Exploring Runners' Preferences of Drone Based Feedback to Support their Well-Being

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Background

- Running is a popular sport

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- There exists a wide-range of running interactive technologies to support runners during the activity [1,2,3]

Source: Strava

Source: Whoop

Source: Polar

Source: Stryd

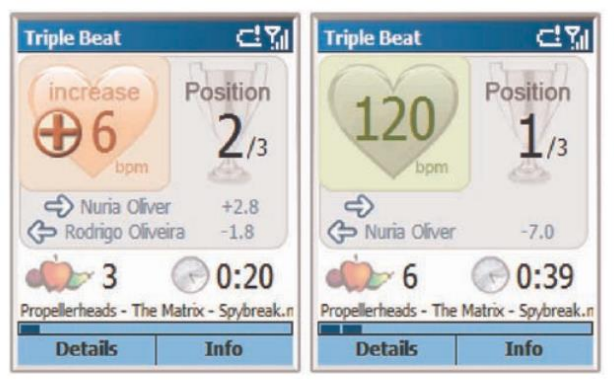
Source: XSens

Source: Zombies, Run!

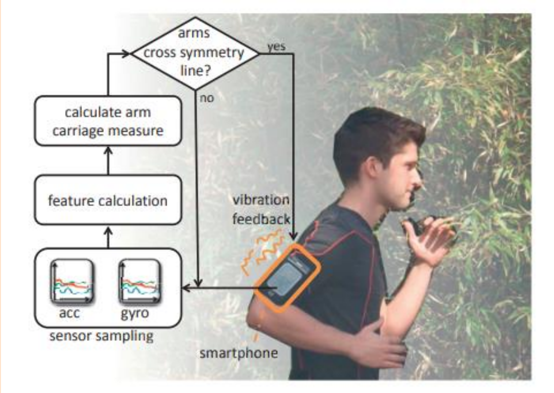
1. Christian A Clermont, Linda Duffett-Leger, Blayne A Hettinga, and Reed Ferber. 2020. Runners' perspectives on 'smart' wearable technology and its use for preventing injury. International Journal of Human–Computer Interaction 36, 1 (2020), 31–40.
2. Mark Janssen, Jeroen Scheerder, Erik Thibaut, Aarnout Brombacher, and Steven Vos. 2017. Who uses running apps and sports watches? Determinants and consumer profiles of event runners' usage of running-related smartphone applications and sports watches. PloS one 12, 7 (2017), e018116
3. Monika Pobiruchin, Julian Suleder, Richard Zowalla, and Martin Wiesner. 2017. Accuracy and Adoption of Wearable Technology Used by Active Citizens: A Marathon Event Field Study. JMIR mHealth and uHealth 5, 2 (Feb. 2017), e24. https://doi.org/10.2196/mhealth.6395

Background

- Running is a popular sport
- There exists a wide-range of running interactive technologies to support runners during the activity
- Most of them do not provide real-time feedback however those that do, help provide very minimal feedback that support performance and prevent injuries [1,2]



Source: De Oliveira, R., & Oliver, N. (2008). TripleBeat. MobileHCI '08.



Source: Christina Strohrmann, Julia Seiter, Yurima Llorca, and Gerhard Tröster. 2013. Can Smartphones Help with Running Technique?

1.Bas Van Hooren, Jos Goudsmit, Juan Restrepo, and Steven Vos. 2019. Realtime feedback by wearables in running: Current approaches, challenges and suggestions for improvements. Journal of Sports Sciences 38, 2 (Dec. 2019), 214– 230. https://doi.org/10.1080/02640414.2019.1690960
2.Fereshteh Amini, Khalad Hasan, Andrea Bunt, and Pourang Irani. 2017. Data representations for in-situ exploration of health and fitness data. In Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare. ACM, New York, NY, USA, 163–172. https://doi.org/10.1145/3154862. 3154879

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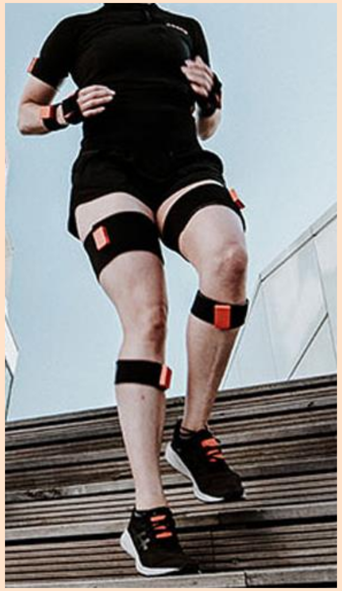
- There exists a wide-range of running interactive technologies to support runners during the activity
- Most of them do not provide real-time feedback however those that do, help provide very minimal feedback that support performance and prevent injuries
- Those that do provide real-time feedback require sensors attached to the runners

Source: MathWorks Blog



Source: XSens

Background

However, runners would like real time feedback that would help **improve their performance** and **prevent injuries** without being **unencumbered** [1,2]

1.Bas Van Hooren, Jos Goudsmit, Juan Restrepo, and Steven Vos. 2019. Realtime feedback by wearables in running: Current approaches, challenges and suggestions for improvements. Journal of Sports Sciences 38, 2 (Dec. 2019), 214– 230. https://doi.org/10.1080/02640414.2019.1690960
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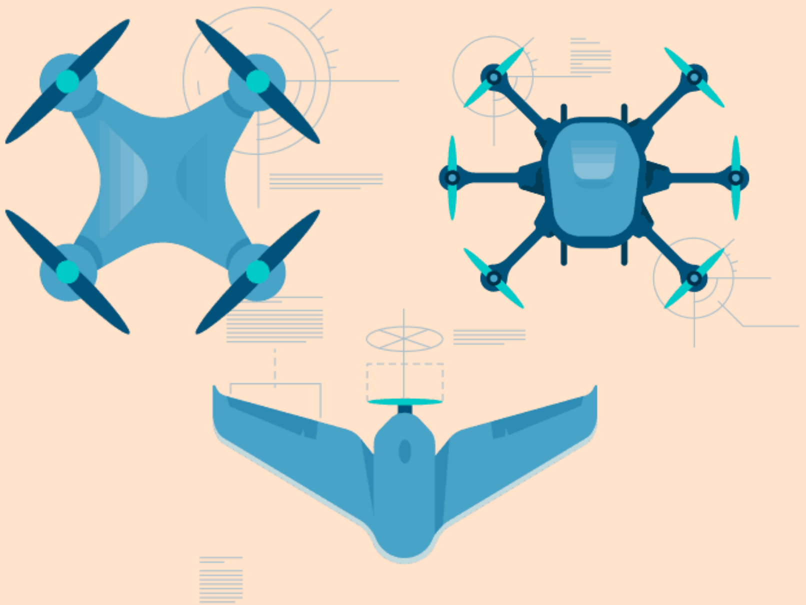
Background

- Drones show potential to fill this gap as earlier works have showcased the potential of drones to support exertion activities [1, 2]

Source: DJI



Source: UAV Coach

1. Viviane Herdel, Lee J. Yamin, and Jessica R. Cauchard. 2022. Above and Beyond: A Scoping Review of Domains and Applications for Human-Drone Interaction. In CHI Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3491102. 3501881
2. Dante Tezza and Marvin Andujar. 2019. The State-of-the-Art of Human–Drone Interaction: A Survey. IEEE Access 7 (2019), 167438–167454. https://doi.org/10.1109/access.2019.2953900

Background

- Drones show potential to fill this gap as earlier works have showcased the potential of drones to support exertion activities
- Existing limited work have shown examples of how drone motions, and drones with cameras speakers or projectors can provide runners with feedback [1,2,3,4]

Source: Mueller, F. "Floyd", & Muirhead, M. (2015). Jogging with a Quadcopter. CHI '15

Source: Romanowski, A., Wozniak, P. W., Mayer, S., Lischke, L., Grudzień, K., Jaworski, T., Kosizski, T. (2017). Towards Supporting Remote Cheering during Running Races with Drone Technology. CHI EA '17

1. Florian 'Floyd' Mueller and Matthew Muirhead. 2015. Jogging with a Quadcopter. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, 2023–2032. https://doi.org/10.1145/2702123.270247
2. Eberhard Graether and Florian Mueller. 2012. Joggobot: a flying robot as jogging companion. In CHI '12 Extended Abstracts on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, 1063–1066. https://doi.org/10.1145/2212776.2212386
3. Andrzej Romanowski, Sven Mayer, Lars Lischke, Krzysztof Grudzień, Tomasz Jaworski, Izabela Perenc, Przemysław Kucharski, Mohammad Obaid, Tomasz Kosizski, and Paweł W. Wozniak. 2017. Towards Supporting Remote Cheering during Running Races with Drone Technology. In Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, 2867–2874. https://doi.org/10.1145/3027063.3053218
4. Sven Mayer, Pascal Knierim, Pawel W Wozniak, and Markus Funk. 2017. How drones can support backcountry activities. In Proceedings of the 2017 natureCHI workshop, in conjunction with ACM mobileHCI, Vol. 17. Association for Computing Machinery, New York, NY, USA, 6.

Background

- Drones show potential to fill this gap as earlier works have showcased the potential of drones to support exertion activities
- Existing limited work have shown examples of how drone motions, and drones with cameras speakers or projectors can provide runners with feedback
- Developments in AI make it possible to analyse real time video sources to extract various running parameters [1]

1. Zhe Cao, Gines Hidalgo, Tomas Simon, Shih-En Wei, and Yaser Sheikh. 2021. OpenPose: Realtime Multi-Person 2D Pose Estimation Using Part Affinity Fields. IEEE Transactions on Pattern Analysis and Machine Intelligence 43, 1 (Jan. 2021), 172–186. https://doi.org/10.1109/tpami.2019.2929257

Background

There exists a gap that does not explore the **runners' preferences** for **feedback through a drone**

Specifically for drones that **functions as a coach**[1,2,3,4], which supports **runners' well-being during runs**

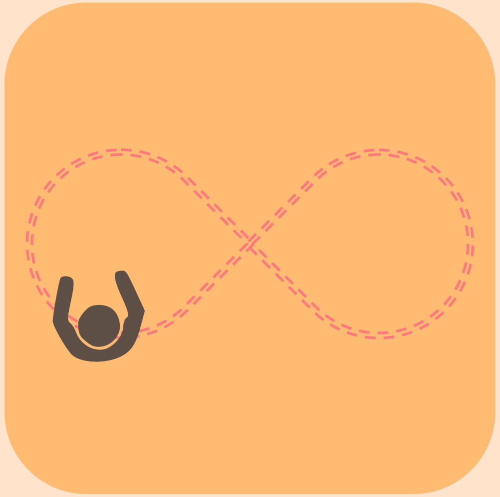
1. Honghao Deng, Jiabao Li, Allen Sayegh, Sebastian Birolini, and Stefano Andreani. 2018. Twinkle: A Flying Lighting Companion for Urban Safety. In Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction. Association for Computing Machinery, New York, NY, USA, 567–573. https://doi.org/10.1145/3173225.3173309
2. Florian 'Floyd' Mueller and Matthew Muirhead. 2015. Jogging with a Quadcopter. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, 2023–2032. https://doi.org/10.1145/2702123.2702472
3. Mohammad Obaid, Wafa Johal, and Omar Mubin. 2020. Domestic Drones: Context of Use in Research Literature. In Proceedings of the 8th International Conference on Human-Agent Interaction. Association for Computing Machinery, New York, NY, USA, 196–203. https://doi.org/10.1145/3406499.3415076
4. Matthias Seuter, Eduardo Rodriguez Macrillante, Gernot Bauer, and Christian Kray. 2018. Running with drones: desired services and control gestures. In Proceedings of the 30th Australian Conference on Computer-Human Interaction. Association for Computing Machinery, New York, NY, USA, 384–395. https://doi.org/10.1145/3292147.3292156

Research Question

How would runners like a drone to present **them real time feedback** on relevant running parameters to support their **well-being**?

Study Design

Runner Recruitment & Study Introduction



Experiential Activity

Reflection

Ideation

Study Design: Runner Recruitment

Runner Recruitment & Study Introduction

Pre-Study Participant Evaluation

The survey will take approximately 10 minutes to complete.
This form is meant to be filled by the participants who have selected a time slot to participant in the Explorative Study to Investigate Feedback and Design Requirements of a New Running Technology. The details collected in this survey will help set the parameters of the study and help us evaluate you as a runner.
To get an overview of the study please read the following information brochure: https://rb.gy/2itob7
Please ensure that you fill this out and read the information brochure before attending the study.

Note:

1. By completing this form you will not be providing the consent for participating in the study. The information we collect using this form will help set the parameters of the study and reduce the time you will spend participating on the day of the study .
2. The information we collect will be anonymized and stored following GDPR regulations.
3. If, under unknown circumstances, you do not appear for the study on the scheduled time slot, the data we collected using this form will be deleted after 48 hours. This will be done to ensure you have enough time to reach out to us in case you have to reschedule but could not earlier.

