote control (using Chrome Desktop Remote).
- Experimental task was designed on Python and included mouse-tracking (5 fps).

Table 1.

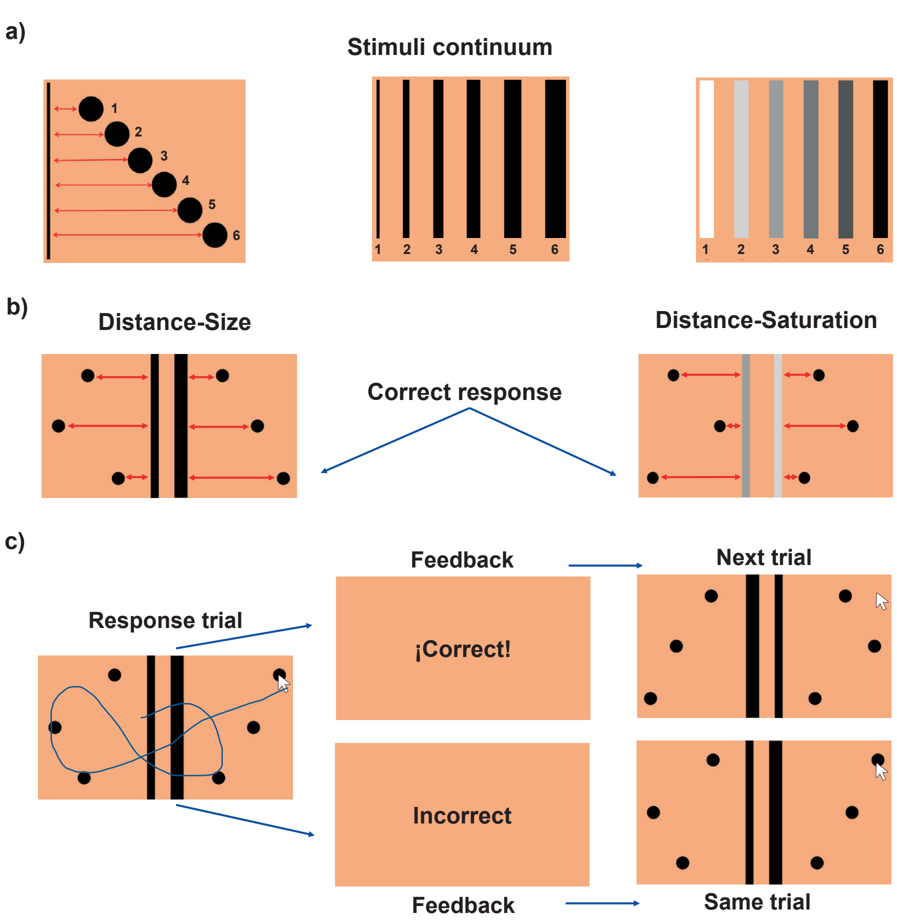
Experimental design.

Group	Training/Test
Distance-Size	Farther and bigger than
Distance-Saturation	Farther and darker than

Note. Groups were conformed by 7 subjects each. For both groups training consisted in 6 sessions of 18 corrective trials each (maximum of 5) with feedback and test consisted of a single session of 18 non-corrective trials without feedback.

Figure 1.

Stimuli continuum and examples of trials for each group.

