IEEE
World Haptics
Conference
2019

Tokyo, JAPAN • July 9 - 12

W5: Affective Haptics as a Direct Link to Emotion

The Affective Dimensions of the Cutaneous Rabbit Effect

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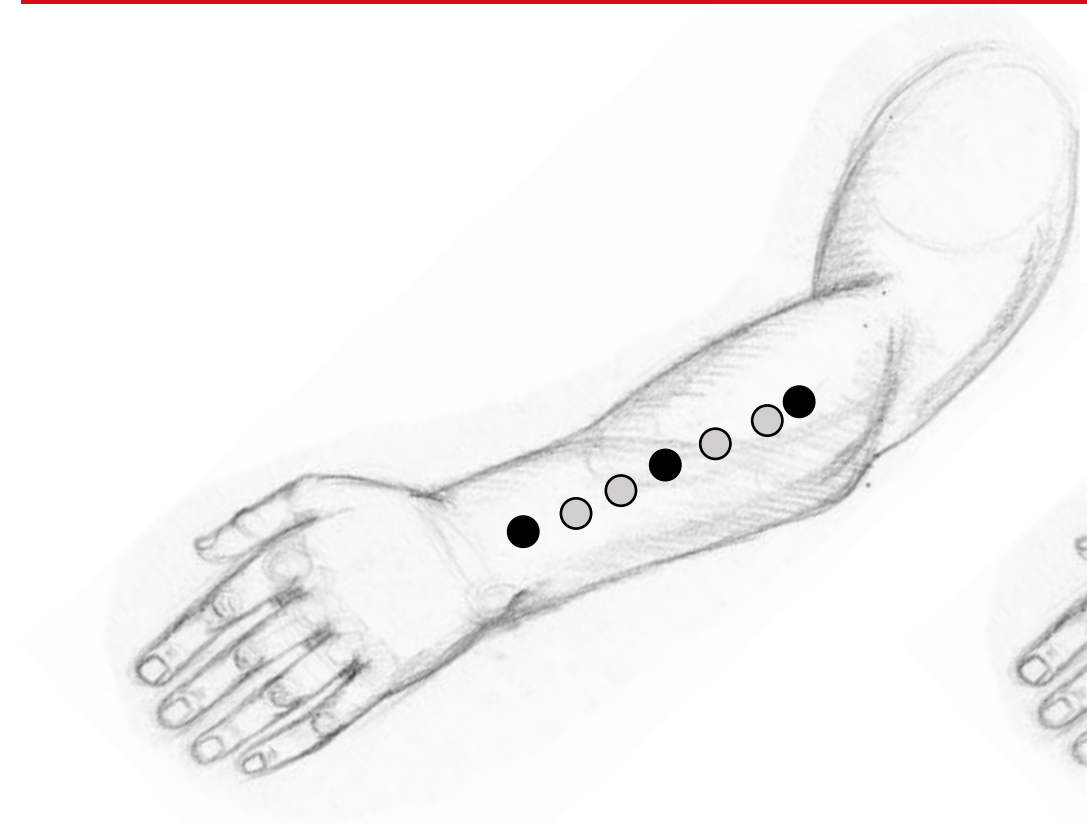
Emotions in VR

- VR goals: create strong emotions
  - The right kind (comfort, fear) but not increase the emotional distress

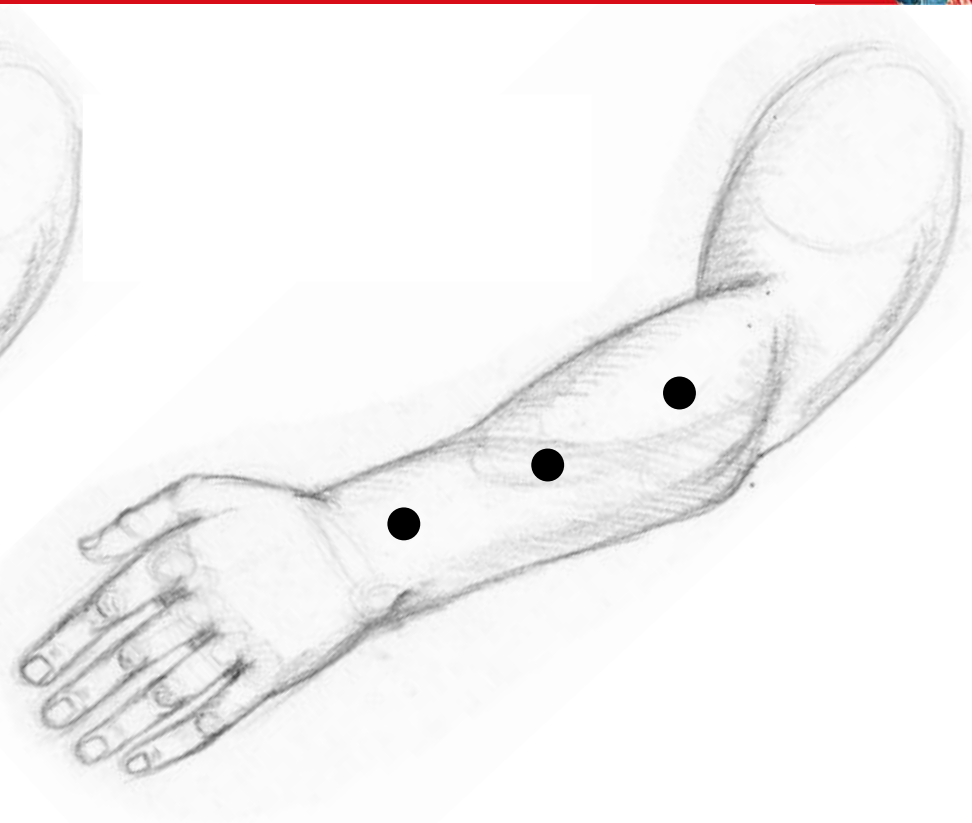
  → Obstacle to the emotional qualia: Lack of physicality (haptic feedback)

- Create new haptic technologies to enhance users' immersion
  - Understand the emotional dimensions provided by a haptic device