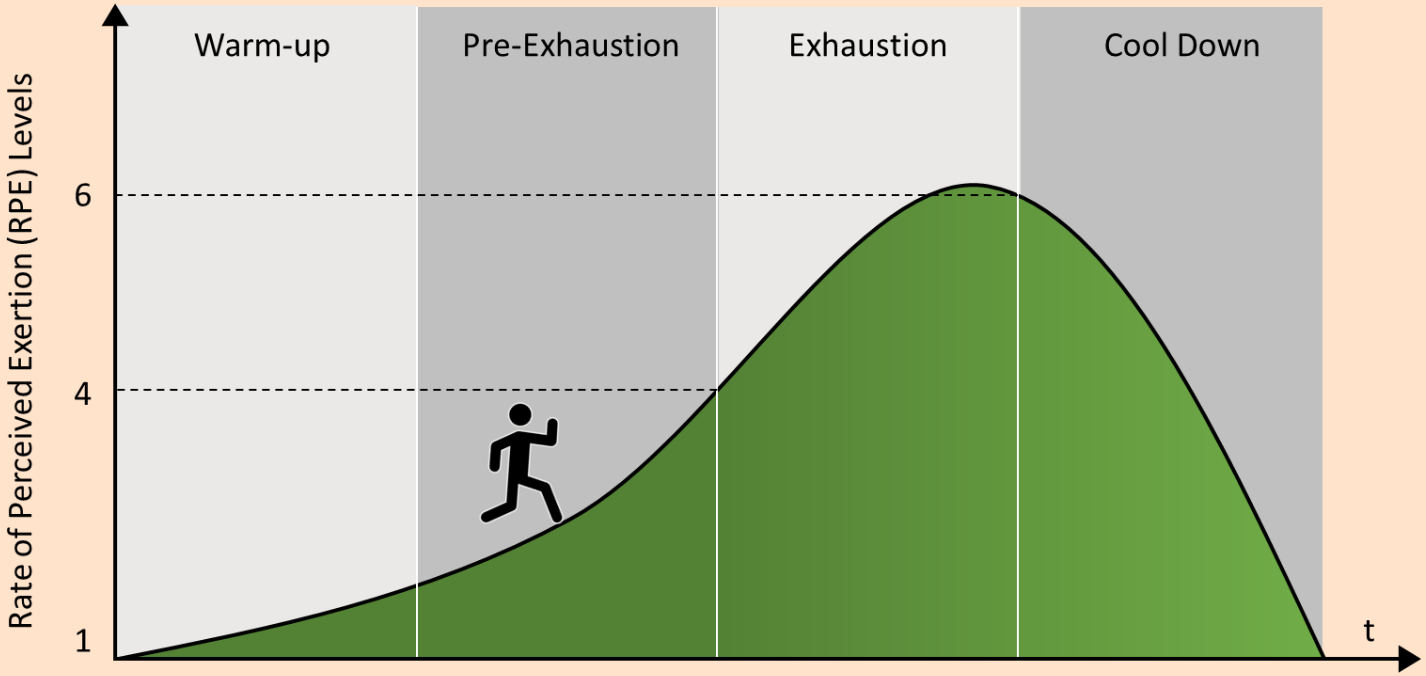
This form has two sections. The responses to some questions are mandatory. The responses that are mandatory can be identified by a *

If you have any questions related to this form please contact the researcher in charge of the study:
Aswin Balasubramaniam
a.balasubramaniam@utwente.nl

To assess their self-reported running activity levels and running motivation scales

Study Design: Study Introduction

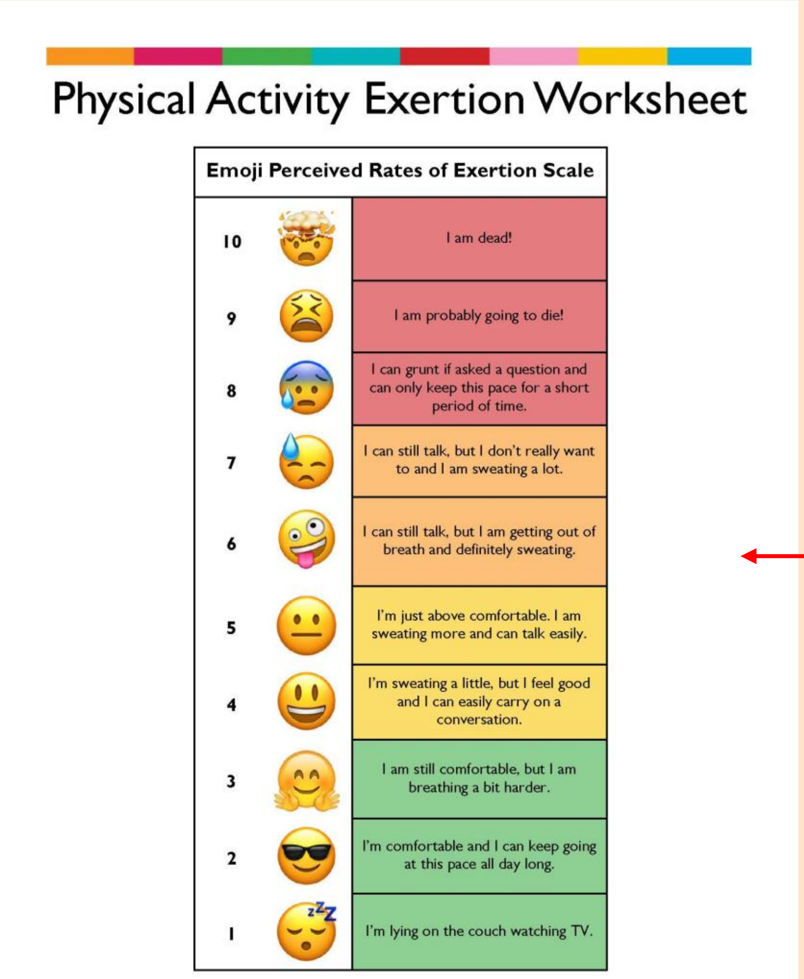
Runner Recruitment & Study Introduction



Recreated from: Florian 'Floyd' Mueller, Chek Tien Tan, Rich Byrne, and Matt Jones. 2017. 13 Game Lenses for Designing Diverse Interactive Jogging Systems. CHI Play

Study Design: Study Introduction

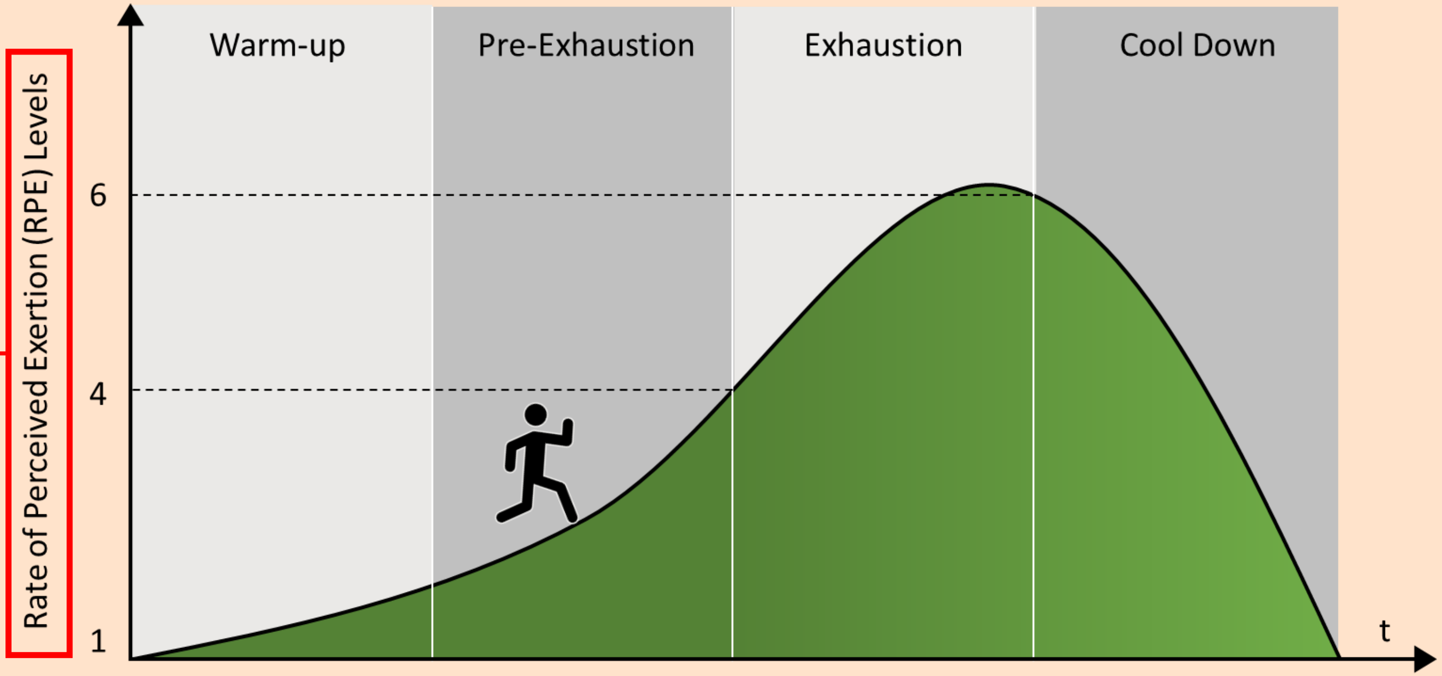
Runner Recruitment & Study Introduction



Physical Activity Exertion Worksheet

Emoji Perceived Rates of Exertion Scale		
10		I am dead!
9		I am probably going to die!
8		I can grunt if asked a question and can only keep this pace for a short period of time.
7		I can still talk, but I don't really want to and I am sweating a lot.
6		I can still talk, but I am getting out of breath and definitely sweating.
5		I'm just above comfortable. I am sweating more and can talk easily.
4		I'm sweating a little, but I feel good and I can easily carry on a conversation.
3		I am still comfortable, but I am breathing a bit harder.
2		I'm comfortable and I can keep going at this pace all day long.
1		I'm lying on the couch watching TV.

Recreated from: LINK



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Study Design: Study Introduction

Runner Recruitment & Study Introduction

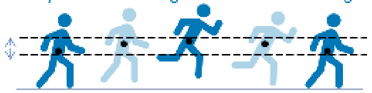
Cadence/Step Frequency

The number of steps taken per unit time during the run

Injuries if not optimal: Bone Stress Injuries, Pain along Shin (ACS); **Trend when fatigued**: Decreases for Recreational & Increases for Experienced
Optimal Values: Increase for Recreational & Decrease for Experienced to Reduce Impact

Vertical Oscillation

Vertically movement during each stride when running.



Injuries if not optimal: None; **Trend when fatigued**: Increases

Optimal Values: i) Decrease Vertical Movement or ii) Increase Stride Frequency

Contact Time

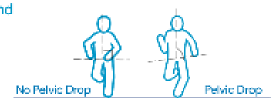
The amount of time that your foot is in contact with the ground on each step

Injuries if not optimal: Pain at Front of Knee (PPS); **Trend when fatigued**: Increases

Optimal Values: Decrease it by i) Increasing Cadence ii) Reduce Peak Hip Adduction at Stance

Pelvic Drop

Movement where pelvis drops on the opposite side of foot on ground



Injuries If not optimal: Middle Shin Injuries (MTSS); **Trend when fatigued**: Increases

Optimal Values: i) Decrease Adduction at Stance ii) Increase Cadence

Trunk Lean

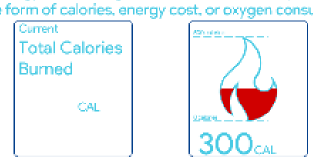
Angle of the torso relative to the ground during the running gait cycle

Injuries If not optimal: Knee Pain on Sides (ITBS); **Trend when fatigued**: Increases in Flexion (Bend Forward)

Optimal Values: Decrease Flexion

Energy Used

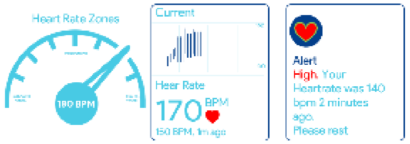
The energy used during the run. This could be represented in the form of calories, energy cost, or oxygen consumption



Trend when fatigued: Increases

Heart Rate

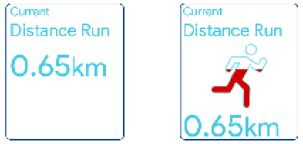
The speed at which the heart beats



Trends: Differs with age, experience, training goals

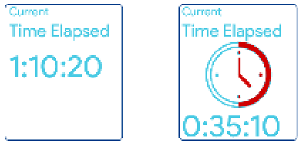
Distance

The total distance run at that moment of the run



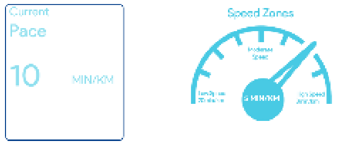
Time Elapsed

Total time that has passed during the run



Speed/Pace

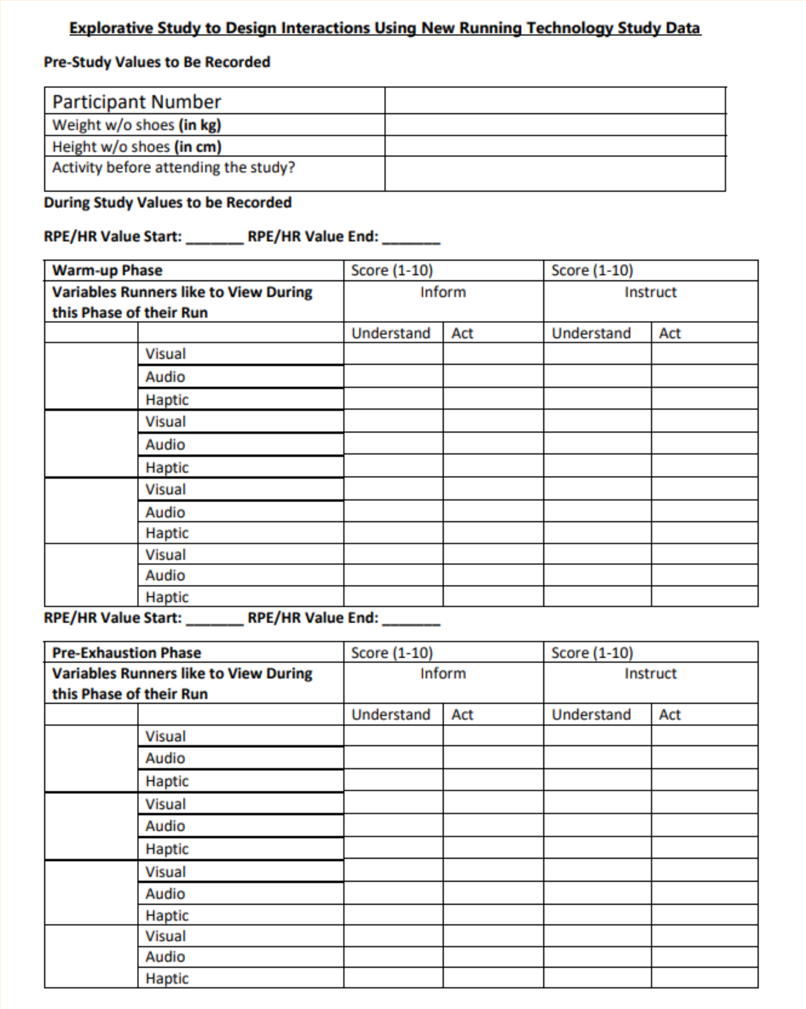
Speed/Pace of run



Trend when fatigued: Varies

Study Design: Study Introduction

Runner Recruitment & Study Introduction



Explorative Study to Design Interactions Using New Running Technology Study Data

Pre-Study Values to Be Recorded

Participant Number	
Weight w/o shoes **(in kg)**	
Height w/o shoes **(in cm)**	
Activity before attending the study?	

