The Effect of Extended Sensory Range via the EyeCane Sensory Substitution Device on the Characteristics of Visionless Virtual Navigation

S Maidenbaum, S Levy-Tzedek, DR Chebat, R Namer-Furstenberg, and Amir Amedi

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Summary

Mobility training programs for helping the blind navigate through unknown places with a White-Cane significantly improve their mobility. However, what is the effect of new assistive technologies, offering more information to the blind user, on the underlying premises of these programs such as navigation patterns? If these devices require different paradigms, could that be one of the causes from problems in their adoption?

We have previously developed such a device, named the EyeCane (Maidenbaum et al. RNN 2014), a small flashlight-like device which transforms the distance to a target into the rate of auditory cues, letting the user reach out and feel the world around him with a range of 5 meters. The EyeCane can augment a White Cane with further distance, more angles protecting from high obstacles, and offers a non-obtrusive way to explore one's environment. We've previously used the EyeCane and demonstrated that even after only 5 minutes of training users can avoid obstacles and navigate in simple environments such as university corridors (Maidenbaum et al. RNN 2014, Buchs et al. EuroHaptics 2014). "This simple device can be a great mobility boost for the blind" says the head of the research team Prof. Amedi, "it is simple and fast to learn, and you immidiatly feel the benefits. All of our users really wanted to take this device home with them".

On this device we modeled the virtual-EyeCane, a minimalistic sensory substitution device translating single-point-distance into auditory cues identical to the EyeCane's in the real world. This virtual device has already been used for tasks such as shape recognition (Maidenbaum et al. ICDVRAT 2012) and navigation in simple virtual environments (maidenbaum et al. PLoS1 2013).

We then compared navigation in a series of different virtual environments when using the virtual-EyeCane, a virtual-White-Cane, no device and visual navigation. "the blind users enjoyed this experiment to the point that they wanted to take it home as a game"

Says prof Amedi "they had a lot of fun with it, and some had always wanted to play first person style maze games." And then added jokingly "Though to their professed disappointment of some of them no shooting was involved in these games".

We show that the characteristics of virtual-EyeCane navigation significantly differ from navigation with a virtual-White-Cane or no-device, and that virtual-EyeCane users complete more levels successfully, taking shorter paths and with less collisions than these groups, and we demonstrate the relative similarity of virtual-EyeCane and visual navigation patterns.

This suggests that additional distance information indeed changes navigation patterns from virtual-White-Cane use, and brings them closer to visual navigation. "in many cases you can barely tell the virtual EyeCane routes apart from visual ones" explains Shachar Maidenbaum, one of the researchers who worked on this project "in contrast, the routes of the users of White Canes always avoided the centers of rooms and stayed by the walls. This led to much lower success rates and much longer routes, especially in the more complex environments".

For more information about the EyeCane and the work of the Amedi lab in general visit brain.huji.ac.il or follow us on twitter at @Amedilab. If you'd like to hear a bit more about our work in general please watch this TEDx talk at https://www.youtube.com/watch?v=jVBp2nDmg7E