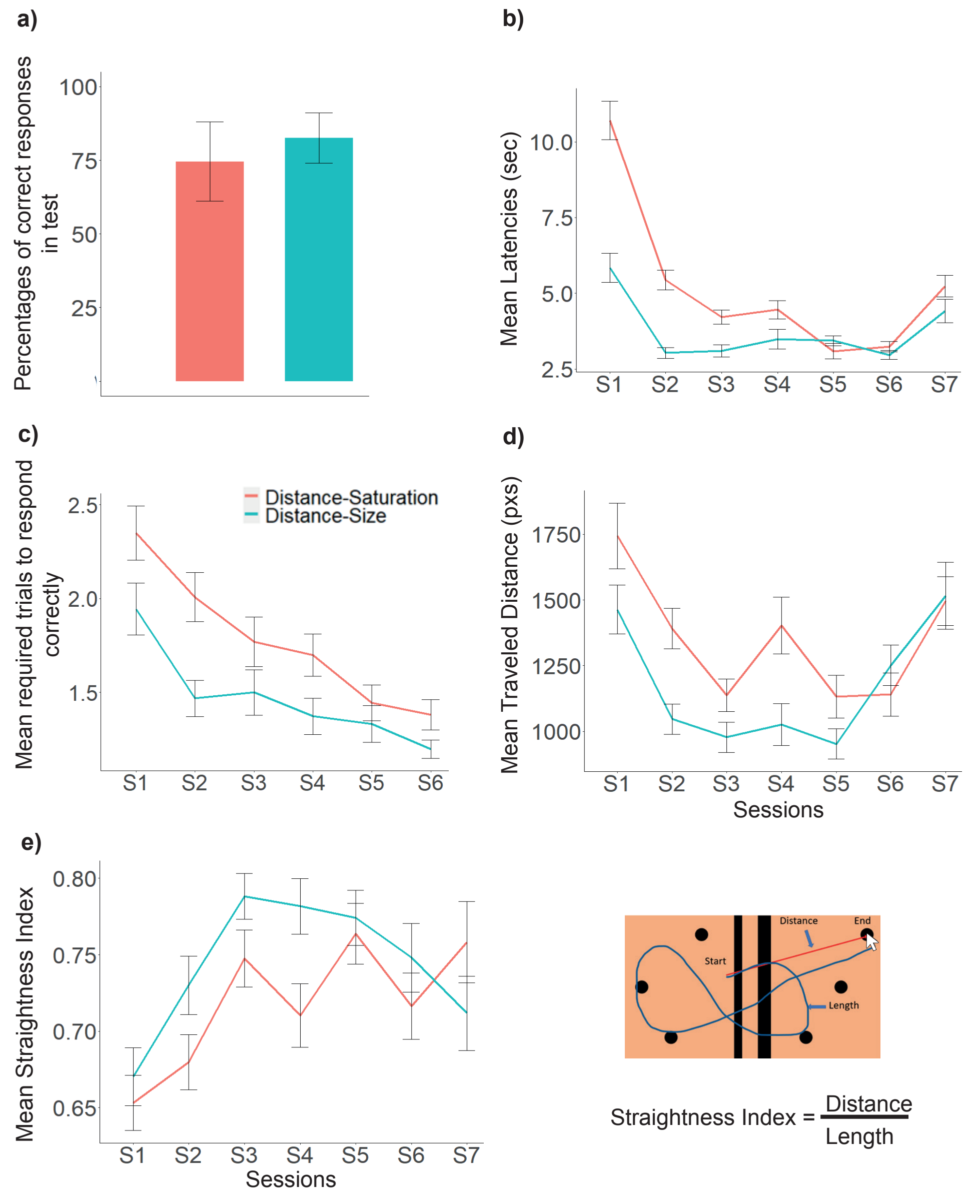


Note. **a)** Stimuli continuum employed, **b)** examples of trials for each group and **c)** sequence of events during training.

Results

Figure 2.

Results of experiment.



Note. **a)** Percentages of correct responses in test, **b)** mean latencies (sec), **c)** mean required trials to respond correctly, **d)** mean traveled distance (pxs) and **e)** mean straightness index and its illustration of how is calculated. For all plots, the error bars show standard error.

Conclussions

- The present task allows the study of RP establishment in a multidimensional stimuli array with two relevant dimensions where space is one of them.
- It was more difficult to identify correct stimuli with saturation as a relevant dimension than with size. This is consistent with findings in the area with STT (Jackson, 1939) and with a modified transposition task (León et al., 2021) in which RP establishment is more hindered with saturation as a relevant dimension than with size (Andrade et al., 2020, Jackson, 1939).
- The present study shows that traveled distance and straightness index are adequate measures to analyze and characterize directionality quality of active patterns.
- The differences in active patterns show that RP establishment was different between groups and provide evidence that active patterns are crucial for perceiving relations (i.e., RP is directly link to action).

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The implications of potential-effective stimuli in James Gibson's ecological psychology: One hypothesis and issues

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Question

What is the basis for James Gibson's claim of environmental richness?

His main argument–direct or action-based perception–can be derived without much emphasis on environmental richness.

This study summarizes the working hypotheses by organizing existing findings.

Conclusion

Gibson's claim of environmental richness seems to have been influenced by his view of stimuli through perceptual learning studies with Eleanor Gibson.

Three tasks need to be analyzed in future studies.

Details

1. The potential-effective diagram underlies Gibson's ecological approach

References to environmental richness

Gibson claims that the environment is rich and inexhaustible.

"But note also that the environment as a whole with its **unlimited possibilities** existed prior to animals. (1979, p.128)"

"The information in ambient light, along with sound, odor, touches, and natural chemicals, is **inexhaustible**. A perceiver can keep on noticing facts about the world she lives in to the end of her life without ever reaching a limit. (1979, p.242)"

"The environment, so considered, would consist of **a sort of reservoir of possible stimuli** for both perception and action. Light, heat, sound, odor, gravity, and potential contacts with objects surround the individual...The variables and covariables and invariables of this stimulus environment are **inexhaustible**. (1960, p.701)"

" Woodworth must have had **some idea of a reservoir of potential stimulation** in the light and sound which fill the world around us, for it is a prerequisite of his argument that perception is fundamentally exploratory. (1958, p.43)"

The potential-effective diagram

Gibson's claims about environmental richness, such as those mentioned above, are often discussed using the potential-effective diagram.

"What I call ecological optics is concerned with the **available** information for perception and differs from physical optics, from geometrical optics, and also from physiological optics. (1979, p.47)"

"In short, whether or not **a potential stimulus becomes effective** depends on the individual. (1960, p.701)"

The potential-effective diagram as the basis of Gibson's ecological approach

Gibson's potential-effective diagram leads to the concepts of ambient optic array and perceptual/visual system.

"The active system of visual perception was **a necessary consequence** of Gibson's understanding of the potential effectiveness of the optic array. (Lombardo, 1987, p.263)"

Gibson's claims on environmental richness are, therefore, considered the key concepts underlying his ecological approach. **How did Gibson develop the idea of environmental richness? What is the basis of this claim?**

2. Perceptual learning studies as the basis of the potential-effective diagram

Studies on perceptual learning (in collaboration with Eleanor Gibson (1955) and the wine differentiation study (unpublished)) are important to understand Gibson's emphasis on environmental richness, along with works on Ganzfeldt, comparative anatomy by Walls, and theoretical works.

"I shall instead review a series of experiments undertaken by the Gibsons that gave this theory of **perceptual learning** life, and also raised serious questions about the nature of perceptual activity, which were eventually to undermine the entire psychophysical approach to perception.(Reed, 1988, p.186)"

"Although he had begun to work on a new book about all the senses, tentatively entitled The World and the Senses...he had not clarified **the difference between available and obtained stimulation**. (Reed, 1988, p.195)"

"Even in the 1950s one area of concern where Gibson's thinking sounds ecological is **perceptual learning**.(Lombardo, 1987, p.240)"

3. Future tasks

How did Gibson's views of the environment change through perceptual learning study? Future studies should analize the following:

1) What were the characteristics of Eleanor Gibson's perceptual learning research. Particularly, how did Eleanor discuss the concept of "differentiation?"
2) What did James and Eleanor's joint study reveal?
3) How did James' view of the environment change after the joint study?

