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# Handbook of Best Practices for Mixed Tactile, Visual and Auditory Stimuli

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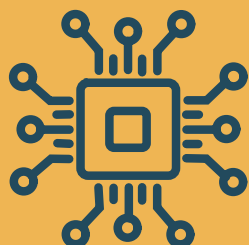
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# Handbook of Best Practices for Mixed Tactile, Visual and Auditory Stimuli



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**MultiTOUCH**

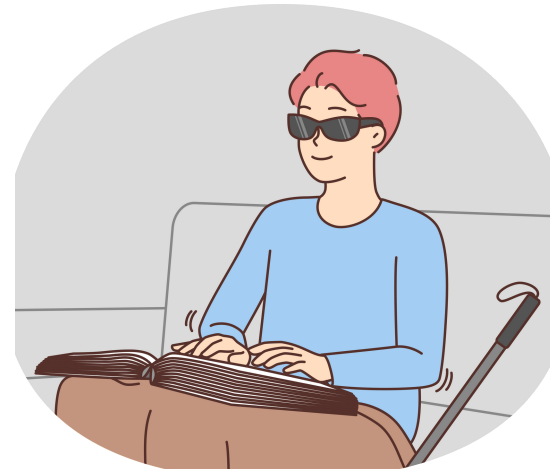


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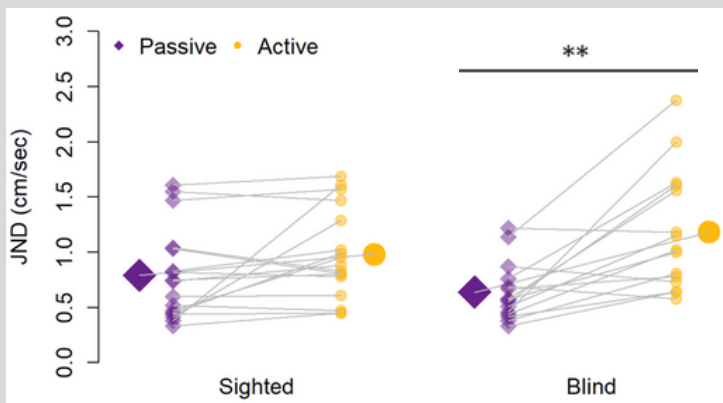
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# Active touch perception in blindness

Motor actions initiate a brain process called movement-related tactile gating, that impact the way we perceive touch. Accurate sensory input and integration are crucial for its effectiveness. Understanding how blindness affects this mechanism is key to developing accessible technology.



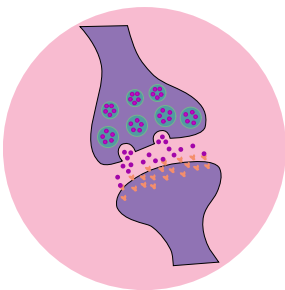
## Implications



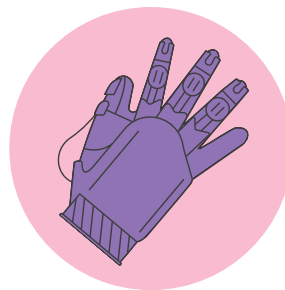
A psychophysical approach revealed a significantly worse precision in blind individuals during active touch conditions compared to passive ones. This difference was not found in the sighted controls.

This finding suggests that blind individuals might experience reduced tactile reliability when exposed to novel tasks involving active touch.

## Applications



Spotlight the need of intervention



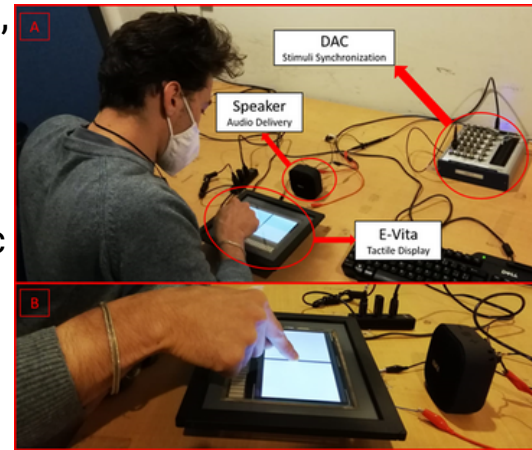
Design of sensory substitution/reinforcement devices