The Cutaneous Rabbit Illusion/Effect - Saltation

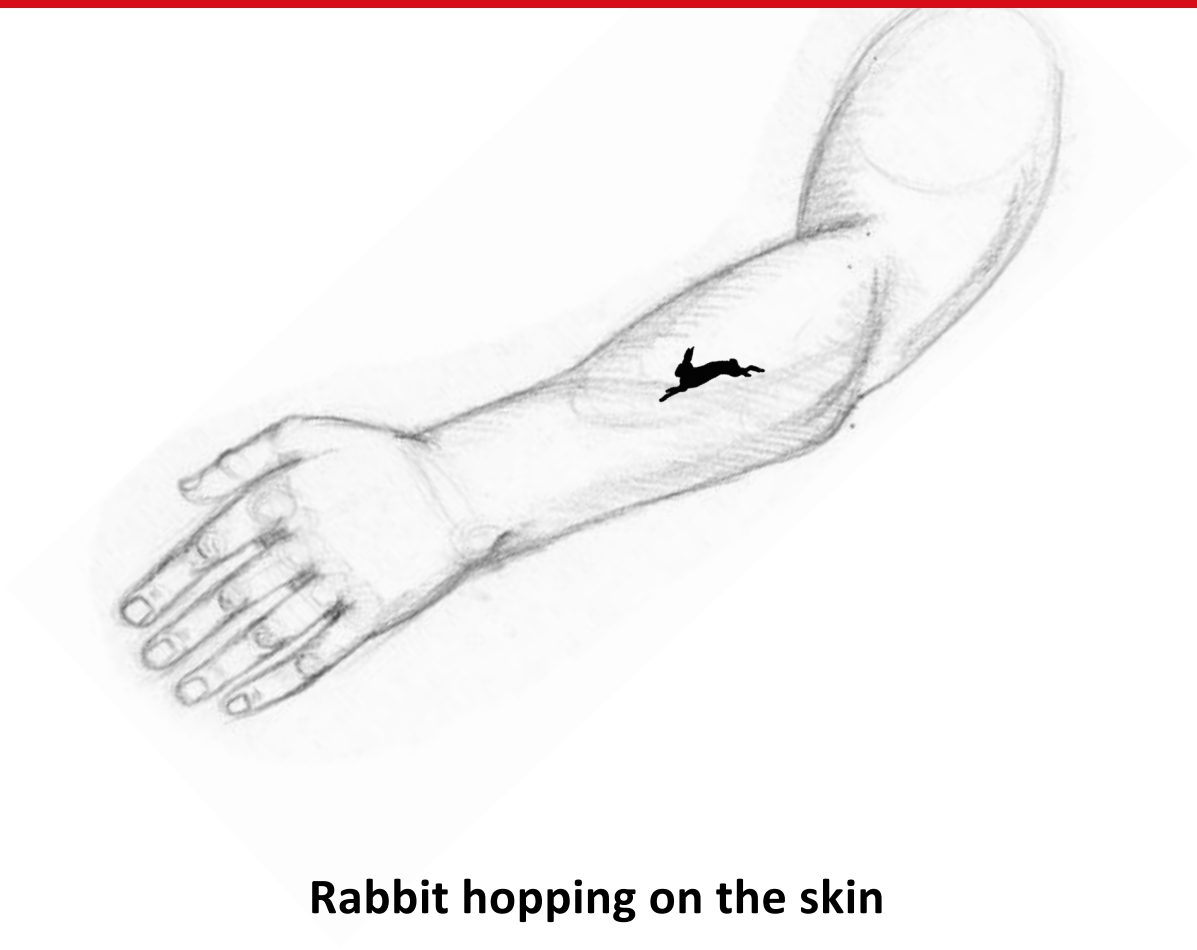


What is perceived



What is happening

The Cutaneous Rabbit Illusion/Effect - Saltation



Rabbit hopping on the skin

Geldard and Sherrick, 1972

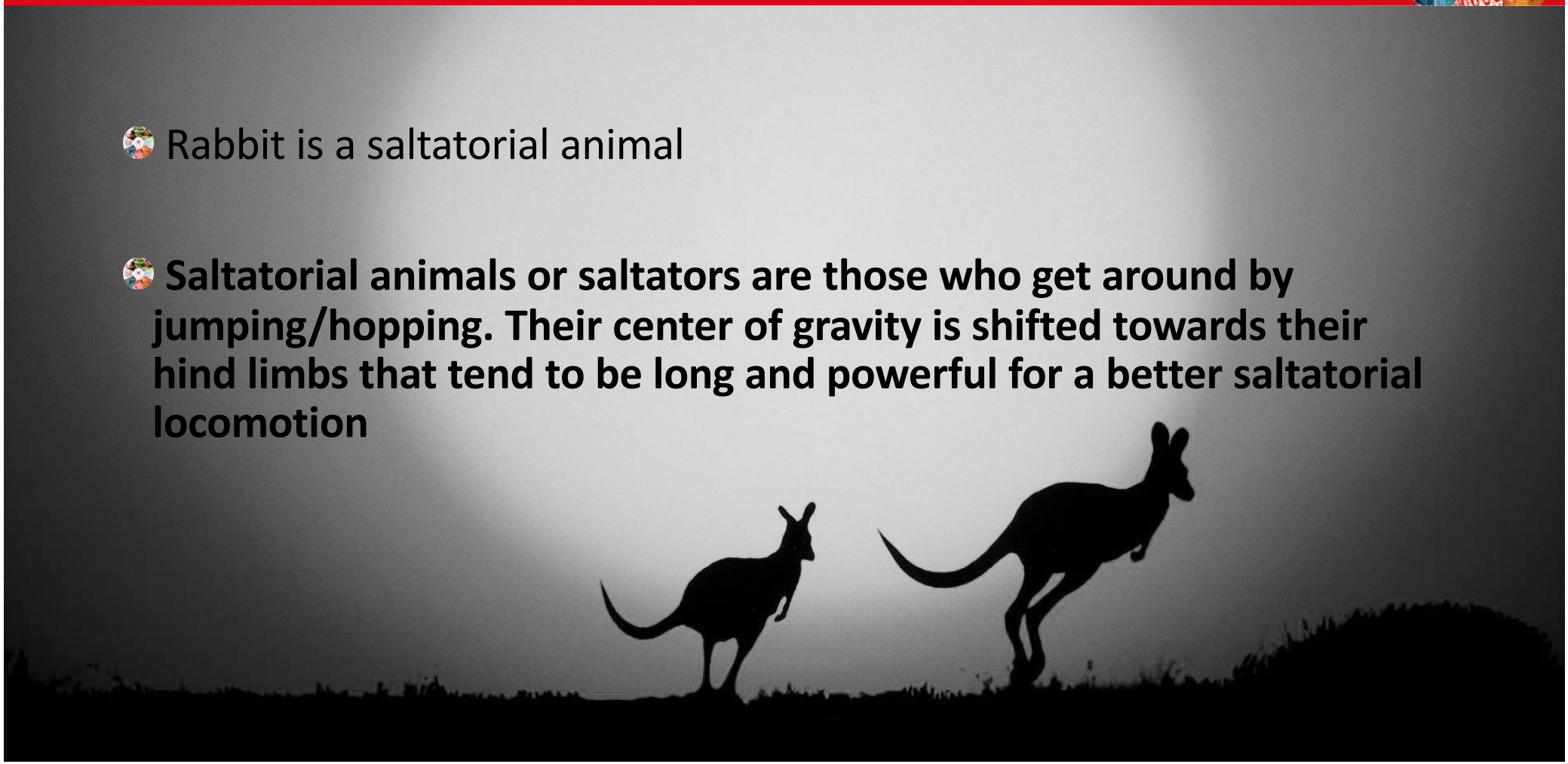
Rabbit hopping on the body

- Low acuity area: forearm
- The name is just a metaphor: no one experienced a tiny rabbit hopping on their arm.
  - Play with this metaphor.
  - Real life: people might have experienced tiny animals/insects hopping on their limbs.