During Study Values to be Recorded

RPE/HR Value Start: _______ RPE/HR Value End: _______

Warm-up Phase		Score (1-10)		Score (1-10)	
Variables Runners like to View During this Phase of their Run		Inform		Instruct	
		Understand	Act	Understand	Act
	Visual				
	Audio				
	Haptic				
	Visual				
	Audio				
	Haptic				
	Visual				
	Audio				
	Haptic				
	Visual				
	Audio				
	Haptic				

RPE/HR Value Start: _______ RPE/HR Value End: _______

Pre-Exhaustion Phase		Score (1-10)		Score (1-10)	
Variables Runners like to View During this Phase of their Run		Inform		Instruct	
		Understand	Act	Understand	Act
	Visual				
	Audio				
	Haptic				
	Visual				
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	Visual				
	Audio				
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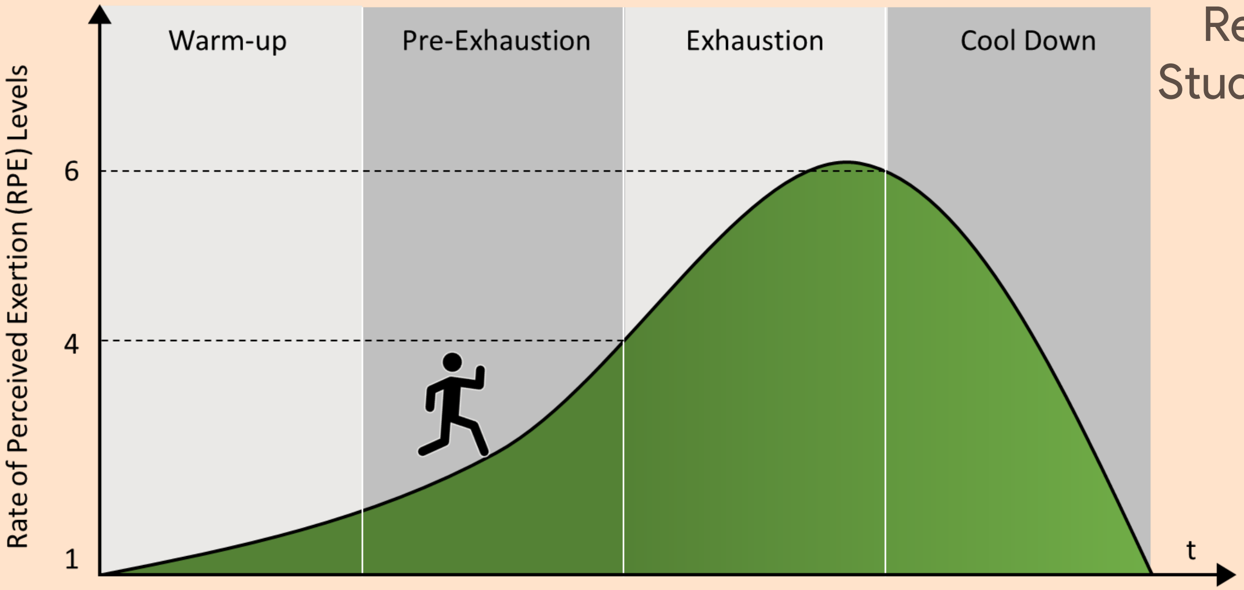
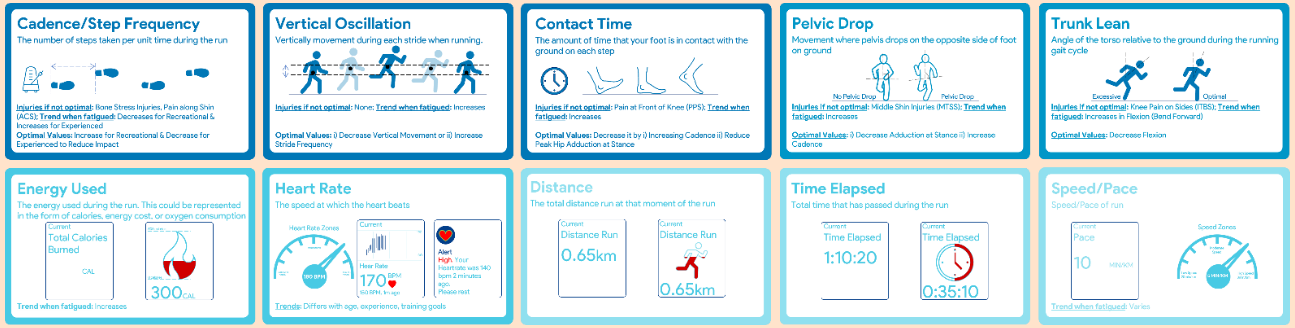
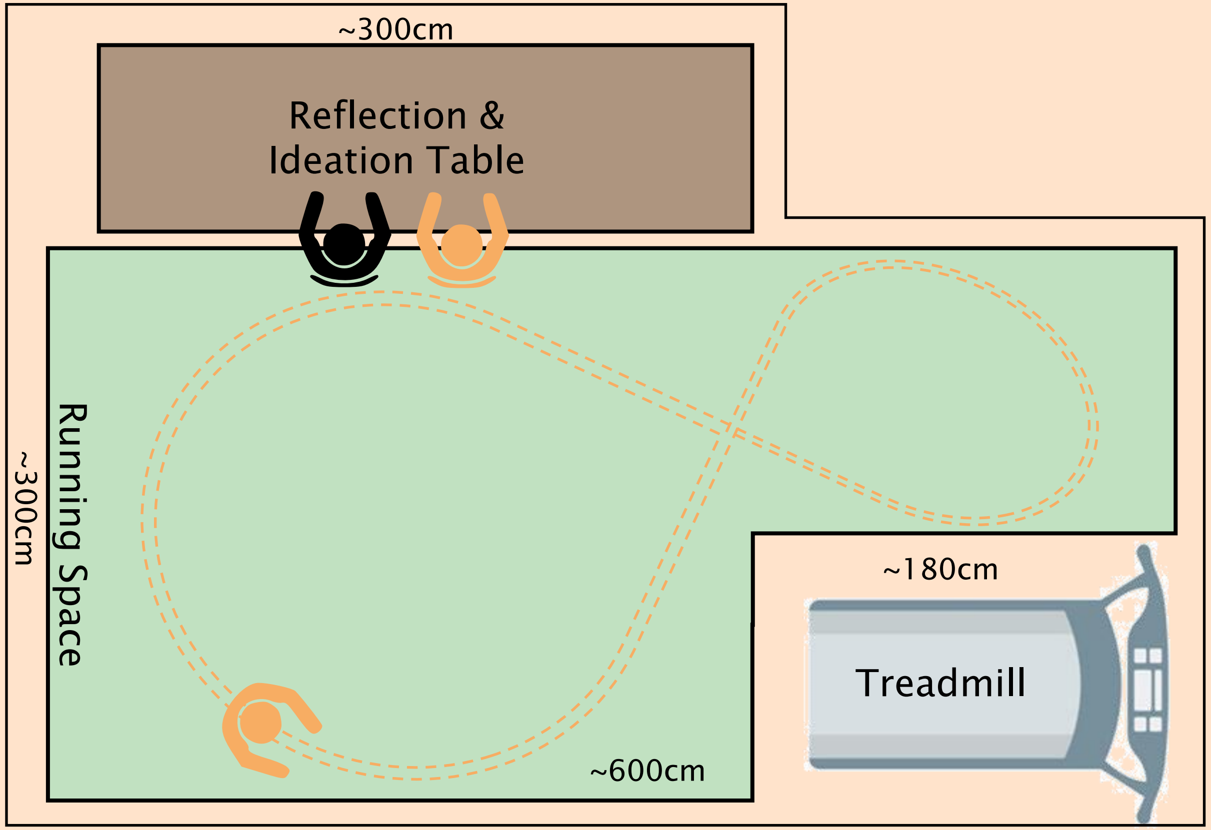




Study Design: Experiential Activity

Experiential Activity

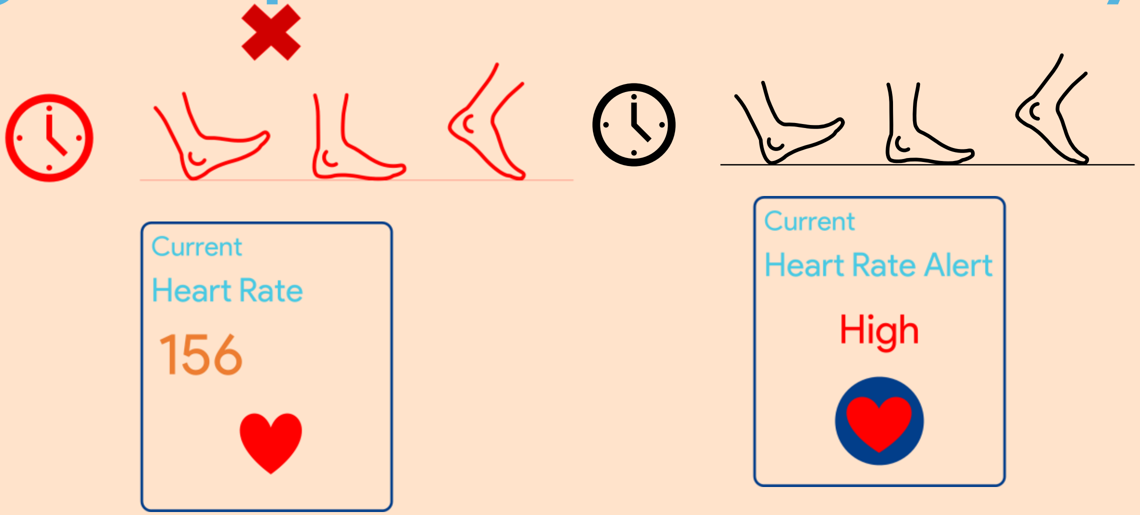
Source: Polar



Running Activity Setup

Study Design: Experiential Activity

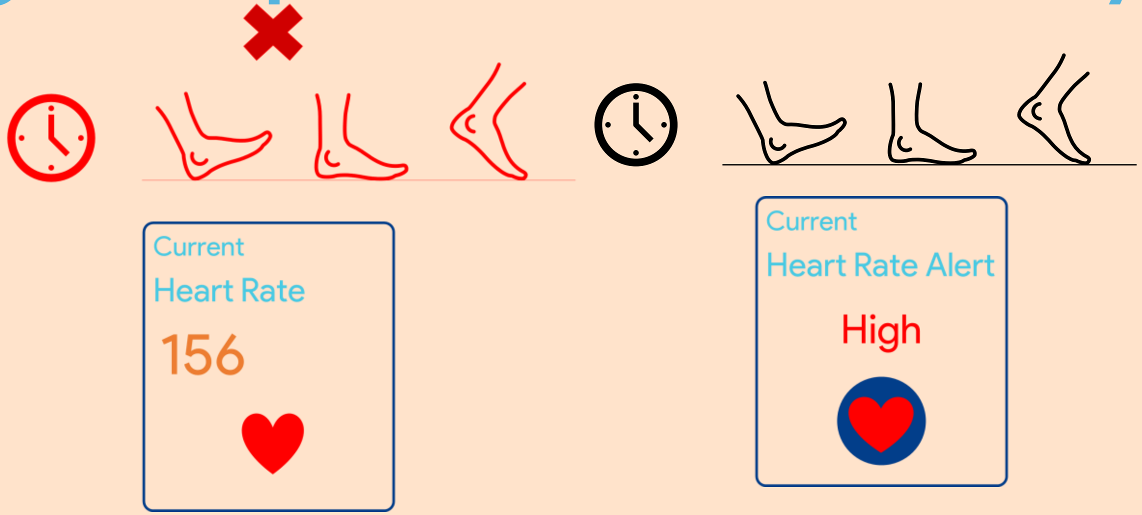
Experiential Activity



Visual Feedback Examples

Study Design: Experiential Activity

Experiential Activity



Visual Feedback Examples

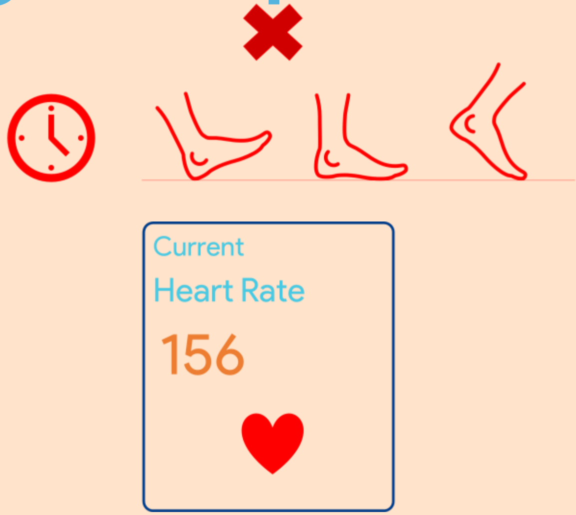
"Your cadence is not optimal"