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A classification algorithm for quantifying behavioral performance in a free operant response-restraint task

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1.- Background

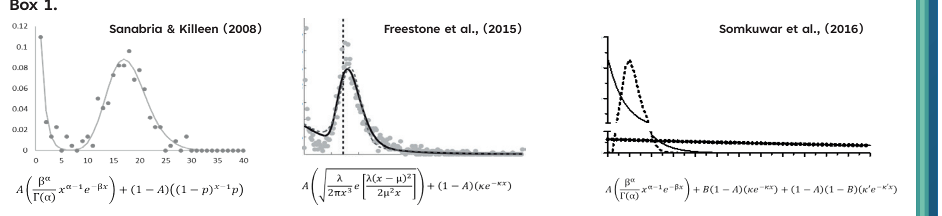
Response Inhibition refers to the capacity to suppress an otherwise prevailing behavioral activity (Sosa, 2022), either prior (response restraint) or following (response cancellation) its initiation.

Differential reinforcement of low rates (DRL) is a useful method to assess response restraint capacity that require agents to wait a specified amount of time and then perform a specific response to earn a reward (Wilson & Keller, 1953).

Inter-response times (IRTs) distributions from DRL protocols consist of fairly regular patterns that can be characterized mathematically through the use of model-fitting techniques (see Box 1).

However, model-fitting techniques demand a large number of IRTs in order to obtain performance indices from DRL tasks, impairing the possibility to examine behavioral fluctuations within short time frames. The latter entails being able to estimate those indices from relatively few datapoints.

Box 1.



2.- Objectives

1. To explore the suitability of a novel classification method that extracts local performance indices from IRTs in a DRL task as a means of conveying information about behavioral traits and states.
2. To explore the sensitivity of a novel sliding-window technique in detecting behavioral tendencies along the duration of a session.

3.- Methods

Subjects and Instruments. We trained 36 rats in a DRL task using an automated computer-to-conditioned-chamber interface for reward delivery and data collection.

Procedure. Training started with a 3 s waiting requirement, which was then increased to 7 s and finally set to the target waiting requirement of 15 s.

All rats underwent 28 (60 min) daily sessions of training with the target 15 s DRL task (see Figure 1), until performance was stable (i.e., when the average of a cost-weighted reward obtention metric ceased to increase).

Then, all rats' performance was assessed for 4 (40 min) sessions in the target DRL task via a classification algorithm (see Figure 2) implemented with R.

We administered two cognitive-enhancing drugs (methylphenidate and modafinil) for 5 days and explored the temporal profile of their effects on behavior. This required conducting a sliding window analysis, depicted in Figure 3, within each sessions' (already classified) data-points using a window length of 8 min and slide length of 20 s, and then contrasting conditions (before, during, and after the drug) and groups by each window.

Figure 2. Classification algorithm

Figure 1. Automated behavioral protocol

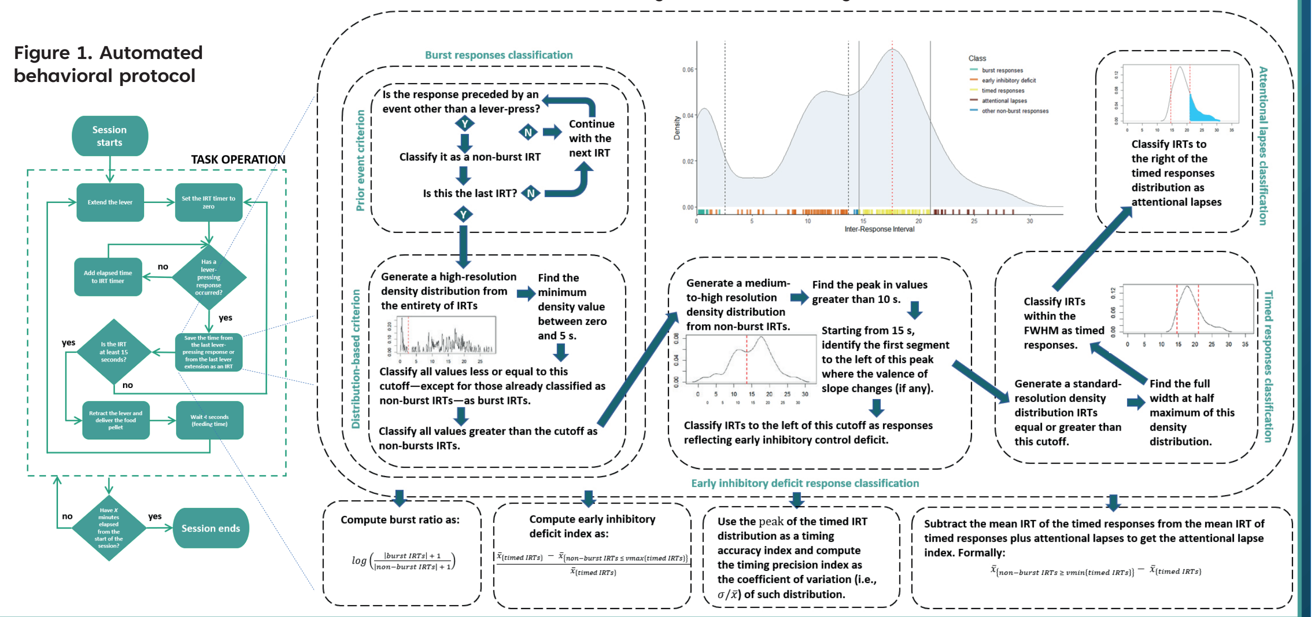
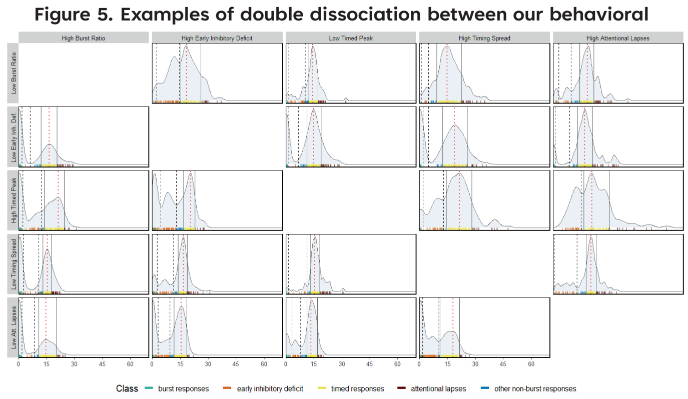