Saltatorial Animals

- Rabbit is a saltatorial animal

- **Saltatorial animals or saltators are those who get around by jumping/hopping. Their center of gravity is shifted towards their hind limbs that tend to be long and powerful for a better saltatorial locomotion**



Saltatorial Animals

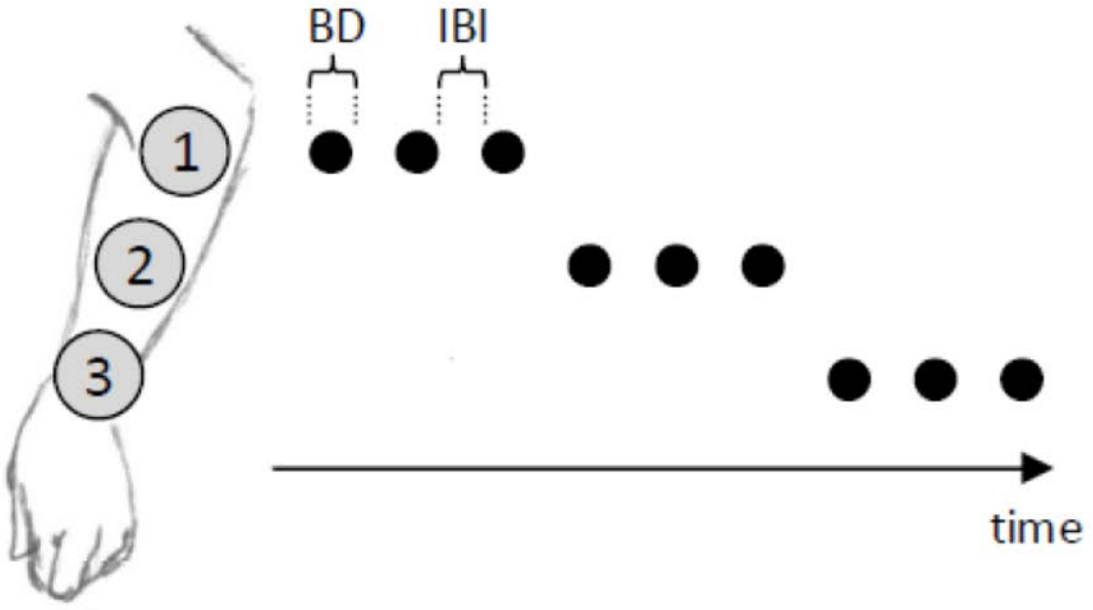
Current experiments

- Combine images of saltatorial animals with the tactile CRE (Cutaneous-Rabbit Effect).

- Two experiments: participants rated the emotional dimensions of the tactile saltation.
  - Ziat, M., & Raisamo, R. (2017, June). The cutaneous-rabbit illusion: What if it is not a Rabbit?. In 2017 IEEE World Haptics Conference (WHC) (pp. 540-545). IEEE.
  - Ziat, M., Snell, K., Johannessen, C., & Raisamo, R. (2018, June). How Visual Images and Tactile Durations Affect the Emotional Ratings of the Cutaneous-Rabbit Illusion. In International Conference on Human Haptic Sensing and Touch Enabled Computer Applications (pp. 58-68). Springer, Cham.

Two factors that affect the CRE: BD and IBI

BD: Burst Duration
IBI: Inter-Burst Interval



Raisamo et al. 2009; Raisamo et al. 2013

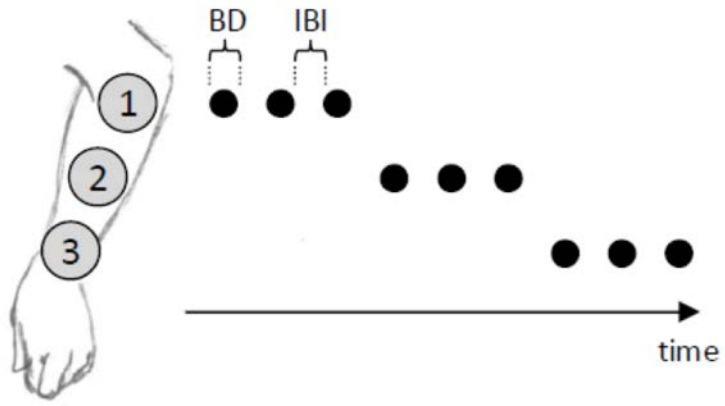
Experiments: Tactile Stimuli

Experiment 1: Varied BD – IBI fixed

Condition	BD	IBI	Total Duration
T12	12 ms	24 ms	300 ms
T24	24 ms	24 ms	408 ms
T48	48 ms	24 ms	624 ms

Experiment 2: Varied IBI – BD fixed

Condition	BD	IBI	Total Duration
T12	24 ms	12 ms	300 ms
T24	24 ms	24 ms	408 ms
T48	24 ms	48 ms	624 ms



BD: Burst Duration
IBI: Inter-Burst Interval

Raisamo et al. 2009; Raisamo et al. 2013

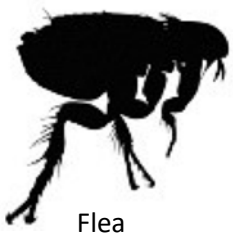
Experiments: Visual Stimuli

- Participants were exposed to 6 (***Exp. 1***) to 8 (***Exp. 2***) silhouettes of saltatorial animals simultaneously