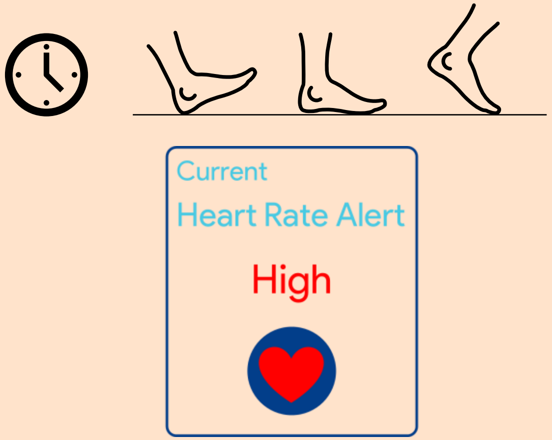
"Reduce your cadence by spending more time in air"

Audio Feedback Examples

Study Design: Experiential Activity

Experiential Activity



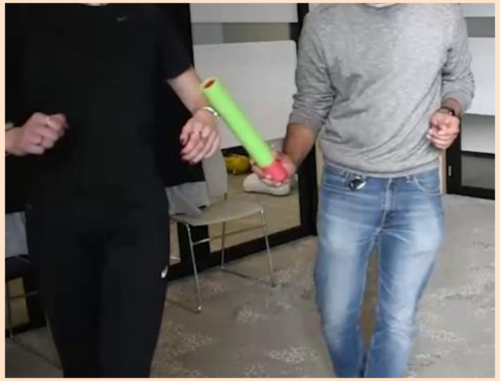


Visual Feedback Examples

"Your cadence is not optimal"

"Reduce your cadence by spending more time in air"

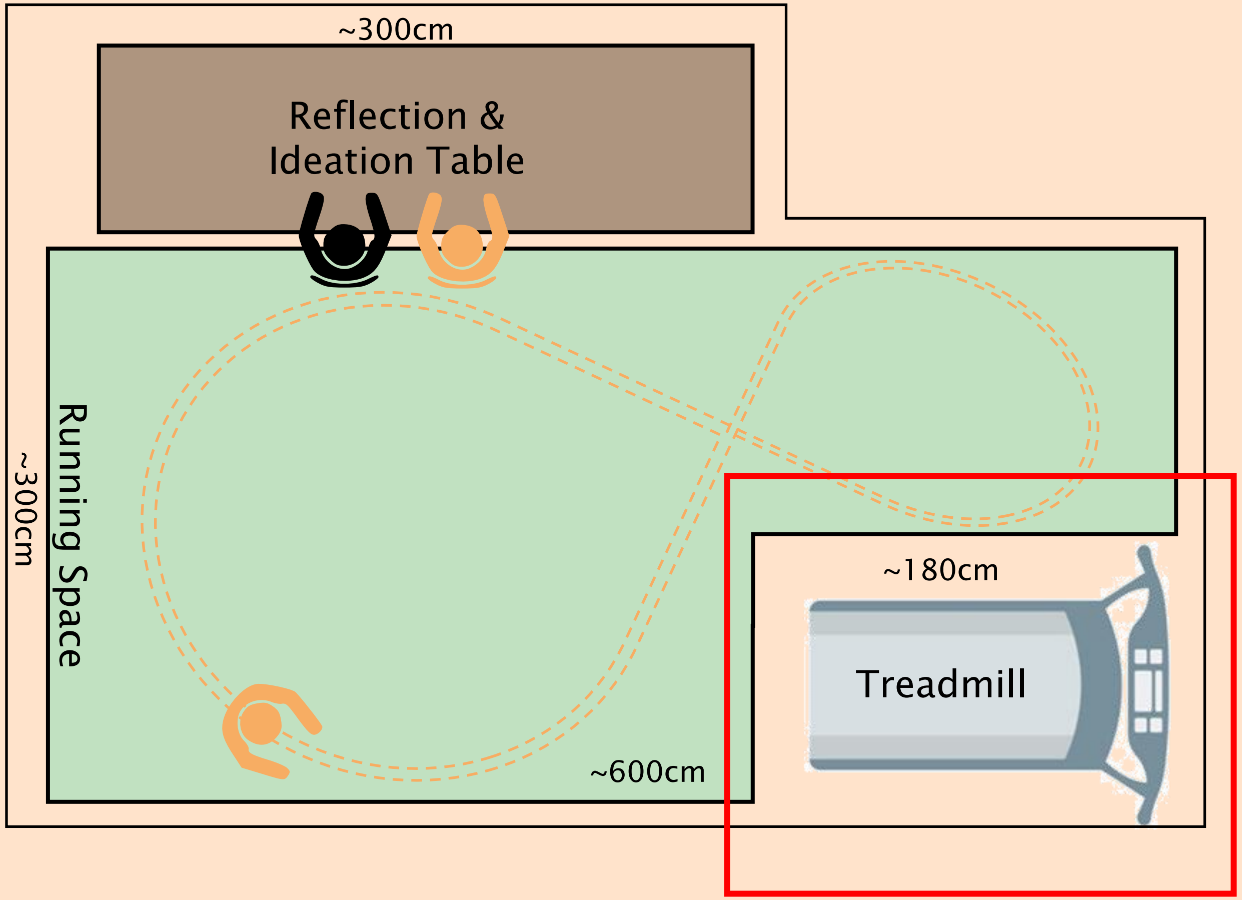
Audio Feedback Examples



Haptic Feedback Example

Study Design: Experiential Activity

Experiential Activity



Study Design: Reflection

Reflection

Participant Number:

View of the body “from the inside”, or how the body’s internal state changes over time as a result of the running (e.g.: heart rate & breathing change, sweating, etc.). This is usually not consciously initiated but user is usually aware of this.

Responding Body

View of the body with respect to your muscular repositioning of body parts relative to one another during the course of running. It is related to kinesthetic sense and proprioception(e.g.: walking without looking)

Moving Body

		Preparation/Warm-Up	Pre-Exhaustion	Exhaustion	Cool Down
Responding Body	Feelings				
	Sensations				
	Likes/Dislikes				
	Expectations vs Reality				
	Relation to Goals/Motivations				
	Impact of Environment				
Moving Body	Feelings				
	Sensations				
	Likes/Dislikes				
	Expectations vs Reality				
	Relation to Goals/Motivations				
	Impact of Environment				

Study Design: Reflection

Reflection

View of the body with respect to sensing and experiencing the world. The sensing body aims to offer a contextual perspective highlighting the body and its interactions with the environment.

Sensing Body

	Preparation/Warm-Up	Pre-Exhaustion	Exhaustion	Cool Down
Feelings				
Sensations				
Likes/Dislikes				
Expectations vs Reality				
Relation to Goals/Motivations				
Impact of Environment				

View of the body with respect to relating it to the others in the environment. E.g.: Contribution of the presence of facilitator or observer on the activity

Relating Body

	Preparation/Warm-Up	Pre-Exhaustion	Exhaustion	Cool Down
Feelings				
Sensations				
Likes/Dislikes				
Expectations vs Reality				
Relation to Goals/Motivations				
Impact of Environment				

Study Design: Ideation

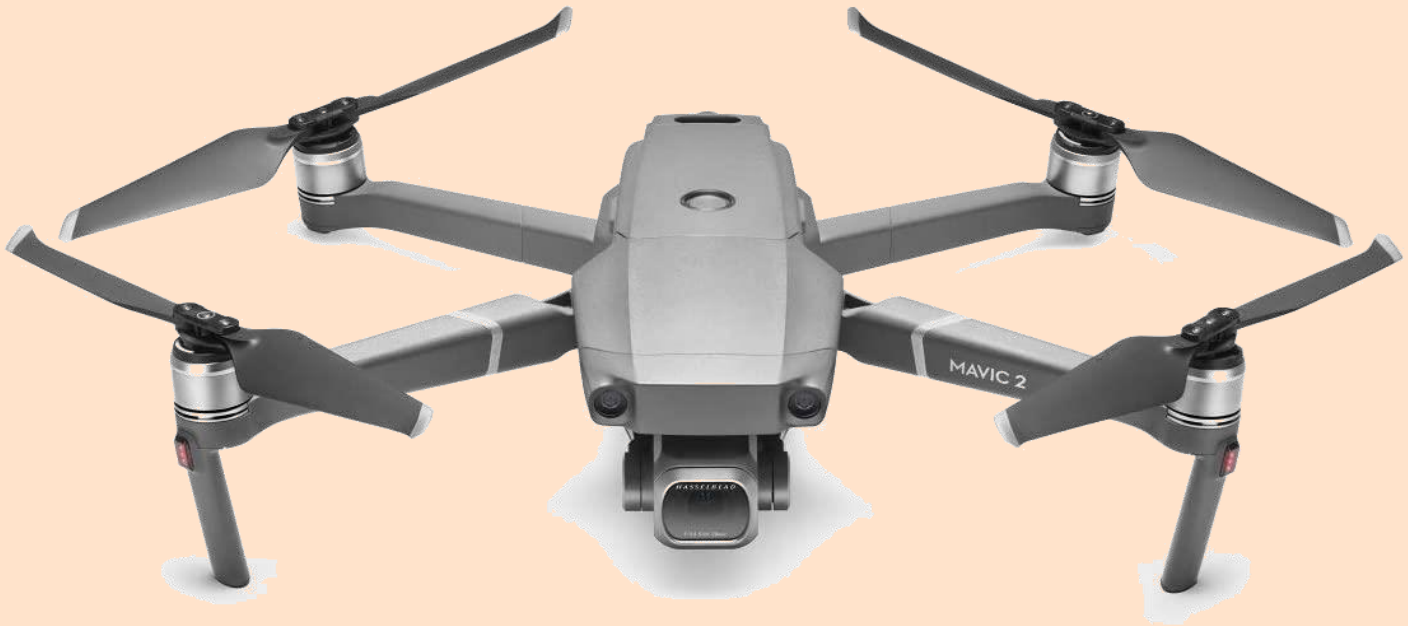
Ideation

Mention of Drones | Likability of Drones Evaluated | Drone Capability Examples | Ideation | Likability of Drones Evaluated