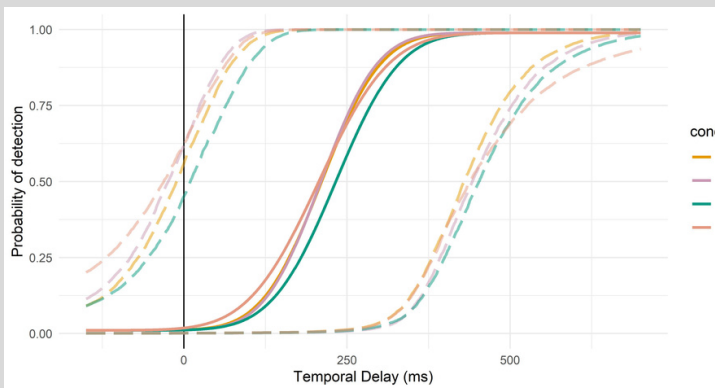
Understanding the role of vision in tactile perception during self-elicited movements

# Audio-tactile synchrony perception in active touch

When a user receives both tactile and auditory inputs, it is important that the two are presented close in time. Achieving an optimal temporal synchronization between the two inputs helps improving user experience when interacting with multisensory haptic displays, where touch feedback is felt through active tactile exploration. Neuroscientific methods, like psychophysics, are especially suitable to study and improve this synchronization.



## Implications



Using psychophysics, we showed that when participants actively explore a haptic display, they tend to perceive auditory and tactile stimuli as synchronous when auditory stimuli are presented around 200 ms after the tactile ones.

## Applications



Define the requirements for multimodal (visuo-audio-haptic) multisensory displays



Understanding audio-tactile interactions in conditions of active touch

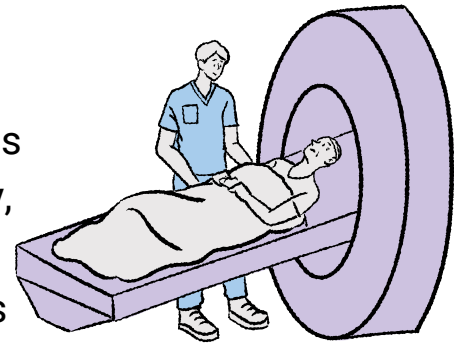


Development of multimodal haptic displays with and without visual feedback

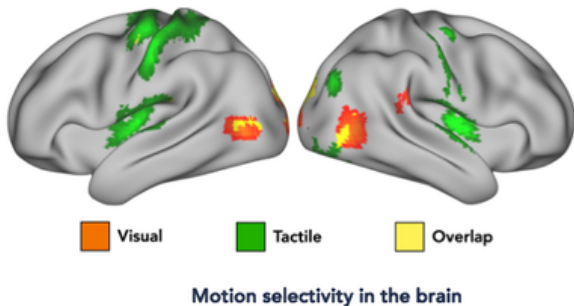
# Alignment of visual and tactile motion-directions in the brain

Motion directions can be perceived through vision and touch. **Where does this motion information coming from different senses match together in the brain?**

The middle occipito-temporal region named hMT+/V5, has been known to process visual motion directions. Recently, it has been seen that it also codes auditory and tactile motion directions also. Therefore, this region can process both visual and tactile motion information by bringing them together on a common map.



## Implications



Using **fMRI and machine learning techniques**, we find that the pattern of activity for visual and tactile motion directions is similar to each other in the brain area called hMT+/V5. This area uses a common external map to bring these sensory modalities together so that we can create a stable percept of the multisensory motion directions.