Kangaroo Rat

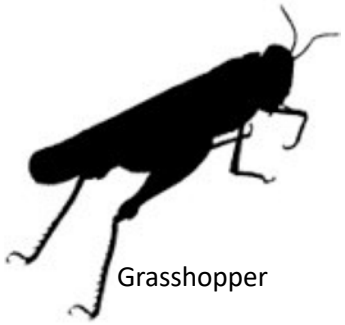

Kangaroo

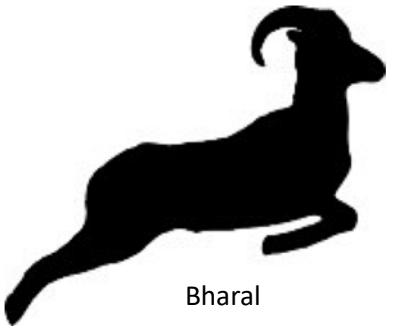

Spider


Flea


Rabbit


Frog

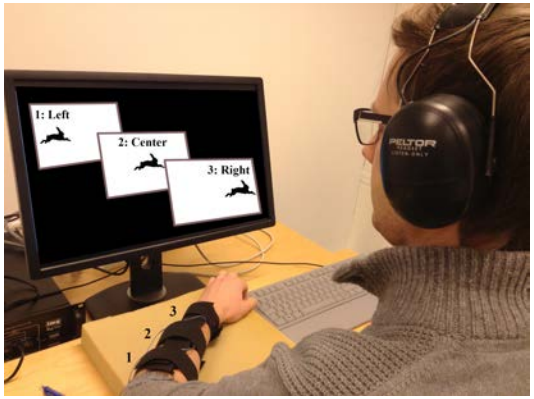

Grasshopper


Bharal

Experiments: Visual and Tactile Combined

Experiment 1: Varying BD

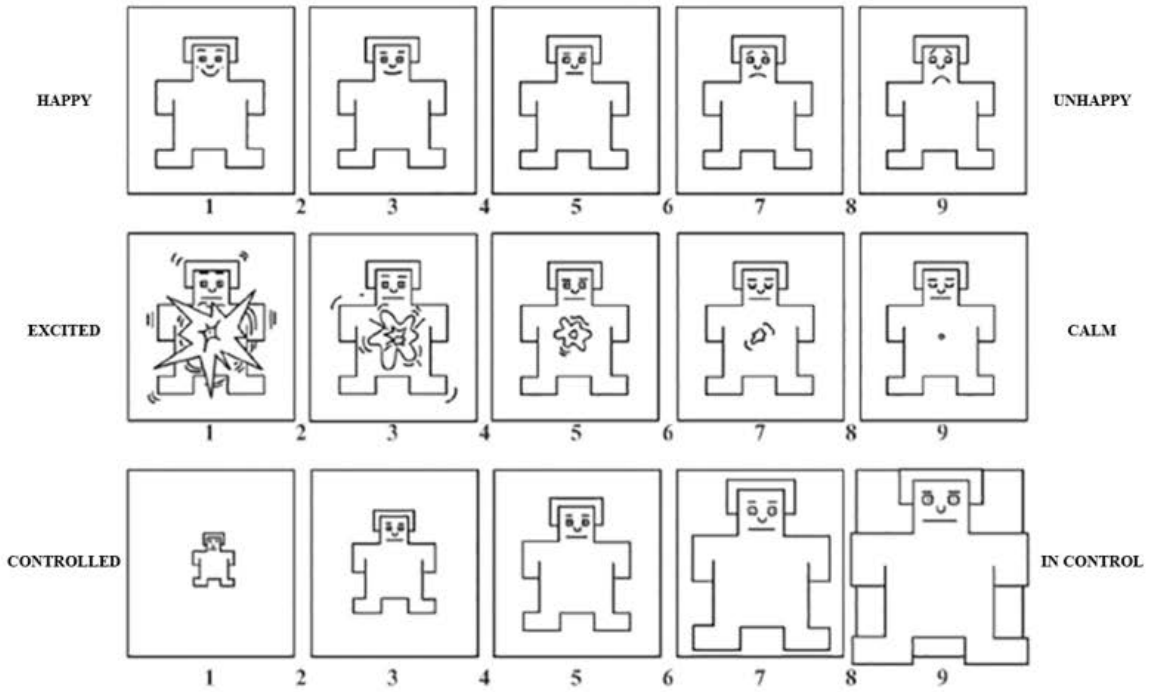
- 14 participants from University of Tampere
- Pre-Survey: online survey to rate the pleasantness of 8 visual saltators using the Self-Assessment Manikin (SAM) – V condition
- 6 images were selected for each participant (3 more pleasant + 3 less pleasant with the Rabbit always included).
- 180 trials (3 Tactile conditions (T12, T24, and T48) * 6 saltators * 10 repetitions each) in two sessions.
- Post-Survey: Strength Animal-Tactile Association, Phobias



BD: Burst Duration

Experiment 1: Varying BD

- Self-Assessment Manikin (SAM): Valence, Arousal, and Dominance dimensions (Bradley and Lang, 1994)



BD: Burst Duration

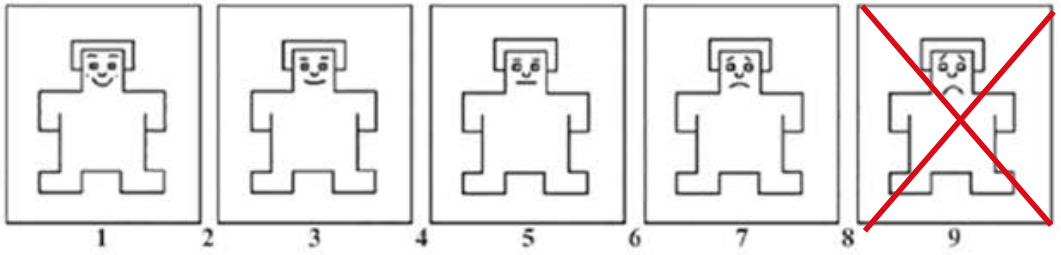
Experiment 1: Varying BD

- Participants were asked to rate the tactile stimulation and give verbally their answer before moving to the next trial
  - Select **1** if the *tactile stimulation* make you feel completely **happy/excited/controlled**
  - Select **9** if the *tactile stimulation* make you feel completely **unhappy/calm/in control**
  - Select **5** if the *tactile stimulation* make you feel completely neutral, **neither happy or sad/neither excited or calm/neither in control or controlled**
- Each emotional dimension rating is independent from each other.

BD: Burst Duration

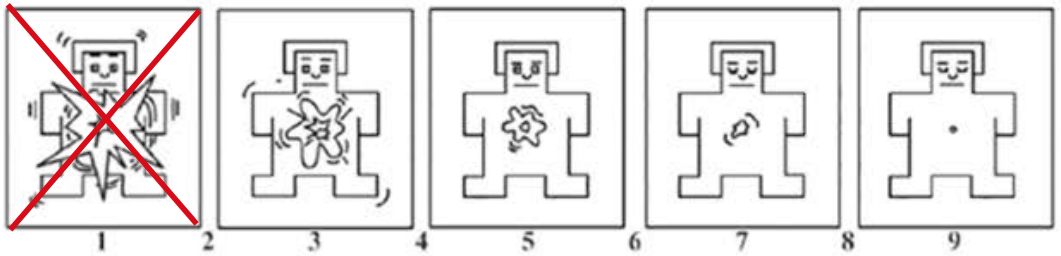
Hypotheses

Valence



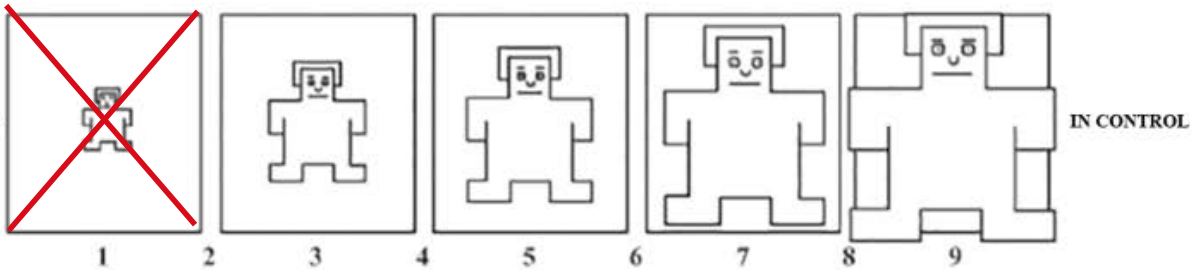
Strong Emotions (the right kind)