Figure 5. Examples of double dissociation between our behavioral



4.- Results and Discussion

The validity of our local behavioral indices is supported by their (cross-sectional and longitudinal) correlation to the more well-established global indices (see Figure 4).

The reliability of the local behavioral indices is supported by their relative within-subject stability (which is quantified by the intraclass correlations; see Figure 4).

The statistical independence of local behavioral indices is backed up by cases of double dissociation (see Figure 5). This means that there are situations where there is a favorable value in one behavioral index and an unfavorable value in another, or the other way around. These occurrences further support the idea that the indices are independent of each other.

Our classification algorithm allowed to generate behavioral indices in relatively narrow time-frames for tracking short-lived drug effects (see Figure 6).

Our approach is a viable alternative to model-fitting techniques to obtain performance indices from DRL data.

To the best of our knowledge, this is the first study reporting the psychometric properties of performance indices from DRL data.

Our classification algorithm in combination with our sliding window technique can be useful in both theoretical and translational research; for example, for studying the dynamics of the behavioral organization and short-lived effects of pharmacological treatments, respectively.

It should be noted that, as any classification system, our algorithm is vulnerable to misclassification; this might be remediated by either increasing the sampling space or augmenting its capacities with a supervised learning overlay.

Figure 3. Sliding window analysis

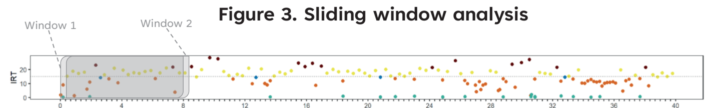


Figure 4. Cross-sectional, longitudinal, and intra-class correlations

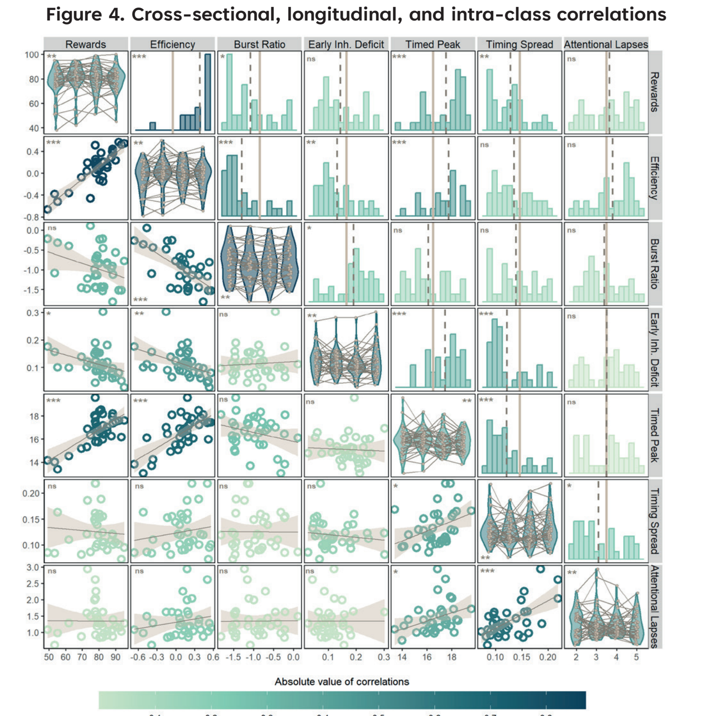
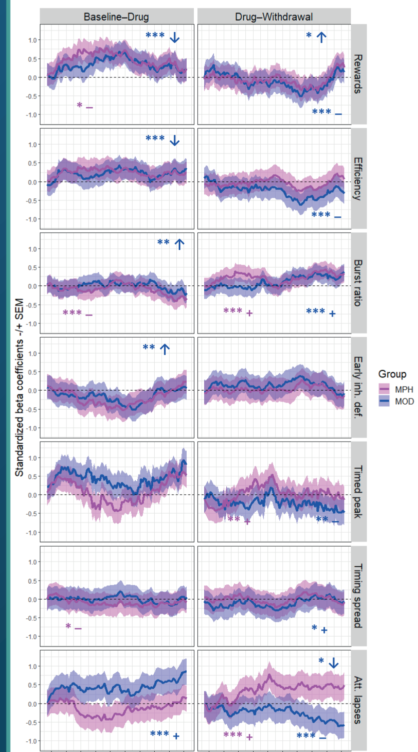


Figure 6. Behavioral patterns through time upon cognitive-enhancement drug administration



Note: Color-Coded annotations in the upper half of each panel denote whether significant effects of drug administration or withdrawal were found in session-wide phase x group contrasts (using conventional statistical significance nomenclature and arrows to denote whether decreases or increases were observed). Annotations in the bottom half of each panel denoted whether a positive (+) or negative (-) within-session slope was obtained when assessing three-way phase x group X window interactions.