## Applications



Assistive haptic technologies for navigation



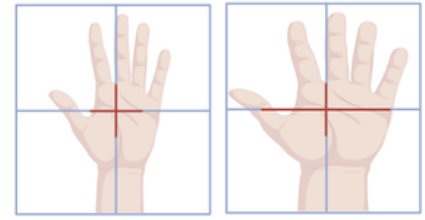
Understanding crossmodal plasticity resulting from visual deprivation in blinds



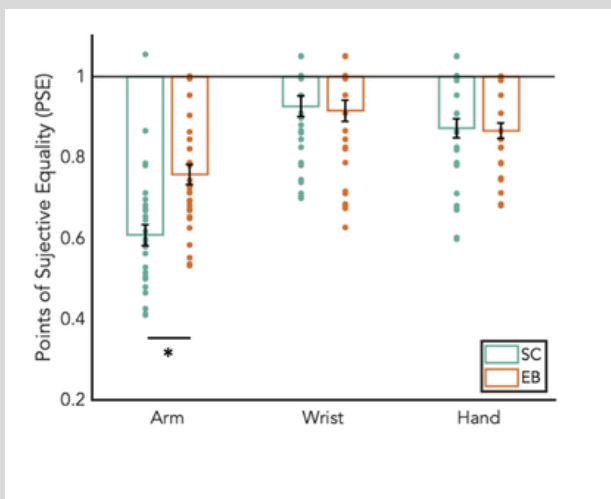
Search for new multisensory areas in the human brain

# The causal role of visual experience in body-shape representation

The representation of touch on our body is not accurate. For instance, tactile distances across the limb are perceived as larger than those running along the limb. This anisotropy in tactile distance perception reflects how body parts are generally perceived wider than they are. To causally test the role of visual experience on body shape representation, we compared tactile distance anisotropies in the sighted and early blind individuals.



## Implications



Tactile distance anisotropies are present in both sighted and early blind individuals. This suggests that the forelimbs are generally perceived wider and this phenomenon is independent of visual experience.

The anisotropies are modulated by vision only on arms and not on hands, suggesting that vision is partially modulating body shape representations.

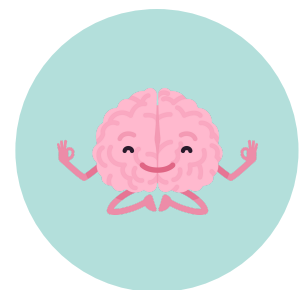
## Applications



Understanding mechanisms underlying body-shape representation



Distorted body representations in conditions such as anorexia nervosa



Psychological well-being, including body satisfaction and self-esteem



# Spatial Haptic: Tactile space perception in VR

Vibrotactile Headphones can be used to provide haptic-based directional information.

Vibrations at the ear level represent an effective body location for guidance in different application domains.



## Implications



Vibrations Headphones allow users to perceive and locate non-visible objects in Virtual Reality without the use of further information.

This method can also be applied outside VR, where it provides additional sensorial cues, such as in situations of reinforcement or substitution of another sense.

## Applications



Navigation scenarios coupled with web-based maps



Guidance for people with sensory disabilities



Enhancing the gaming experience and immersion in VR and beyond

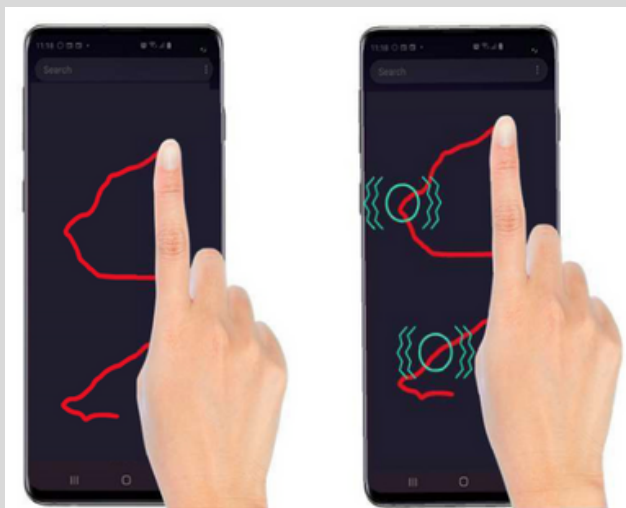
# An eyes-free interaction technique using gestures and haptics

Eyes-free smartphone use, needed in situations like driving, presents challenges without visual feedback. Finding simple, effective ways to interact using touch is crucial for accessibility and safety.

We introduced an interaction concept which allows to give command to phone using eyes-free gestures and retrieve information from it by combining haptic feedback of smartphone and gesture drawing.