Arousal



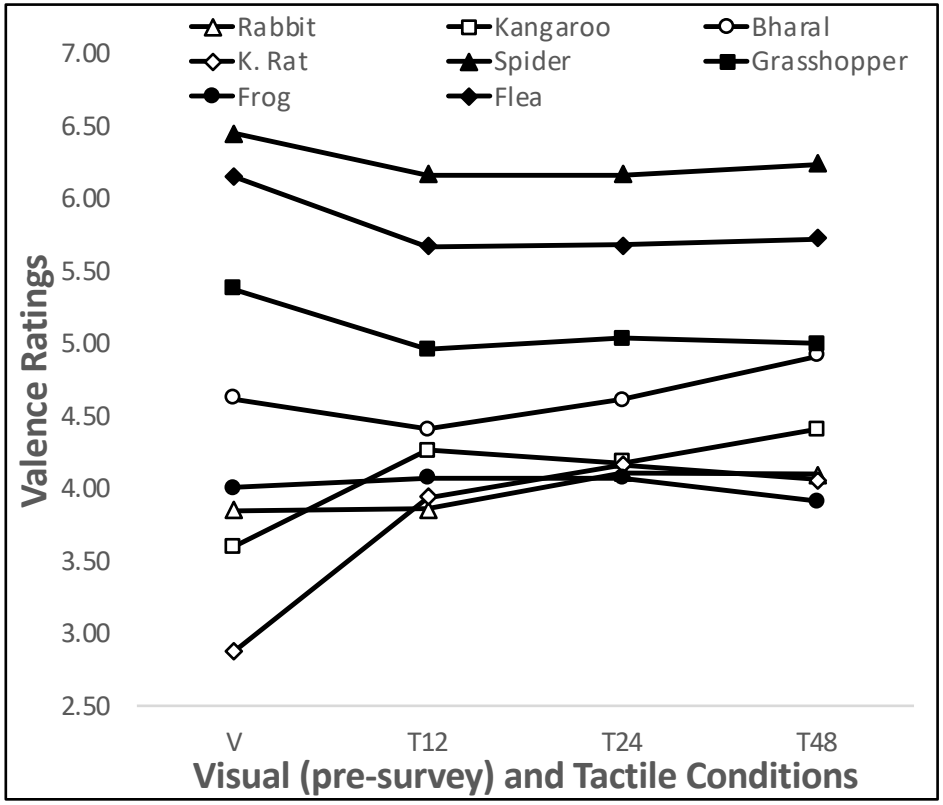
Emotion Intensity

Dominance



Experiment 1: Valence

- ***BD*** ($F_{(6.1, 6.5)}$ = 8.45, ***p < .02***) and ***Saltator*** (***p < .05***)
- T48: Significantly > with largest animals
- T24: > scores for smaller animals
- The less pleasurable the animal, the less variation is noticeable between T12, T24, T48 (***p < .05***)
- The variation is significantly perceptible for pleasant or neutral animal (***p < .05***)

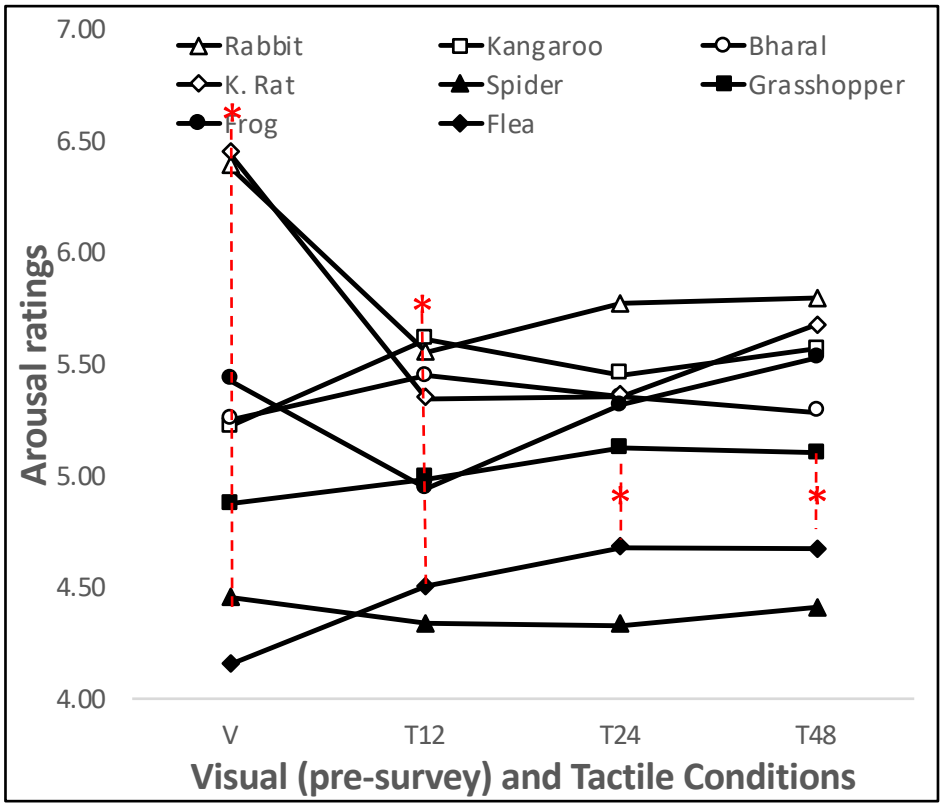


V: Visual condition, **T12:** BD: 12 ms, **T24:** BD: 24 ms, **T48:** BD: 48 ms with **BD:** burst duration

Experiment 1: Arousal

- ***BD*** ($F_{(60.28, 272.24)} = 5.39$, ***p < .02)*** and ***Saltator*** (***p < .05***) factors were significant.
- Significant difference between V and T12, T24, and T48 (***p < .05***).