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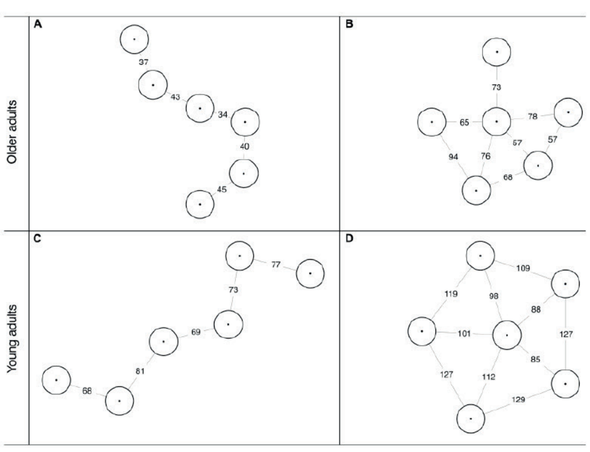
Chosen stepping-stone configurations depend on task constraints

Maisha Tahsin Orthy[1], Tyler Duffrin[1], Amy M. Jeschke[2], Jeffrey B. Wagman[1], & Rob Withagen[2]

Architectural or playground features tend to be standardized…

…but people differ in both action capabilities and intentions

Jeschke et al. (2020) found that people with different action capabilities make different stepping-stone configurations…



…older adults created smaller gaps (but same level of challenge) as younger adults

We investigated whether people with different **intentions** make different stepping- stone configurations

EXPERIMENT 1

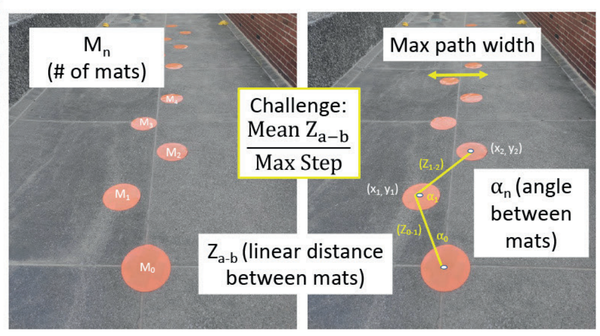
Participants created a stepping path with rubber mats to cross an outdoor space…

…as **carefully** as possible
…as **comfortably** as possible, and
…as **quickly** as possible.

METHOD

Participants could use up to 12 mats to make the path and could readjust the position of each mat after trying out the path

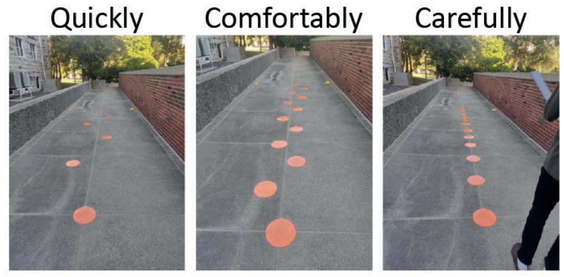
Among other variables, we measured:



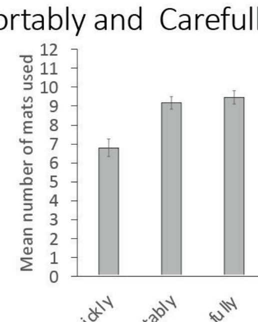
RESULTS

Representative paths created:

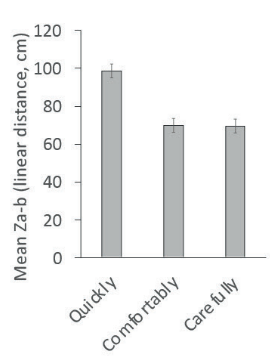
Quickly Comfortably Carefully

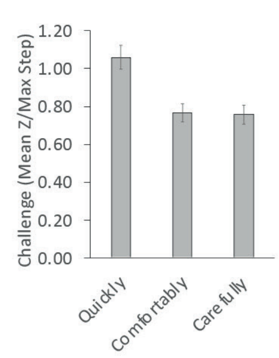


Fewer mats used in Quickly than in Comfortably and Carefully and…



Longer (linear) distances between mats and greater Challenge for mat distances in Quickly than in Comfortably and Carefully





EXPERIMENT 2

Participants created a stepping path with rubber mats to cross an indoor space…

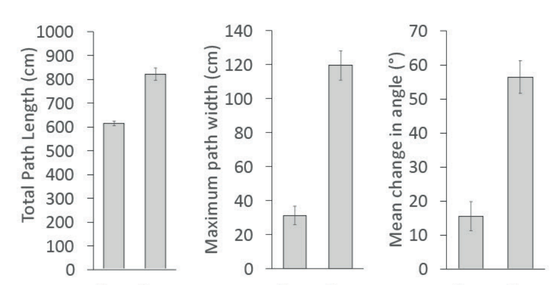
…that would be **fun** to cross
…that would be **easy** to cross

Representative paths created:

fun **easy**

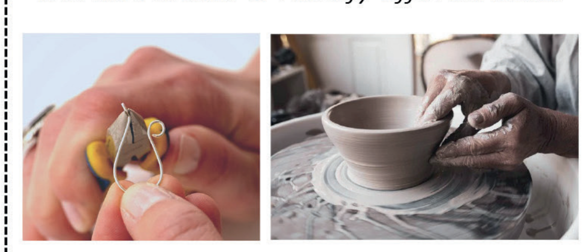
As in Experiment 1, there were differences in # of mats used, linear distances, and Challenge, but also in…

…total path length, max path width, and mean change in angle between mats…



DISCUSSION

Animals perceive and act on affordances, but also *create or modify affordances…*



…and they do so differently in the context of different intentions

Performing any behavior requires choosing the initial conditions that guarantee the intended final condition

It requires creating the circumstances under which the goal is achieved

TOWARDS A THEORY OF ECOLOGICAL RESILIENCE

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UCONN | UNIVERSITY OF CONNECTICUT