Study Design: Ideation

Ideation

Mention of Drones



Source: DJI

Study Design: Ideation

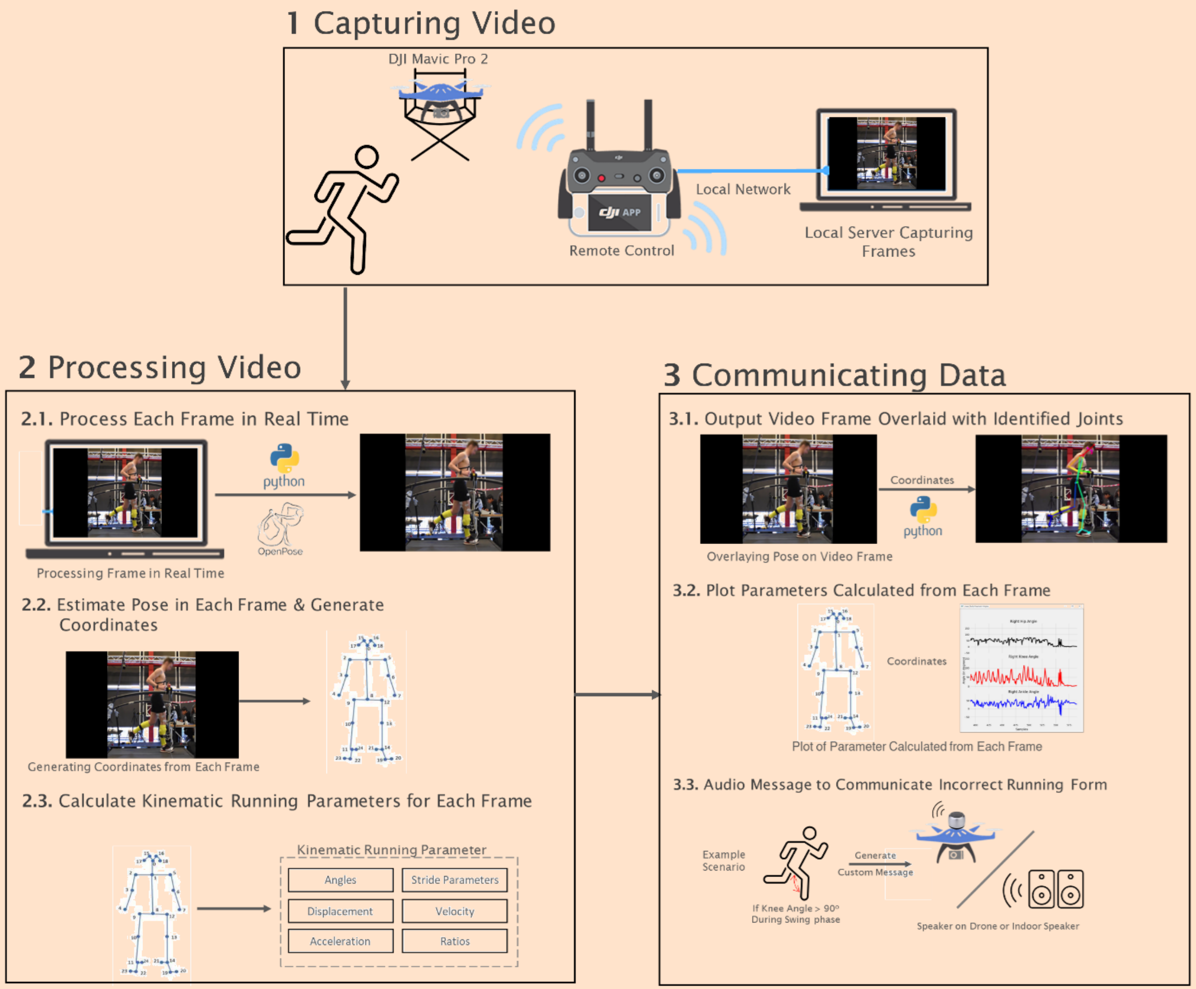
Ideation

Likability of Drones Evaluated

Section	Items		
Anthropomorphism	Fake	-	Natural
	Machinelike	-	Humanlike
	Unconscious	-	Conscious
	Artificial	-	Lifelike
	Moving rigidly	-	Moving elegantly
Animacy	Dead	-	Alive
	Stagnant	-	Lively
	Mechanical	-	Organic
	Artificial	-	Lifelike
	Inert	-	Interactive
	Apathetic	-	Responsive
Likeability	Dislike	-	Like
	Unfriendly	-	Friendly
	Unkind	-	Kind
	Unpleasant	-	Pleasant
	Awful	-	Nice
Perceived Intelligence	Incompetent	-	Competent
	Ignorant	-	Knowledgeable
	Irresponsible	-	Responsible
	Unintelligent	-	Intelligent
	Foolish	-	Sensible
Perceived Safety	Anxious	-	Relaxed
	Agitated	-	Calm
	Quiescent	-	Surprised

Source: Christoph Bartneck, Dana Kulić, Elizabeth Croft, and Susana Zoghbi. 2008. Measurement Instruments for the Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety of Robots.

Study Design: Ideation

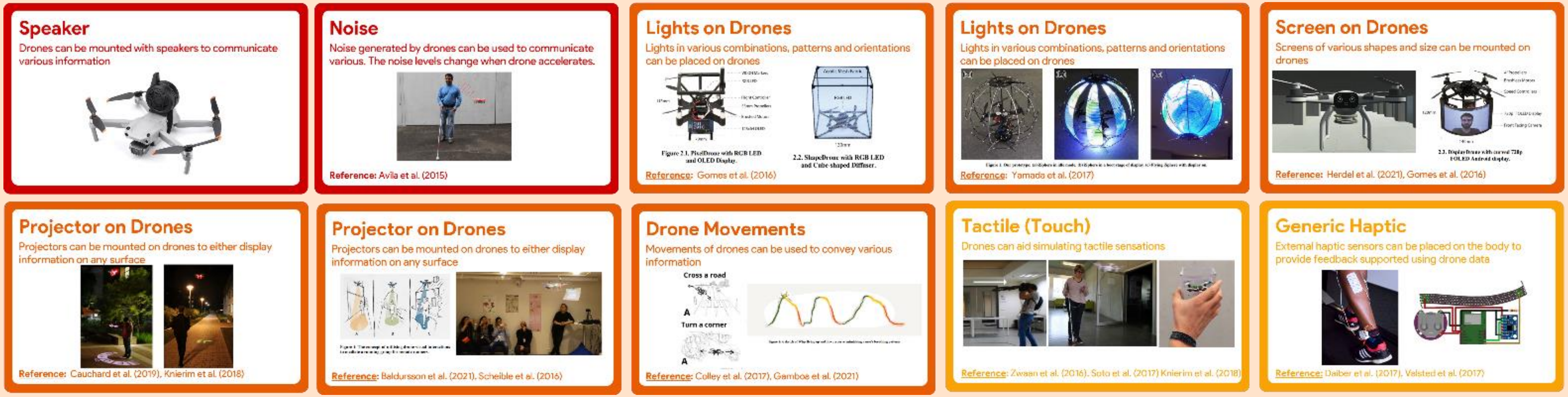


Real Time Feedback Capabilities

Study Design: Ideation

Ideation

Drone Capability Examples



Examples from Existing Research

Study Design: Ideation

Ideation

DRONE INTERACTION IDEATION WORKSHEET

Participant Number:

____

Shortlist the parameters that would drive the interaction:

☐ _____________________

☐ _____________________

☐ _____________________

☐ _____________________

☐ _____________________

☐ _____________________

Consider some of these points when ideating:

1. Make use of your reflections and the experience to inform answers
2. Use the objects around to help you to enable creative thinking
3. Think about the purpose of the interaction (e.g.. Notify (Represent Body Sensation) or Instruct them (Help transform their body) etc.)
4. Think about when should the interaction take place (e.g.: When something goes wrong, At some specific time, when indicated etc.)
5. Think about how often should the interaction be presented
6. Think about the design requirements of the drone and use the available sheet to get inspired

Space to Generate Metaphors & Ideas & Storyboards

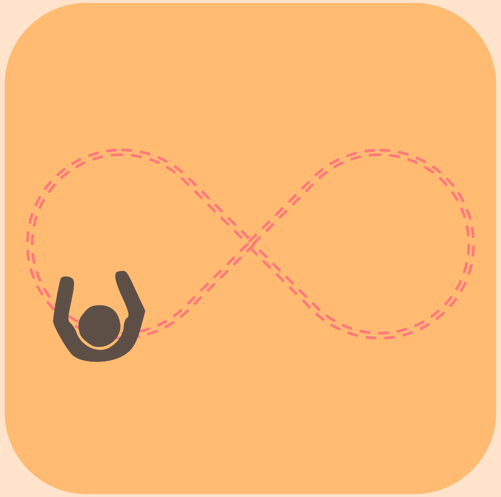
Space to Generate Metaphors & Ideas & Storyboards

Participants

25 Participants (15 Male & 10 Female)

- **Age**: 19 to 52 years (mean: 30.32)
- **Running Experience**: Few weeks to 25 years
- **Running Distances:** 3.5 km to 42 km @ 5.5km/h to 13km/h
- **Use of Technology**: 19/25 (smartwatch: 11, smartphone: 7, both: 1)
- **Sports Motivation Levels:** 23/25 positive value
- **Physically Activity Levels:** Mean: ~702kcal/day
- **BMI**: Mean: 24 (Healthy Range)
- None had run with a drone before

Data Analysed



Experiential Activity

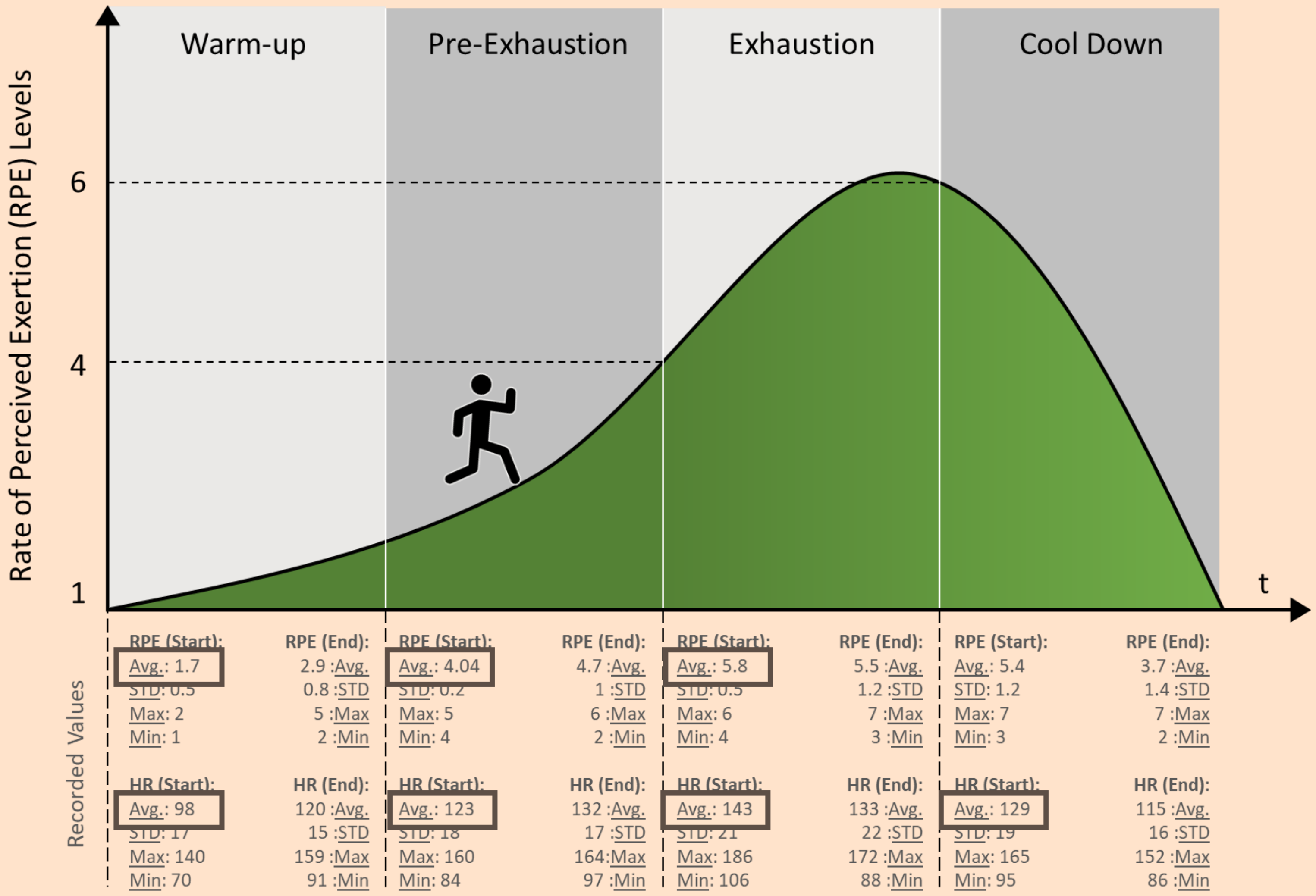
- Heart Rate Values
- Rate of Perceived Exertion

Ideation

- Godspeed Questionnaire Responses
- Running Parameters Selected
- Ideas Generated for Selected Running Parameters