## Implications



Using a gesture elicitation study, we gathered end users' most preferred input gestures, output gestures, and haptic feedback types for a total number of 25 interaction scenarios involving various smartphone tasks.

## Applications



Touchscreen manipulation while driving without distracting visual attention



Improving interaction with smartphone for blind people



Private retrieval of information through the haptic channel only for the target user

# Enhancing in-pocket smartphone interaction using haptic feedback

With smartphones becoming an indispensable part of our daily routines, the need to retrieve them from pockets or bags often leads to disruptions and potential safety hazards.

We conducted a study to explore the effects of haptic feedback on gestures performed on pocket fabrics can be a means of interacting with smartphones.



## Implications



Our results showed that users prefer receiving vibrations on the smartphone, but not the smartwatch, as a confirmation for touch input.

Users prefer a continuous vibration feedback throughout the gestures they draw on the pocket.

## Applications



Subtle use of smartphones in social situations, such as during meetings



Doesn't allow thieves to steal your smartphone since you are not actually holding it



Enables smartphone use while secured in the pocket and prevents it from falling, e.g., during jogging

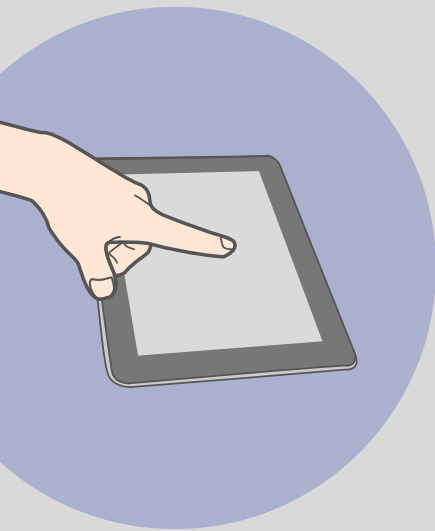
# Using distal vibrotactile feedback

Distal vibrotactile feedback can be used to enhance the User Experience (UX) of touchscreen input.

It is important to know the locations on the body where vibrotactile feedback should be delivered to achieve a high-quality experience in various scenarios.



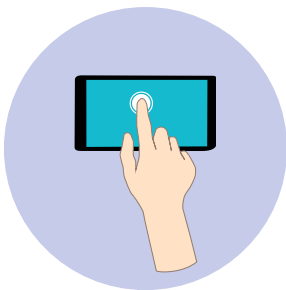
## Implications



During touch input, vibrotactile feedback should be delivered on areas close to the interaction point, such as the finger or wrist.

The significance of vibrotactile feedback decreases as the body location is farther away from the touch point, during eyes-free interaction, or when the hands are not in view.

## Applications



Enhancing UX for entertainment applications



Enhancing the driving experience with distal vibrotactile cues



Providing distal feedback for wearable users, e.g., guiding joggers during their exercise

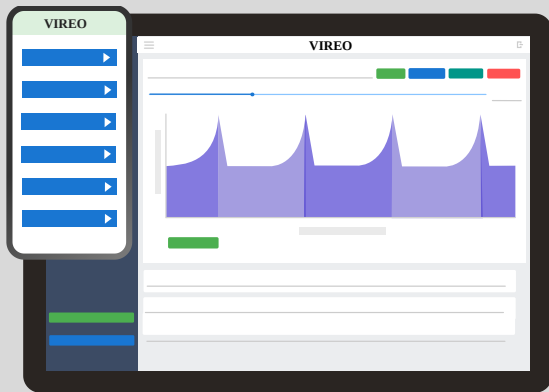
# Effective design of vibrotactile patterns using web technologies

Vibrotactile feedback can significantly improve the usability and user experience of mobile and wearable applications.

Effective design and implementation of vibrotactile feedback into end-user applications is essential for enhancing user experience.



## Implications



Software tools for integrating vibrotactile feedback into applications increase their usage and expand the use of haptic technology beyond hapticians.

Web technologies enable mobile and wearable devices to render complex vibrotactile patterns.

## Applications



Increasing the accessibility of vibrotactile feedback for web applications



Assisting task execution on wearables with an enhanced user experience



Conveying information through vibrotactile feedback for mobile and wearable interactions



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