Understanding the thermodynamic processes that predict an organism's ability to survive and adapt to dynamic forces in terms of first principles

BACKGROUND & DEFINITIONS

RESILIENCE: In living systems, resilience is here defined as ***the ability of a system to recover and endure in the face of disrupting forces via maintained relationships,*** in such a way as to maintain global stability. Resilience is crucial to surviving and thriving in a dynamic world.[2]

HOMEODYNAMICS: The view that biological systems are fluid-plastic-elastic systems operating away from equilibrium, and governed by dissipative, thermodynamic processes with varying time delays between inputs and outputs. In such systems complexity is measured by the ratio of bulk to sheer viscosity.[4, 6]

NETWORK PHYSIOLOGY: The interdisciplinary study of complex spatiotemporal interdependence of vertically and horizontally integrated systems governing both function and state of the organism.[1]

PROBLEM STATEMENT

» Theories of resilience from traditional psychology have been somewhat contentious and inconsistent, due to lack of unified theory and systems ontology.[3] In medicine and physiology, psychosocial factors are largely overlooked.

» Network physiology is based on the same thermodynamic principles as homeokinetic/homeodynamic theories previously embraced by ecological psychology may offer new insights into perception-action.[1]

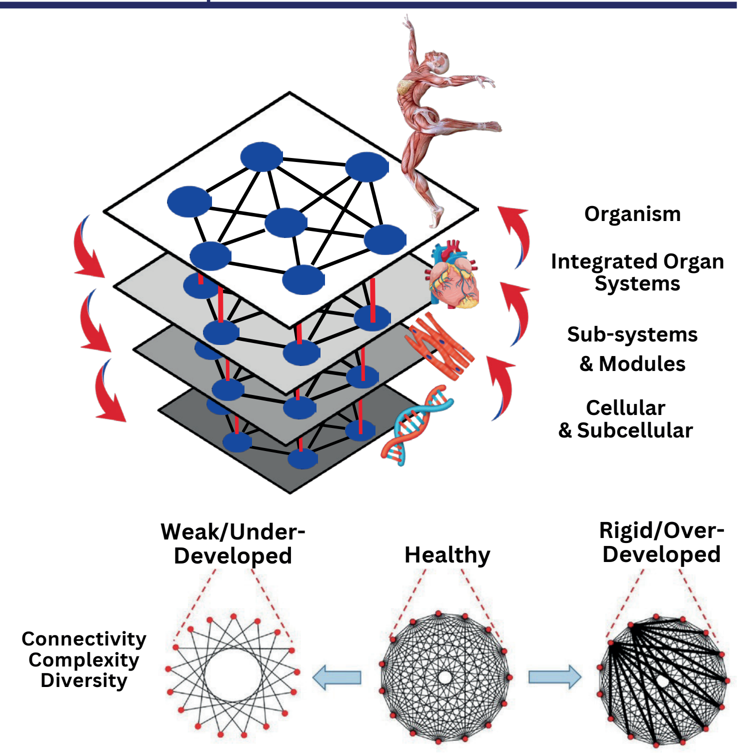
» A growing body of research suggests changes in the dynamics of oscillatory systems, can have profound effects not only on mental and physical health, but also perceptual abilities & motor control.

» Agency and intentional control require stability and flexibility.[5]

RESILIENCE IN DYNAMICAL SYSTEMS

Krakovska and colleagues[2] proposed multiple parameters from engineering and ecology research to be used in interdisciplinary research. We propose to apply these parameters in modeling and investigating the dynamics of human resilience.

PROPOSED PARAMETERS	
Distance to Bifurcation	How far from criticality an attractor state is perched
Resistance	How open the system is to a transfer of energy or information
Elasticity	How quickly the system returns to stability after perturbation
Persistence	How long/how much perturbation the system can tolerate before failure
Rate Induced Tipping	How much time variation the system tolerate before nonautonomous instabilities arise



TOP: Conceptual diagram of vertically and horizontally integrated physiological networks From an ecological perspective.
BOTTOM: Underdeveloped networks lack stability, but rigidity and inflexibility tends to emerge when they become too robust, leading to increased vulnerability. A healthy amount of "flee & dwell" dynamics in metastable systems supports flexibility and autonomy. (Adapted from Balagué et al., 2020)

RESEARCH QUESTIONS

1.) Does physiological network stability/flexibility predict psychosocial resilience?

2.) Intrapersonal: Are there characteristic bodily responses to perceptual, cognitive, environmental, or social demands that relate to adaptive performance and psychosocial resilience?

3.) Interpersonal: Is the body's response to both social and environmental rhythms related to stability of emotions, relationships, or group cohesion?

4.) Can we use insights from the resilience of dissipative systems to craft more effective interventions?

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SCAN ME

The nonlinearity of pupil diameter fluctuations in an insight task as criteria for detecting children who solve the problem from those who do not

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Introduction

Insights are an intriguing phenomenon in problem-solving research that occur when people suddenly discover the only possible solution after unsuccessfully trying to solve a problem while expressing astonishment (Chu & MacGregor, 2011). The group of Dixon and collaborators sought to approach insight from a perspective linked to dynamic systems (Dixon et al., 2010). This approach offers an ecological view in which cognition is context-dependent and Insight would be a self-organizing behavior that emerges from the coupling of perceptual-motor processes during phase transitions (Kelso, 1995).

This conjecture emerged after they observed two features in the dynamics of behavior linked to self-organizing physical and biological systems: a peak in entropy and a sharp manifestation of 1/f noise, both just before discovering a new and effective solution to gear system task (Stephen & Dixon, 2009).

Importantly, one criticism to these results is that the Gear System task lacks the characteristics of a real insight problem. Specifically, a phase known as impasse. Because of this, the Gear System task is classified as a pseudo-insight task, limiting the applicability of Dixon's findings to real insight tasks.