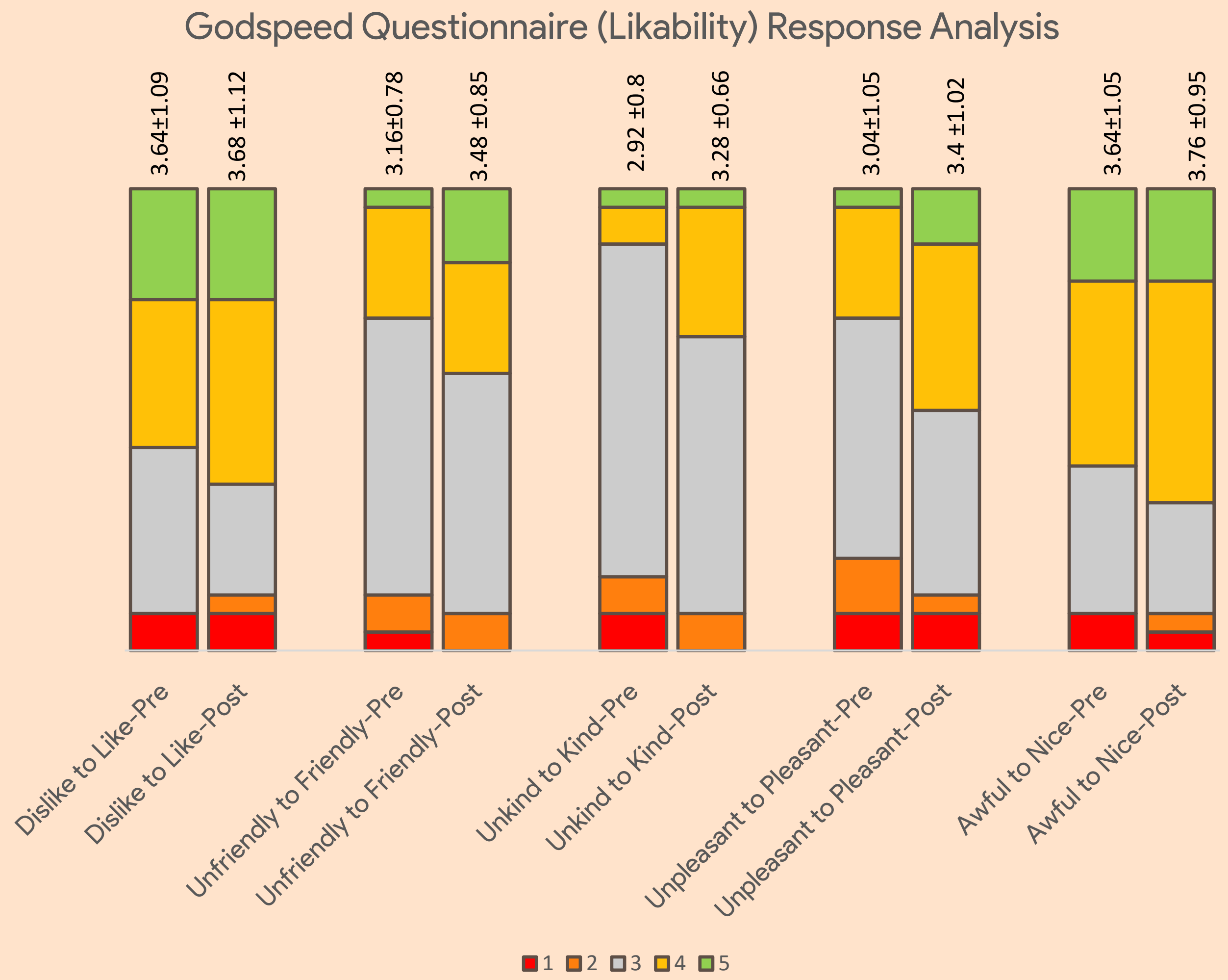
Results

Experiential Activity



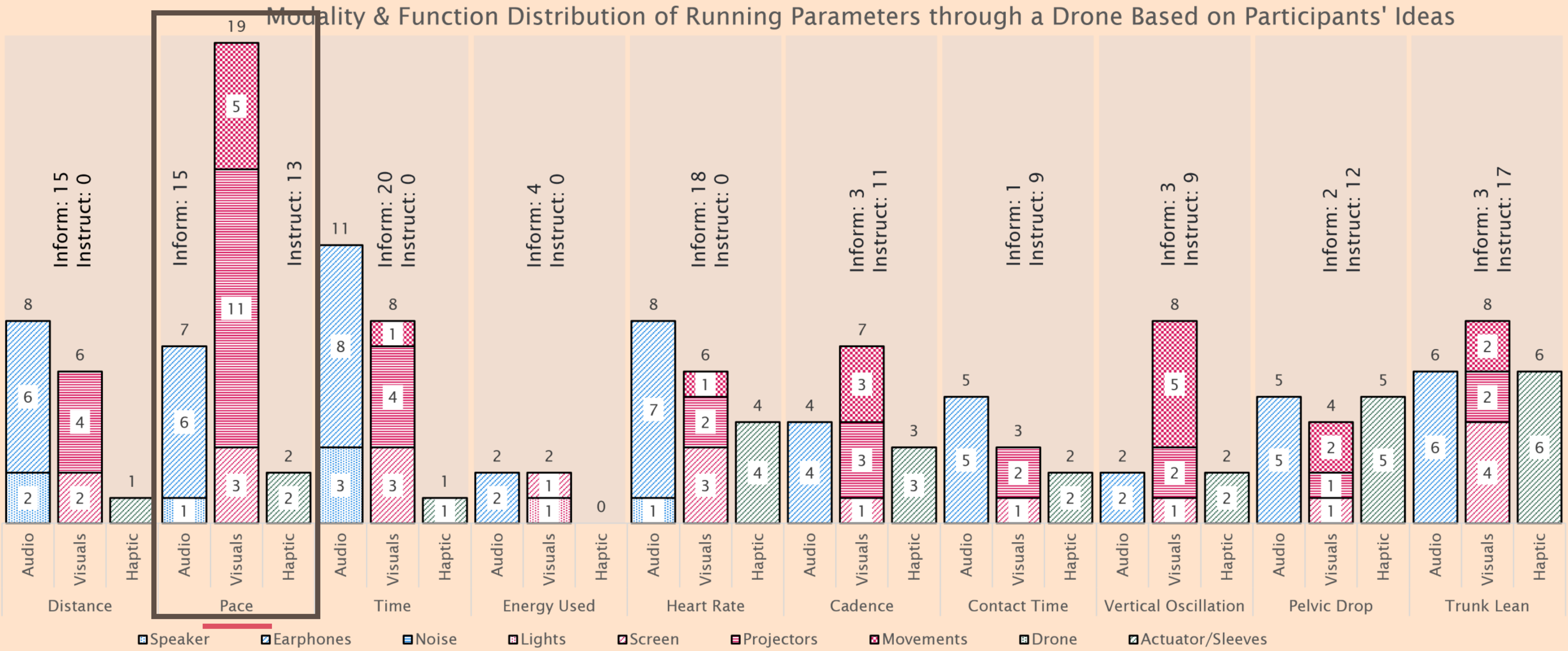
Results

Ideation



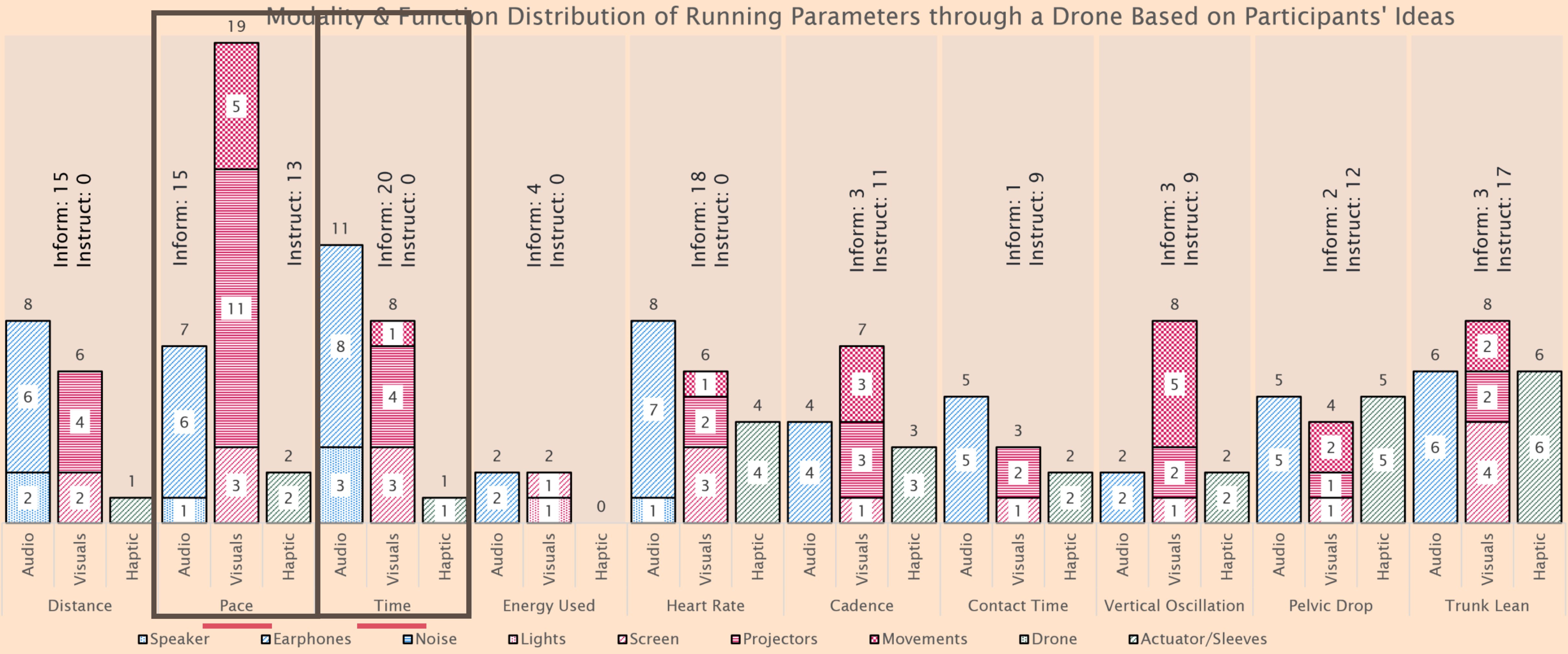
Results

Ideation



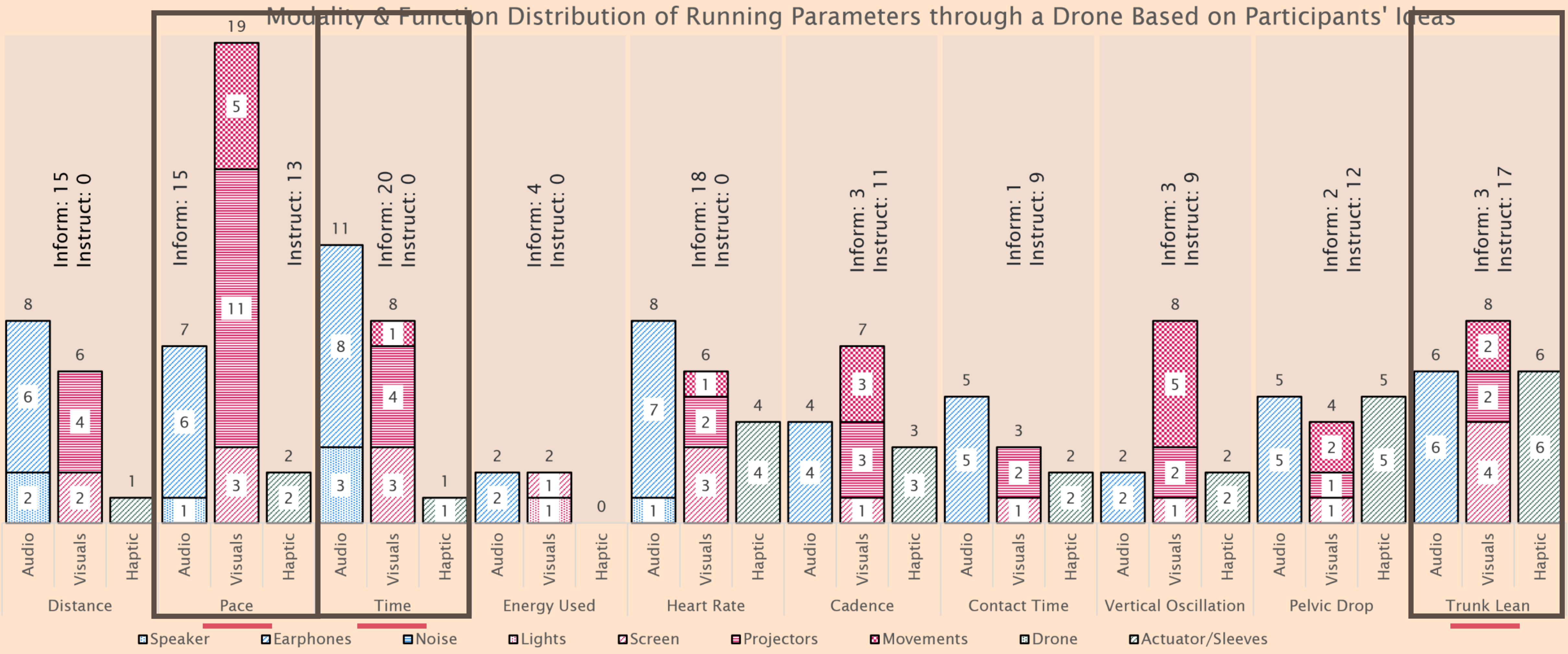
Results

Ideation