Calm



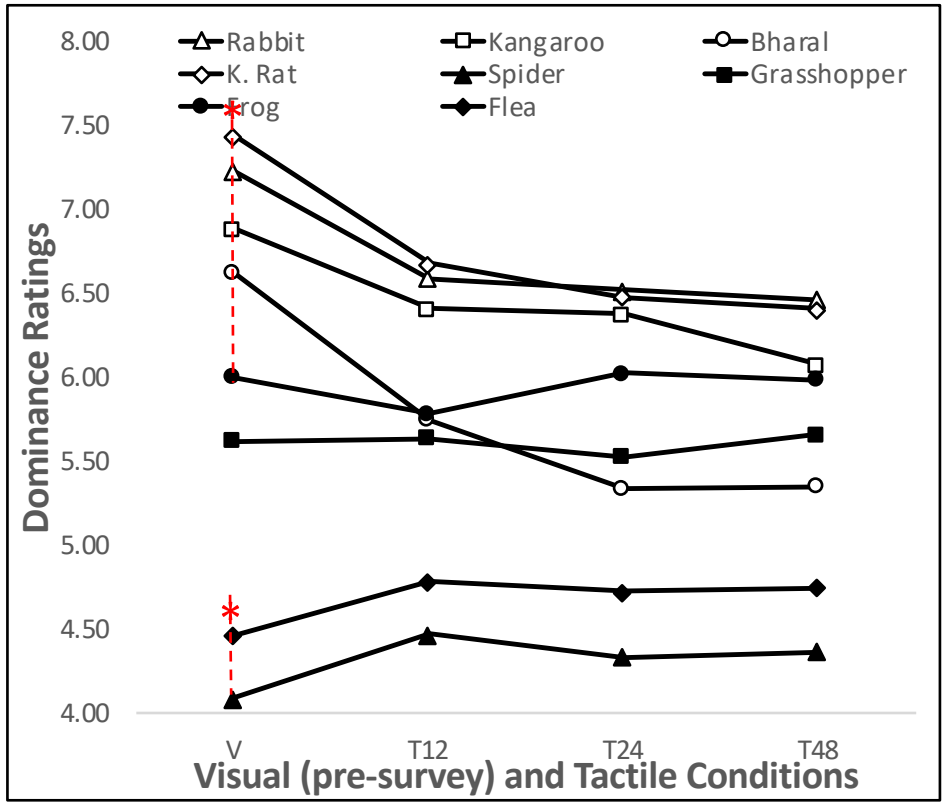
Excited

BD: Burst Duration

Experiment 1: Dominance

- ***BD*** ($F_{(76.25, 271.53)} = 6.27$, ***p < .02***) and ***Saltator*** (***p < .02***) factors were significant.
- Significant difference between V and T12, T24, and T48 (***p < .05***).

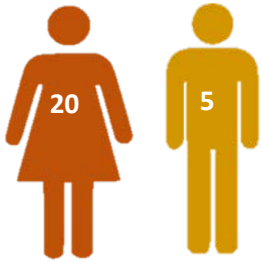
In Control



Controlled

BD: Burst Duration

Experiment 2: Varying IBI



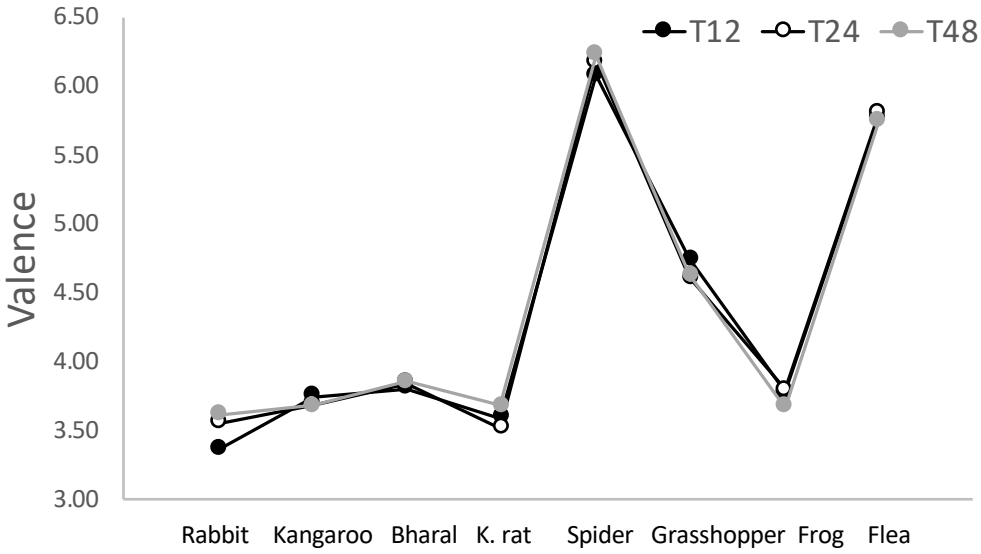
- 25 participants from Northern Michigan University
- 8 saltators
- Two sessions of 120 trials (3 Tactile conditions (T12, T24, and T48) * 8 saltators * 10 repetitions each).
- Post-Survey: Strength Animal-Tactile Association, Phobias

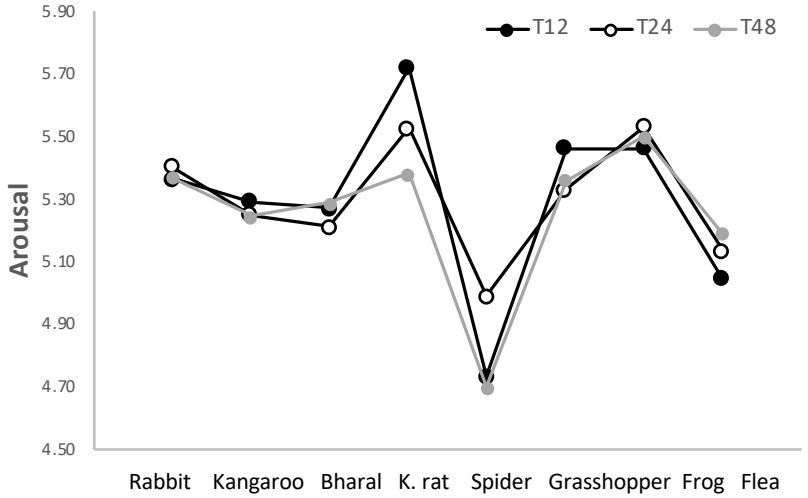
IBI: Inter-Burst Interval

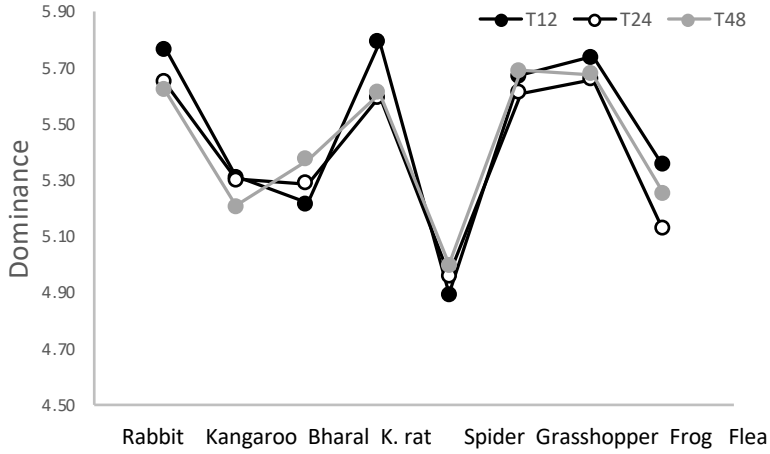
Experiment 2: Results

Two-way ANOVA with factor ***Saltator***

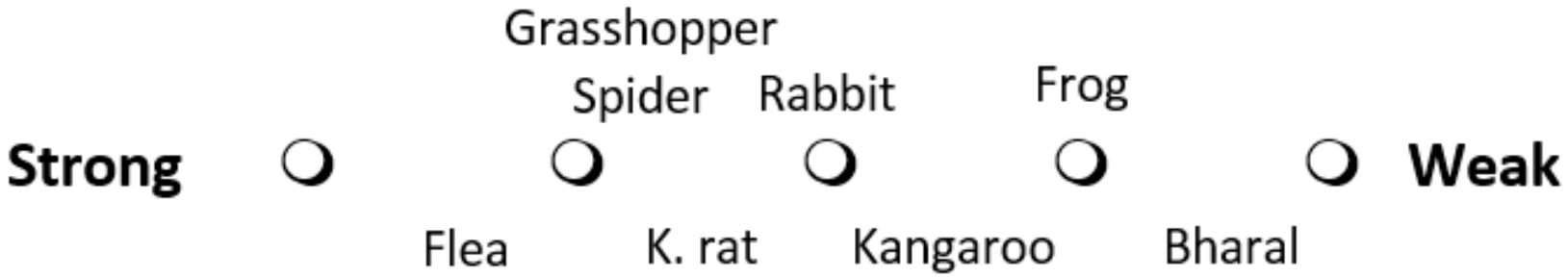
$F(7, 140) = 22.84$, $p < 0.01$ (Valence)







Experiments 1 and 2: Strength Tactile-Animal Association



- The smallest animals were the ones who were associated strongly to the tactile sensation; while largest animals reduced the effect of the hopping sensations.