We explored if entropy fluctuations and fractal scaling can differentiate children who solve an insight problem from those who do not. We used the 8-coins task, considered a real insight problem task (Öllinger et al., 2013) and analyzed the pupillary diameter fluctuations of participants; measure associated with insight (Salvi et al., 2020; Mathôt, 2018).

Method

67 children between 6 and 12 years old (M=9.39; SD=1.53) tried to solve 8-coin problem (Öllinger et al., 2013). Pupillary diameter fluctuations of children were registered, and Recurrence Quantification and Power Spectrum Density analyses were used to estimate Entropy, Determinism, Recurrence Ratio, and the β scaling exponent.

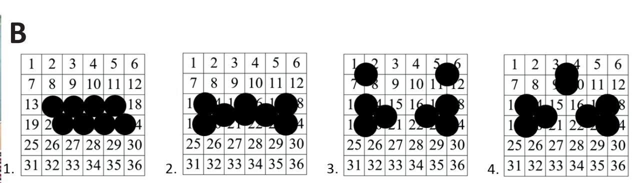

Figure 1: Panel A shows the participant using the Tobii Eye Tracker X2-60 eye tracking device when is solving the 8-coins task on the platform. Panel B depicts 4 configurations of the 8-coins task. (1) 2D-Grouped; (2) 3D-Grouped; (3) 2D-Ungrouped and (4) 3D-Ungrouped

Results

Two groups were formed depending on who solved the task. We calculated Entropy (ENT), Recurrence Ratio (RR), determinism (DET), and Beta Scaling Exponent (β), for each participant in the last 56 windows, each lasting around 10 seconds, with an 8-second overlap with the next window. A mixed ANCOVA was used to analyze the data, with the group solvers versus no-solvers being the between-subjects factor and the fifty-six windows being the within-subjects factor. The model included children's age as a covariate (*Figure 2*).

Regarding ENT (Panel A), the solver group had a lower average than the no-solver group ($F(1,64)=10.271$; $p=.002$; $\eta p2=.138$). There was also a significant group-windows interaction effect ($F(55,3520)=2.960$; $p=.000$; $\eta p2=.044$), indicating that children who solved the problem had lower ENT than those who did not, specifically in 24 windows, from 47 to 39 and from 25 to 11. The analysis did not reveal any effect of children's age on ENT or windows or any significant windows-age interaction.

Regarding DET (*Panel C*), a significant group-windows interaction effect was detected ($F(55,3520)=1.959$; $p=.001$; $\eta p2=.030$). Solver group had lower DET than the not-solver group from window 22 to 18. Children's age was associated with DET ($F(1,64)=5.27$, $p=.025$). However, the analysis did not find any significant effects of groups, windows, or windows-age interaction.

In terms of RR (*Panel E*), the solver group had a lower average than the no-solver group ($F(1,64)=4.227$; $p=.044$; $\eta p2=.062$). There were no differences among windows and no significant windows-groups or windows-age interaction effects. Children's age had no significant effect on RR.

We examined the β scaling exponent (*Panel B*) and found that there were no significant effects related to children's age, group, windows, windows-group interaction, or windows-age interaction. Furthermore, it is worth noting that the beta values observed in each window fell within a range of -1.7 to -2.0, close to the range associated with Brownian noise.

We analyzed the mean average and the average standard deviation of pupil diameter (*Panel D and F*, respectively). For the mean average (*Panel D*), we found no interaction effect, and there were no significant differences among windows or between groups. The children's age, as a covariate, had no effect. The average standard deviation of pupil diameter, we found that the solver group had a higher average than the no-solver group ($F(1,64)=26.104$; $p=.000$; $\eta p2=.290$). However, no interaction effects were observed, and there were no significant differences among windows. The children's age, as a covariate, had no effect.

Figure 2: Comparisons of the last 120 seconds of those who did and did not solve the task on different metrics. These metrics were computed in overlapping windows of 500 data points, moving 100 data points at each step. The vertical lines represent the standard error.

Discussion

The most important finding occurs between seconds 58 and 30, where an entropy peak was appreciable in the group that solved the problem. The pupil of this group that exhibited greater randomness, which was accompanied by less predictability in the measure. This finding is consistent with the hypotheses put forward by Dixon et al. (2010).

Contrary to expected, the Beta scaling exponent (β) of groups did not differ throughout the windows. In fact, β scaling exponent of both groups moved systematically in the Brownian noise spectrum, far from 1/f pink noise. It is possible that the 8-coin task induced a different type of variability in pupil diameter fluctuations, which may reflect the unique cognitive demands of this task.

Conventional statistics failed to detect significant differences between groups at specific windows. The advantages of Recurrence Quantification Analysis (RQA) in these cases are clear.

Evidence suggest that human beings (in this case, children) may experience the self-organization of a novel and effective response pattern during the resolution of insight tasks

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RDC thanks the Agencia Nacional de Investigación y Desarrollo (ANID) for its support through the FONDEQUIP EQM190153 and FOVI210047 grants; and Programa de Investigación Asociativa (PIA) en Ciencias Cognitivas de la Universidad de Talca. FM-R would like to thank ANID for its support through the FONDECYT INICIACION Grant # 11190742. DM-B would like to thank ANID for its support through the Doctorate Scholarship FONDECYT-ANID Grant # 21220612. SV-P would like to thank ANID for its support through the Doctorate Scholarship FONDECYT-ANID Grant # 21231638.