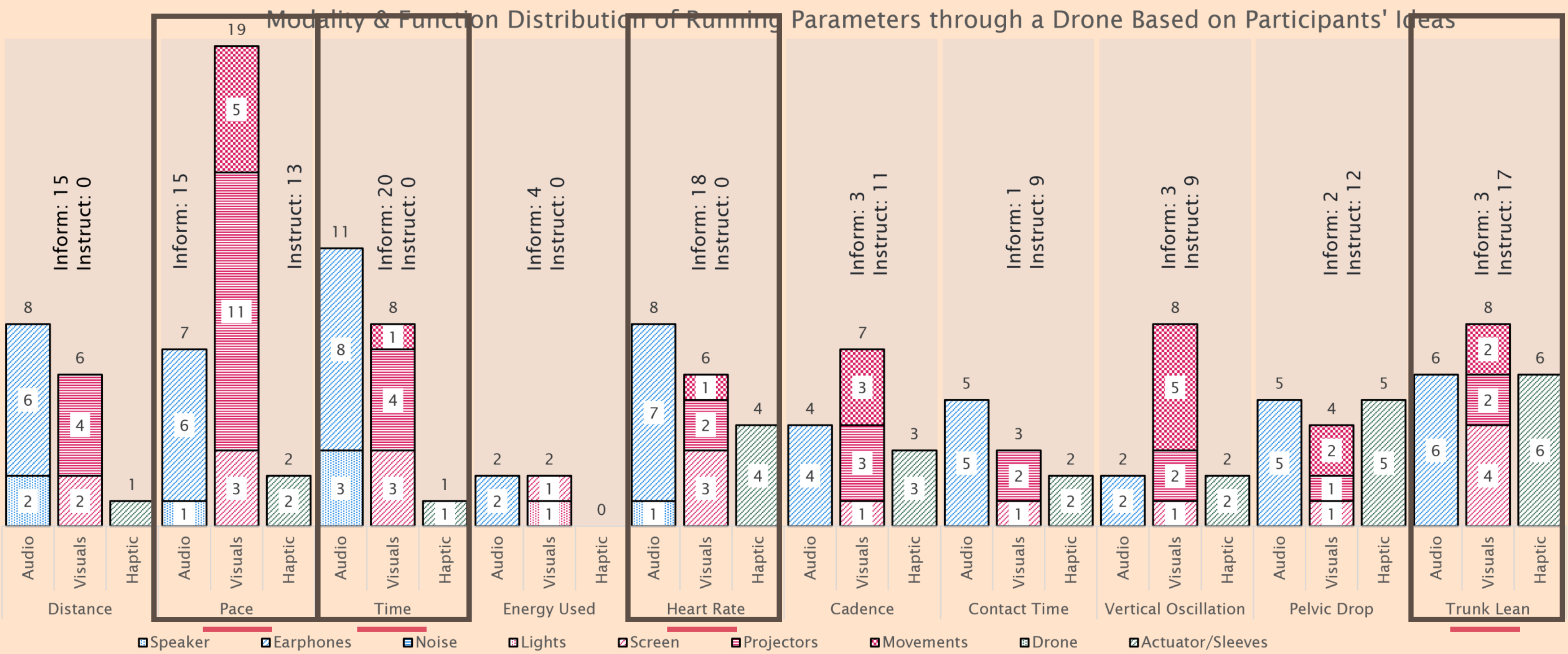
Results

Ideation



Results

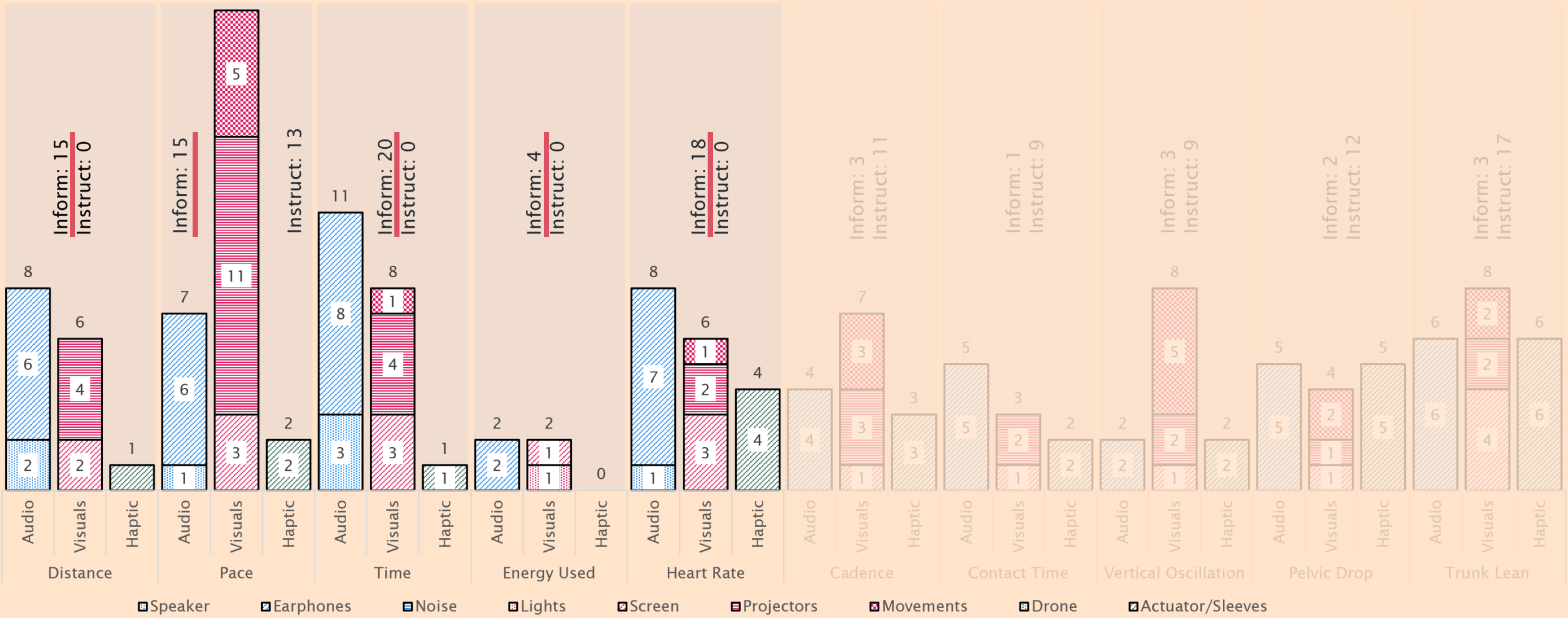
Ideation



Results

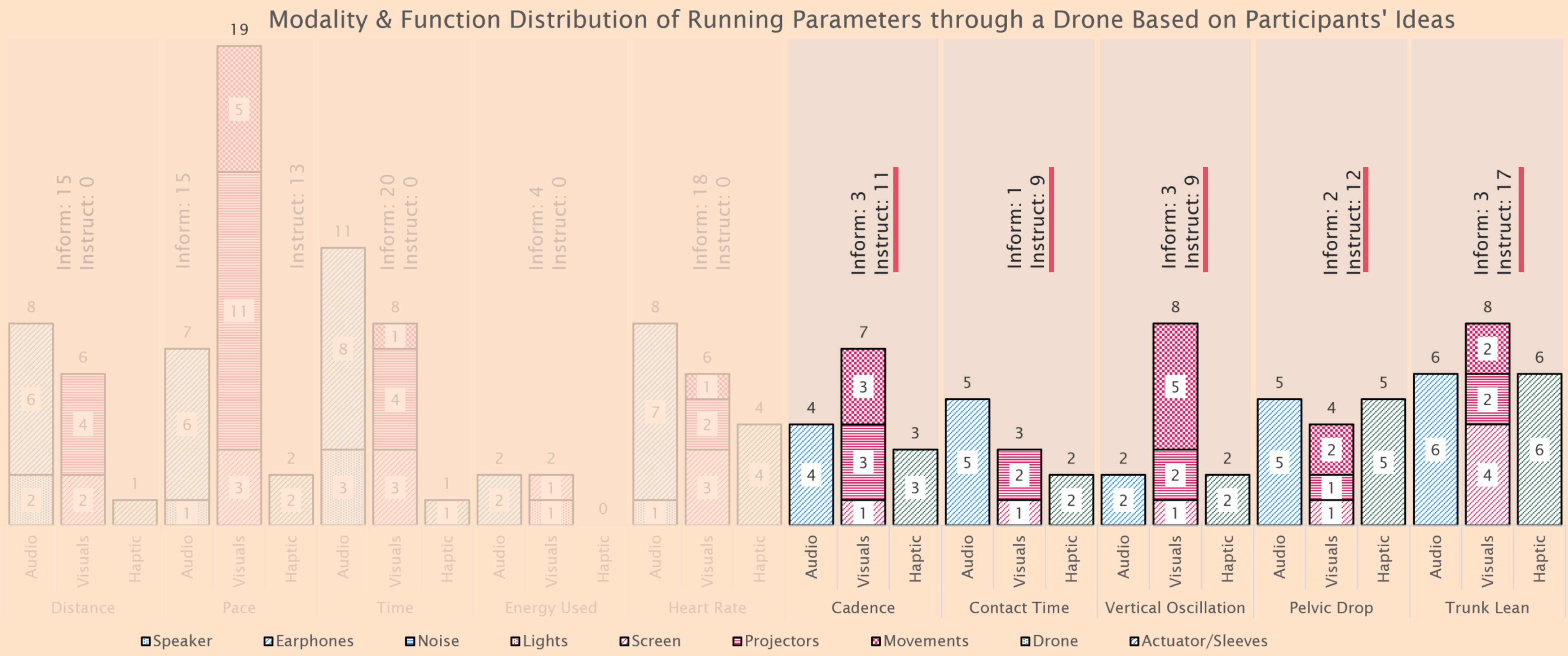

Ideation

Modality & Function Distribution of Running Parameters through a Drone Based on Participants' Ideas