Discussion and Conclusion

- Varying the Burst Duration (***Exp. 1***) seems more effective for emotional variations than varying the inter-burst duration (***Exp. 2***).
- ***Exp. 1***: Varying the tactile duration affects the valence of the tactile stimulation. Tactile durations:
  - Were rated differently for happy/neutral stimuli
  - were rated similarly when associated with “unhappy” visual stimuli.

→ Similar to human touch

- When an unpleasant or aversive visual stimulus is presented, the tactile stimulation does not need to be sophisticated, as a simple tactile sensation can do the trick.
- When a pleasant visual stimuli is present, the tactile stimulation need to be refined and complex to affect emotionally the user.

Discussion and Conclusion

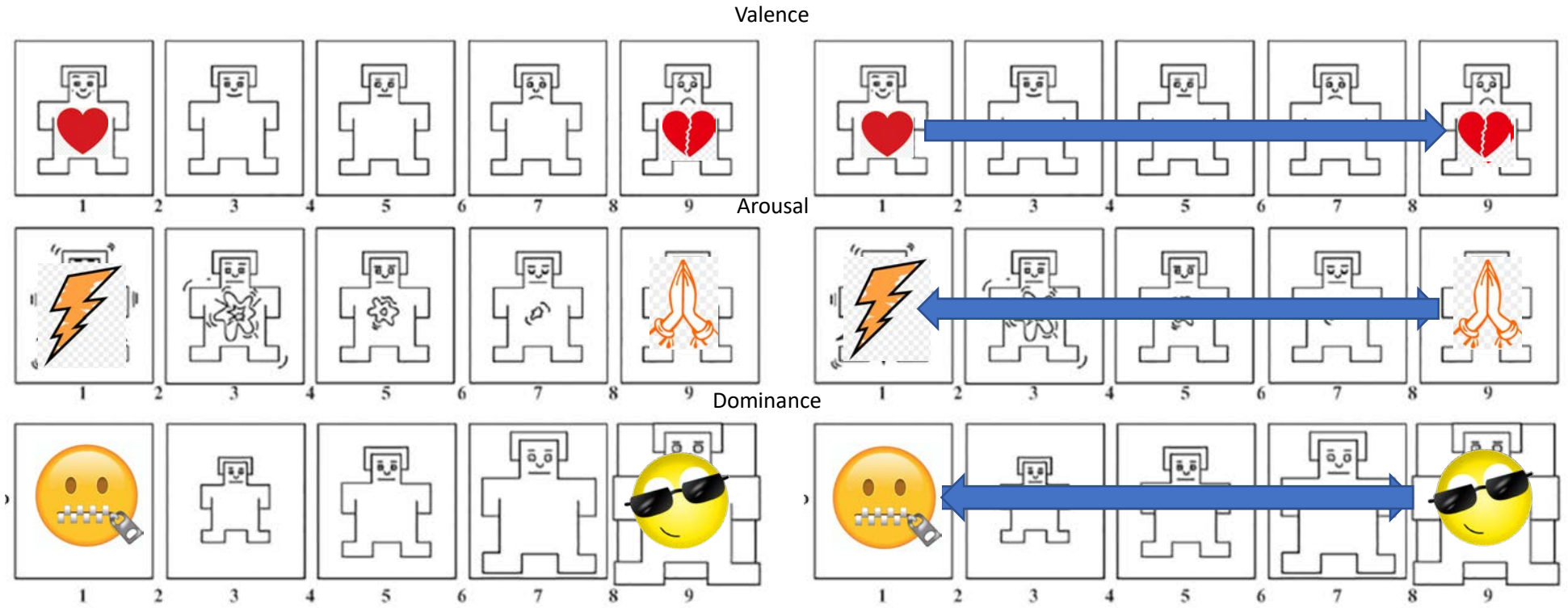
- **Exp. 1:** Arousal and Dominance ratings followed the same trend
  - Stimuli judged “excited”/“controlled” in the visual only condition were rated “calming”/“in control” when associated with any of the tactile stimuli; while the ones judged “calming”/”in control” were rated more “exciting”/“controlling” when associated with the tactile stimulation.

- It can be beneficial if a visual stimulus has a low level of excitement, a tactile stimulation could enhance the arousal/dominance level and the opposite can be true if a visual stimulus has high arousal/dominance levels, a tactile stimulation could help reducing it.