International Conference on Perception and Action ICPA2023
POSTER SESSION 02

Longitudinal observation of the arrangement of a nursery room

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ABSTRACT

According to Gibson (1979), environments have a nested structure and cannot be described within a permanent and hierarchically intermittent framework. The fact that the posture is functionally nested reflects this environmental structure. In this study, we report on the evolution of the layout of a nursery room over approximately one year, focusing on the description of the environment according to the aforementioned views. A nursery is a place occupied by children and their caregivers that contains various objects such as daily necessities, toys, furniture, clothes, and many other things. Some of these objects are moved back and forth throughout the day, from day to day, or from season to season, while others are rarely moved throughout the year. Moreover, some objects are not moved by children but by adults. These room layout modifications are influenced by the size and height relationships between the people carrying the objects and the objects being carried, as well as the tasks that result in the rearrangement.

We collected a year's worth of photo data documenting the layout of nursery rooms containing different objects and attempted to describe "place" in terms of the patterns of object movement. Based on these data, we discuss the 'perception of place' that animals may experience as they habituate to a particular part of their environment.

RESEARCH QUESTION

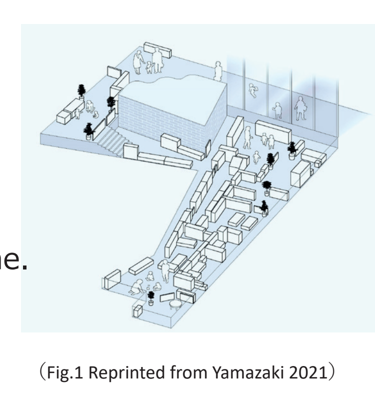
- What is the nature of the structure of the environment to which the posture relates?
- Related to Gibson's ideas on posture and movement and nested structure theory of posture (Reed, 1988).
  - The nested structure of ambient optical arrays is established by surfaces in the environment.
  - Posture is considered to be dynamically nested.
  - The layout of the surface has such characteristics that relate to the dynamic nature of the posture.
- Can we describe the dynamic nesting of environments in terms of ecological psychology?
- Can we describe a place by the way things move?

LITERATURE REVIEW

1. The layout of a nursery room was divided into three categories based on the height of infants: those that can easily be sat on or stepped over, those that can be seen beyond but require turning around when moving, and those that block the view, and the extent to which these changed over the year was examined (Yamazaki, 2021).
   →The dynamic nature of the environment confronting the posture is not included in the study.
2. Focused on attempts to describe the dynamics of plant and animal ecology.
   - Animal behavior
     Classification of movement patterns such as settlement, migration, and nomadism (Mueller & Fagan, 2008)
   - Plant ecology
     Describing transition mechanisms such as dispersal, invasion, establishment, competition, and tolerance
3. Place（Gibson, 1978)
   - "What you can see from here and hereabouts"
   - Not separated from adjacent places by clear boundaries
   - How is knowledge of the habitat acquired by locomotion and by place learning?
   - Place is a nested component of habitat

METHODS

- Location: Nursery school building and entrance area where a total of 43 children aged 2–5 years (Fig 1).
- Data: Photographs collected bi-weekly over a period of 9 months; approximately 250 photographs taken at one time.
- Analysis: Based on the collected photographs, the longitudinal movement of objects was examined.



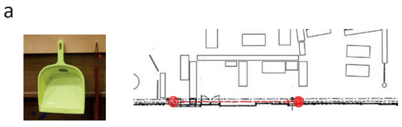
（Fig.1 Reprinted from Yamazaki 2021）

RESULTS AND DISCUSSION

Over the course of nine months, objects were moved around the room in various ways by the children and their teachers. During the observation period, some objects disappeared or were put away and hidden. The way things are moved includes three types

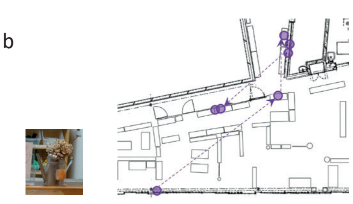
- Becoming settled
- Unsettled
- Becoming settled but never settled

a



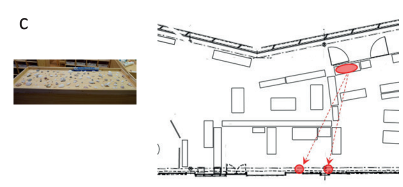
Dustpan. Going back and forth between the two locations. Replaced by a similar one during the course of observation.

b



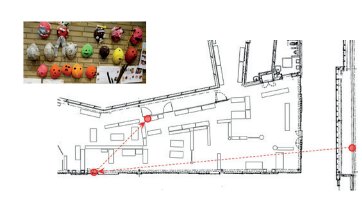
Vase. Repeatedly moving within a certain narrow area, sometimes moving away from.

c



Shells. Placed in one group, but moved in two groups along the way, then settled.

d

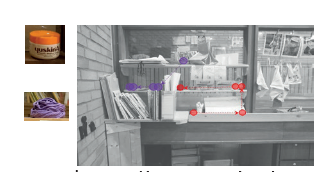


Masks (crafted). Large migratory movements over a very large area, becoming unobservable in the 6th month.

e

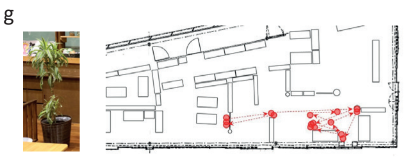
Post (toy). Moves quite far across the zone during the course of observation and cannot be seen in the 5th month.

f



Hand cream and rope. Keeps moving in a small area and does not settle on one spot.

g



Plant pots. They continue to move within a limited area consisting of adjacent zones.

Fig.2 Variation of moves

- Places are not necessarily determined only by immovable objects.
- Many of the non-static layouts result from the actions of animals with detached objects.
- Places are made up of things that are fixed, things that are non-stable, and things that are stable without being fixed.
- It is important for place perception to perceive the layout that constrains the movement of the non-stationary things.

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FUNDING This study was supported by JSPS KAKENHI Grant Numbers:22H00988

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