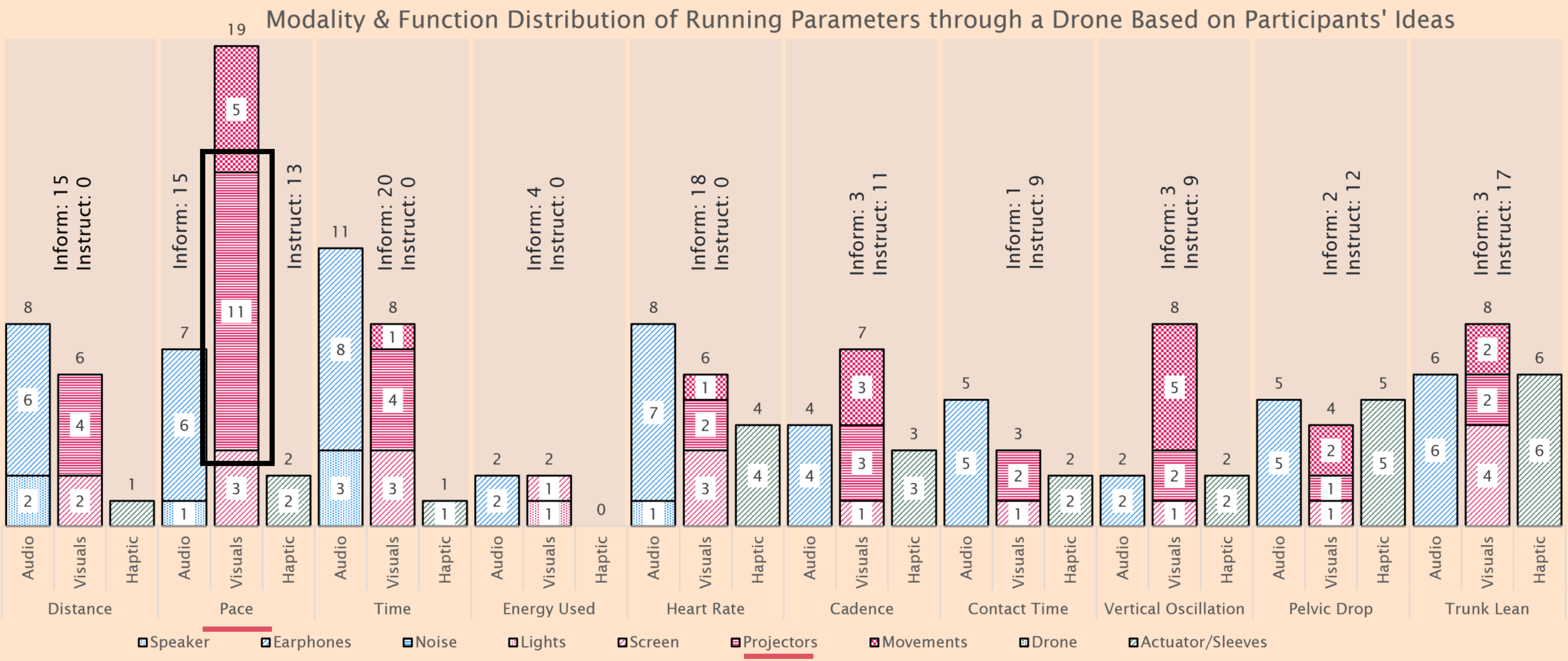
Results

Ideation



Results

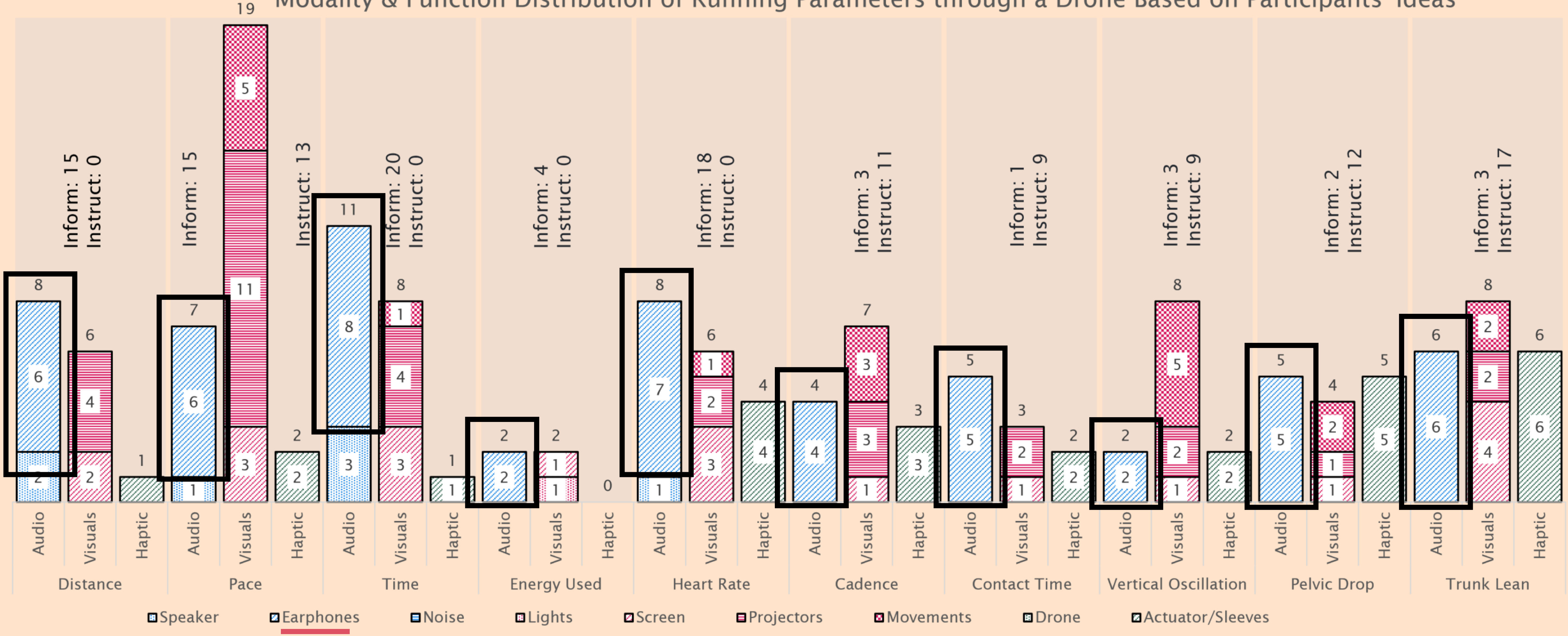
Ideation



Results

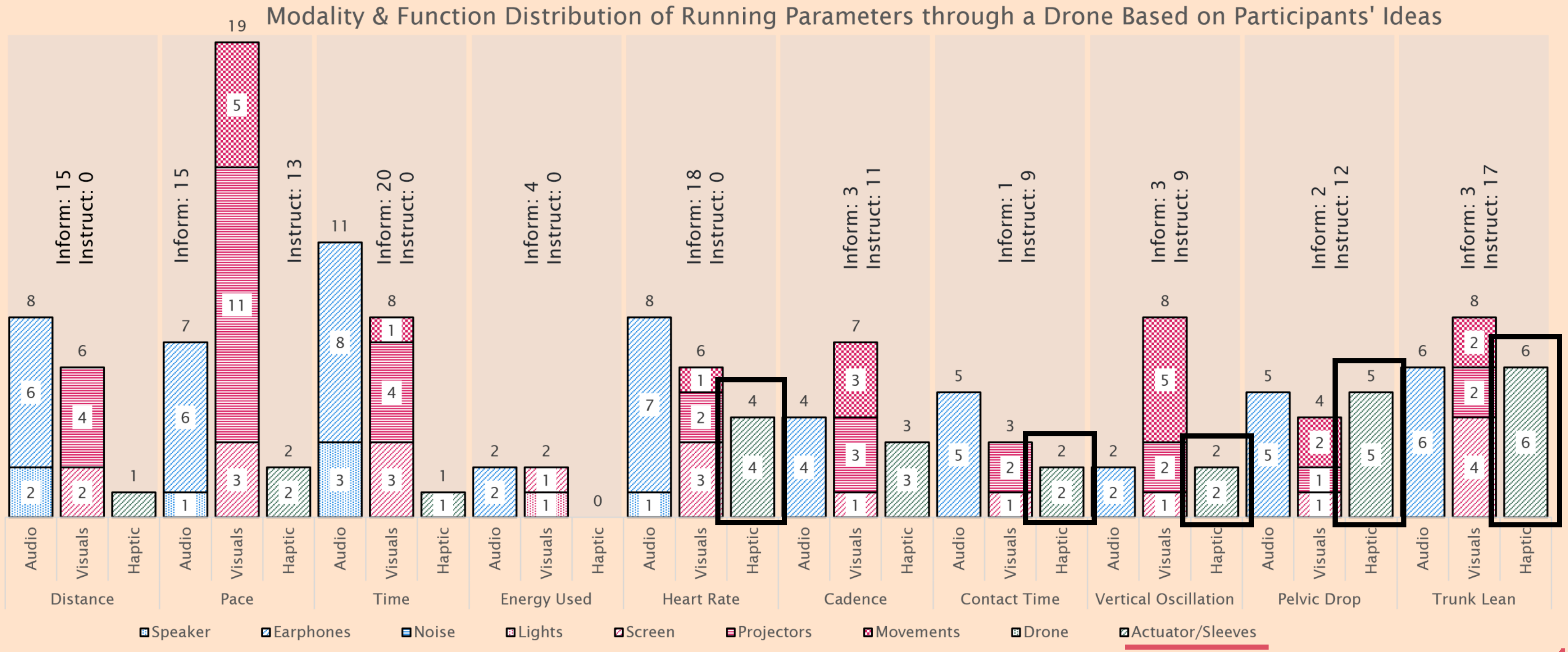
Ideation

Modality & Function Distribution of Running Parameters through a Drone Based on Participants' Ideas



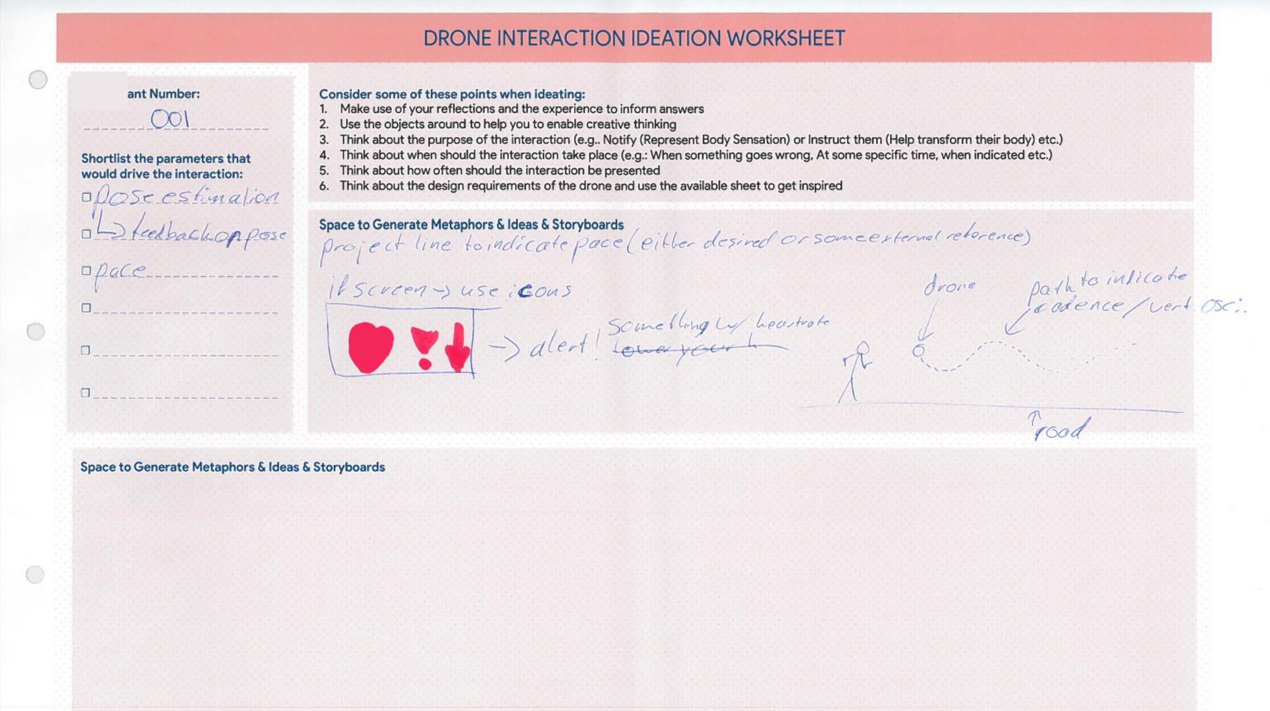
Results

Ideation



Data Analysis of the Ideas

Ideation



Converted the information in the ideation sheet to text

Transcribed the conversations during the session

Data Analysis of the Ideas

Ideation

Data Analysis of the Ideas

Reflexive Thematic Analysis

- Two coders
- Positioning during coding process:
  - Inductive over deductive (orientation to data)
  - Semantic over latent (focus on meaning)
  - Experiential over critical (qualitative framework)
  - Realist-essentialist over relativist-constructionist (theoretical framework)
- Objectives:
  - What are the feedback design considerations we can uncover from the data?

Drone Feedback Design Considerations

Two Themes

Feedback Presentation

Feedback Timing and Frequency

Drone Feedback Design Considerations

Two Themes

Feedback Presentation

- Non-Distracting Feedback
- Interpretable Feedback
- Intuitive Feedback
- Privacy-Conscious Feedback
- Environment-Aware Feedback

Feedback Timing and Frequency

- Incorrect Motion
- To Achieve Desired/Target Motion
- Signaling (Gestures) During Run
- Time
- Distance
- Physiological Changes
- Frequency: Self Selected
- Frequency: Triggered Always

Drone Feedback Design Considerations

Feedback Presentation

Non-Distracting Feedback

- Non-distracting while pulling their attention to allow them to maintain their flow during runs.
- A consensus on less distracting feedback designs in the form of alerts presented through earphones or haptic sleeves.

"I like to be in my running experience without getting too distracted" – [P25]

Interpretable Feedback

- Allows runners to easily interpret the presented details.
- Depending on the runner and run type the level of detail and simplicity may vary.

"I want something simple and if something is wrong, I want verbal instructions to correct it" - [P13]

"I am usually more of a visual learner and would like an animation on what you're supposed to be doing" - [P7]

Drone Feedback Design Considerations

Feedback Presentation

Intuitive Feedback

- Feedback should be understood without burdening the minimal attention span of runners.
- Some ideas used certain qualities of modalities and mapped them to certain parameters.
- Haptic to accentuate body sensations and motions. Drone motions to represent body motions.

"I found haptic the clearest...it requires less attention, ... I can react faster and felt it was ... most natural way of communicating information about movement.“ - [P6]

"[...] prefer drone movements for speed where it speeds up or slows down.“ - [P3]

Privacy-Conscious Feedback

- Runners value their privacy as such do not prefer their data presented publicly.
- Some were open to open public display if they are coded and contextually understood only by the runner or if the feedback is geared towards encouragement. Striking a good balance between privacy and public feedback

"I do not want screen, because it will make my heart rate public“ - [P16]

"As long as the visual is color coded, then I don't have to look at a number. “ - [P17]

"A drone with a speaker that talks to me, in the last quarter to help me get motivated. “ - [P14]

Drone Feedback Design Considerations

Feedback Presentation

Environment-Aware Feedback

- Bright conditions or uneven surfaces may hinder projections.
- Haptic feedback might be difficult to discern on uneven terrains due to the vibrations already experienced during running
- Use of speakers could disturb quiet areas
- Drone movements may be misunderstood without prior context, especially when navigating obstacle

Drone Feedback Design Considerations

Feedback Timing and Frequency

Triggered by Moving Body & Expectations:
Incorrect Motion

- Some preferred feedback on specific parameters when their body movement deviated from optimal levels or pre-set value

Triggered by Moving Body & Expectations:
To Achieve Desired/Target Motion

- There was a preference for continuous feedback on pace and cadence to help maintain desired or optimal levels of motion throughout their run.

Triggered by Moving Body & Expectations:
Signaling (Gestures) During Run

- Some expressed a preference for having the autonomy to receive feedback only when they made specific gestures.

Triggered by Time

- Some expressed a preference for receiving feedback at set intervals, allowing them to track their progress and performance over time.

Drone Feedback Design Considerations

Feedback Timing and Frequency

Triggered by Distance

- Some expressed a preference for receiving feedback at set distance markers, allowing them to monitor their performance and progress.

Triggered by Physiological Changes

- Some expressed a preference for receiving feedback based on changes in their exhaustion level.

Frequency of Feedback: Self Selected

- Some found constant feedback annoying and preferred self-selected intervals.
- Few also indicated a necessity of a buffer time between feedback.

Frequency of Feedback: Triggered Always

- There were a few ideas suggesting continuous feedback for parameters to maintain target motion.

Discussion Points

- Runners preferred feedback presentations aligned with their established running habits (information about their current activity levels) which is consistent with earlier research [1]
  - Runners rely on trackers for notifications about activity parameter deviations and familiar feedback presentation help maintain their cognitive flow.
- Their inclination toward instructional feedback for biomechanical parameters likely stems from their goals of performance improvement and injury prevention
  - Running-related injuries can demotivate runners and lead to discontinuation [2]
- Runners' ability to articulate their reason behind their preferences indicates that our study successfully fostered an experiential awareness and allowed meaningful reflections.

1. Armağan Karahanoğlu, Rúben Gouveia, Jasper Reenalda, and Geke Ludden. 2021. How Are Sports-Trackers Used by Runners? Running-Related Data, Personal Goals, and Self-Tracking in Running. Sensors 21, 11 (May 2021), 3687. https://doi.org/10.3390/s21113687
2.Tsai-Hsuan Tsai, Yung-Sheng Chang, Hsien-Tsung Chang, and Yu-Wen Lin. 2021. Running on a social exercise platform: Applying self-determination theory to increase motivation to participate in a sporting event. Computers in Human Behavior 114 (Jan. 2021), 106523. https://doi.org/10.1016/j.chb.2020.106523

Limitations

- Some runners felt the space to run was small and faced few challenges
- Some runners felt overwhelmed with the presentation of feedback during step two of the study
- The way haptic feedback for cadence was provided could have introduced a limitation
- Participants' prior knowledge and experience with feedback presentation

Future Work

- Explore preferences among runners with different characteristics and motivations through cluster analysis [1]
- Explore the hardware and software design consideration for drones

1. Mark A. Janssen, Carine Lallemand, Kevin Hoes, and Steven B. Vos. 2020. Which app to choose? An online tool that supports the decision-making process of recreational runners to choose an app. In Design 4 Health (1 ed.) (Design4Health, Vol. 2). Lab4Living, Sheffield Hallam University, Sheffield, UK, 32–38.

Summary & Conclusion

- Devised a methodology that allowed runners to reflect on an activity that replicated the transition of their running exertion levels while providing context on the various feedback presentation method
- Uncovered runners' preferences for running parameter feedback presented through a drone
- Identified some drone feedback design considerations

Acknowledgements

- UT-EEMCS "Theme Team Health Funding" for the project Sports Data Interaction (SDI)
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- Members of the project and the team at the University of Twente and Chalmers Interaction Design (IxD) Unit.
- All the participants!

Thank You for Listening

Any Question?

More questions? Feel free to reach out:
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