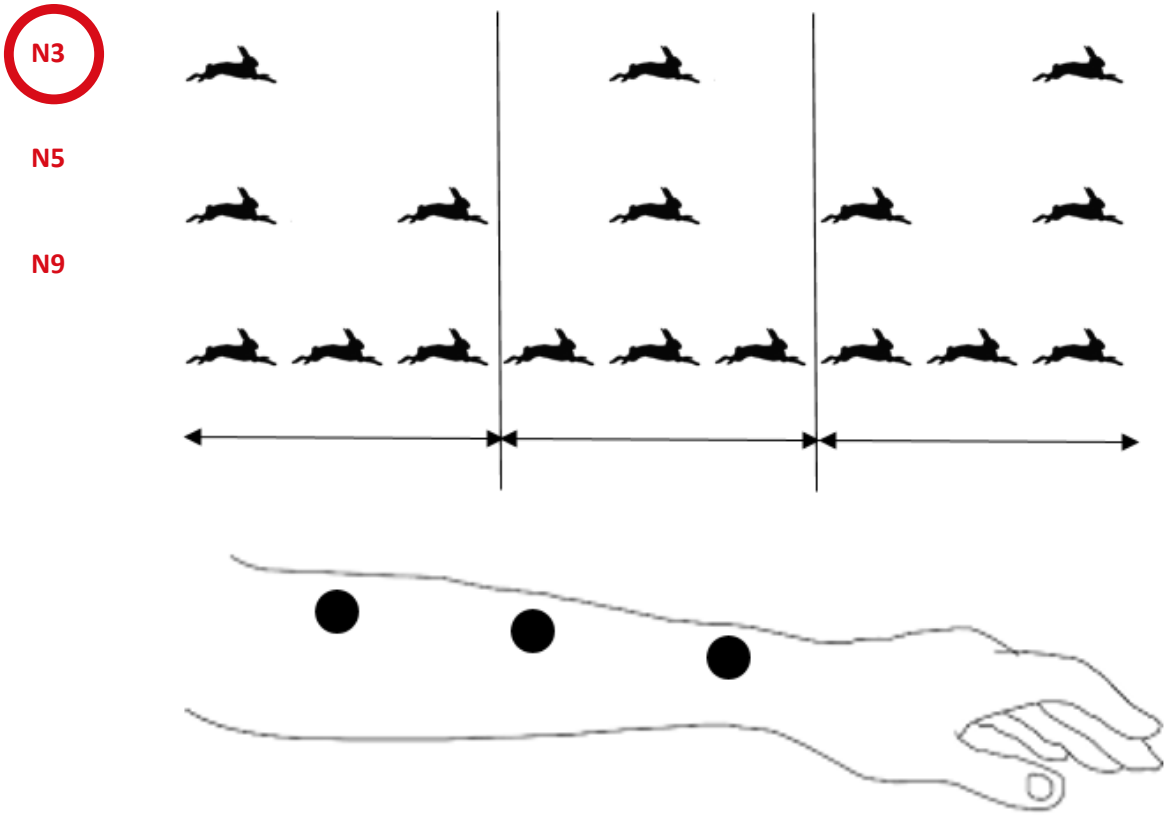
Summary: Self-Assessment Manikin

Visual Emotion

Tactile Modulation of Emotion



Additional findings



Ziat et al., Eurohaptics 2018

Futures Investigations

Landing: Passive
Taking-off: Active

Landing

Taking-off

Landing

Taking-off

Landing

Taking-off

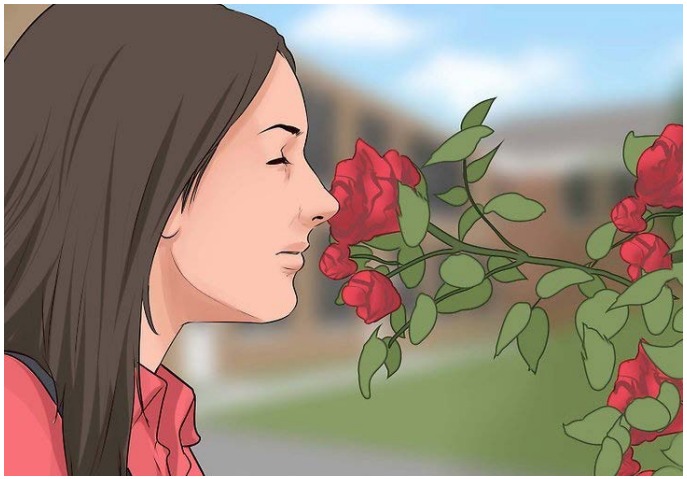
Futures Investigations

Investigating in depth human emotional states

- Looking for new methods of emotional assessment specific to human touch.

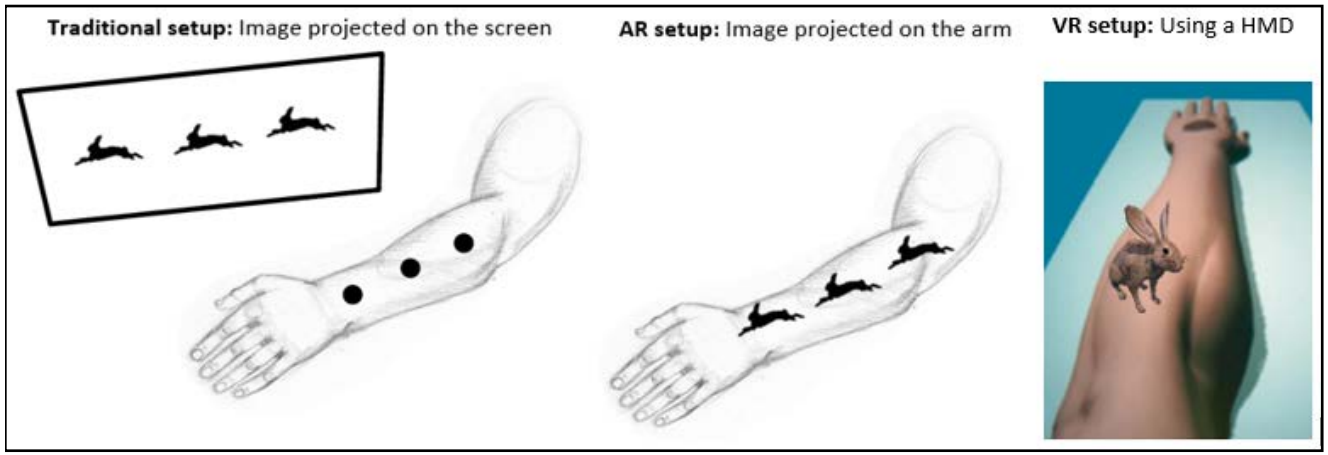
Enhancing the virtual experience

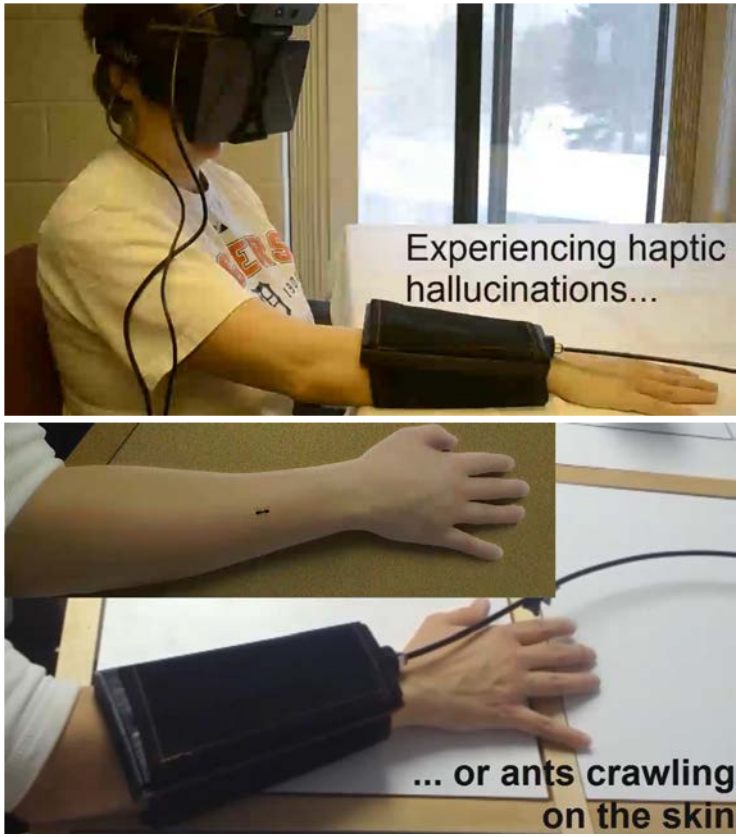
- Multisensory integration: often our emotional reactions are multimodal



Futures Investigations

- **AR Setup:** Images projected directly on the forearm.
- **VR Setup:** Head-mounted display





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ACKNOWLEDGMENTS

Hiroyuki Shinoda, The University of Tokyo, Japan

Roope Raisamo, University of Tampere, Finland

Thank you

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