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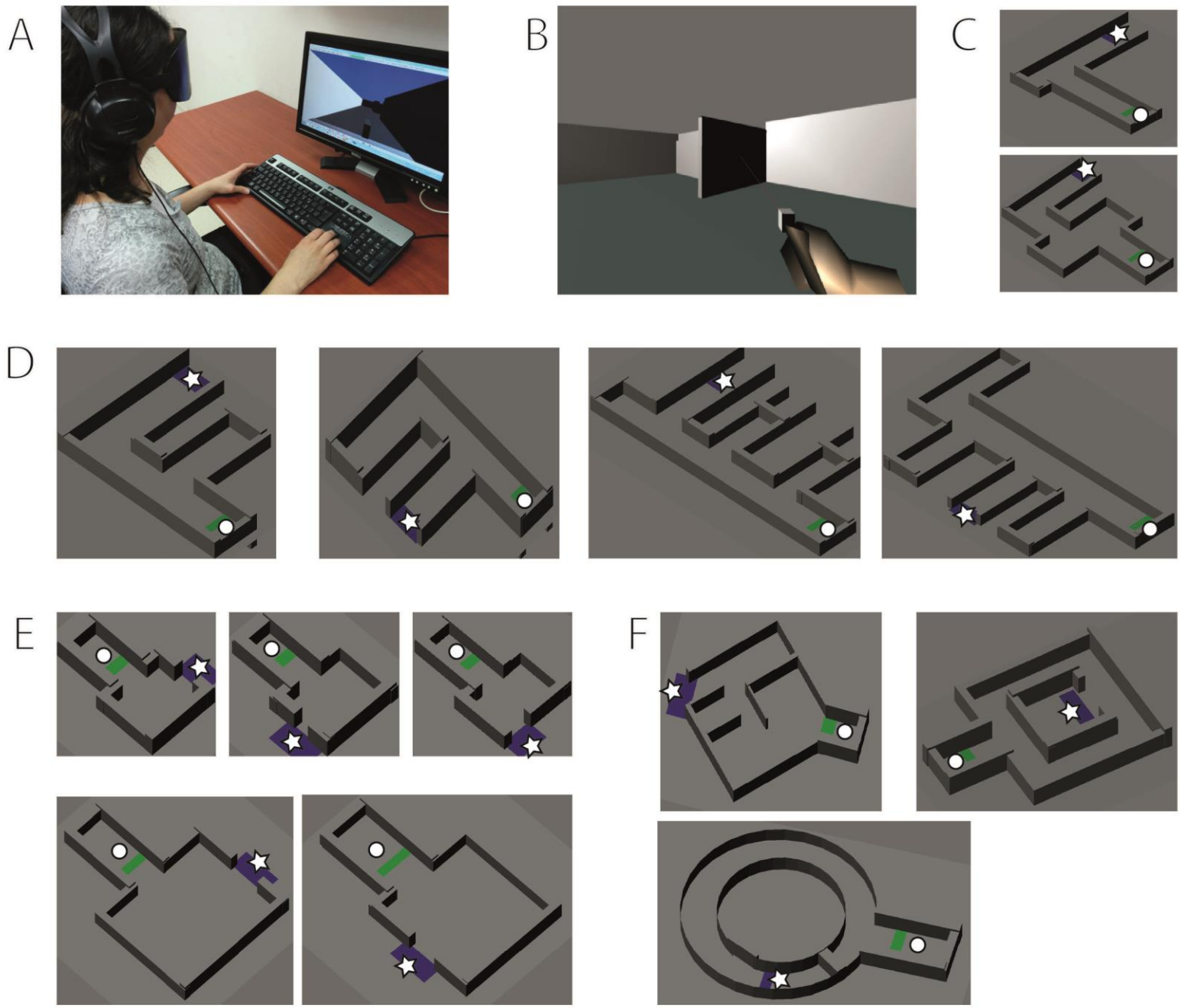
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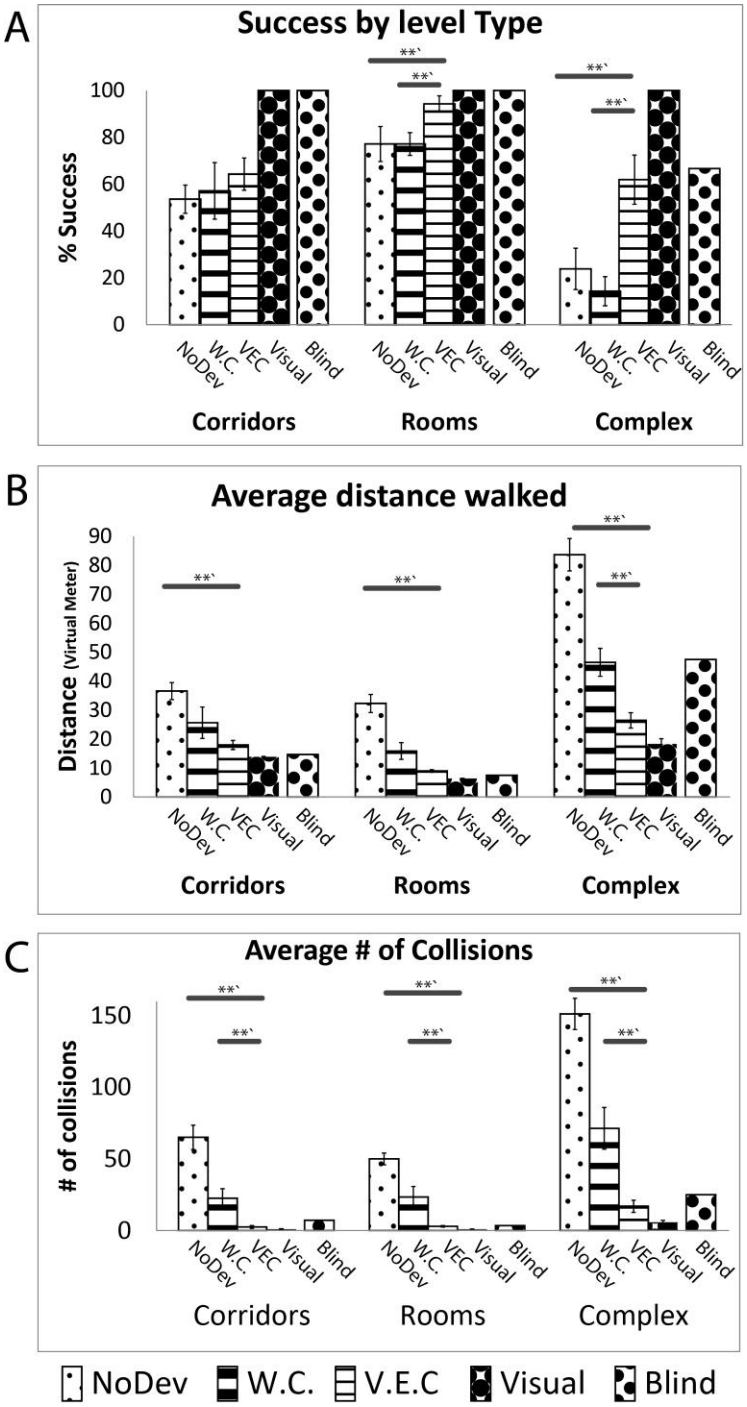
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0
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VEC
Visual
Blind
Corridors
Rooms
Complex
B
Average distance walked
Distance (Virtual Meter)
90
80
70
60
50
40
30
20
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Average # of Collisions
# of collisions
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50
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NoDev
W.C.
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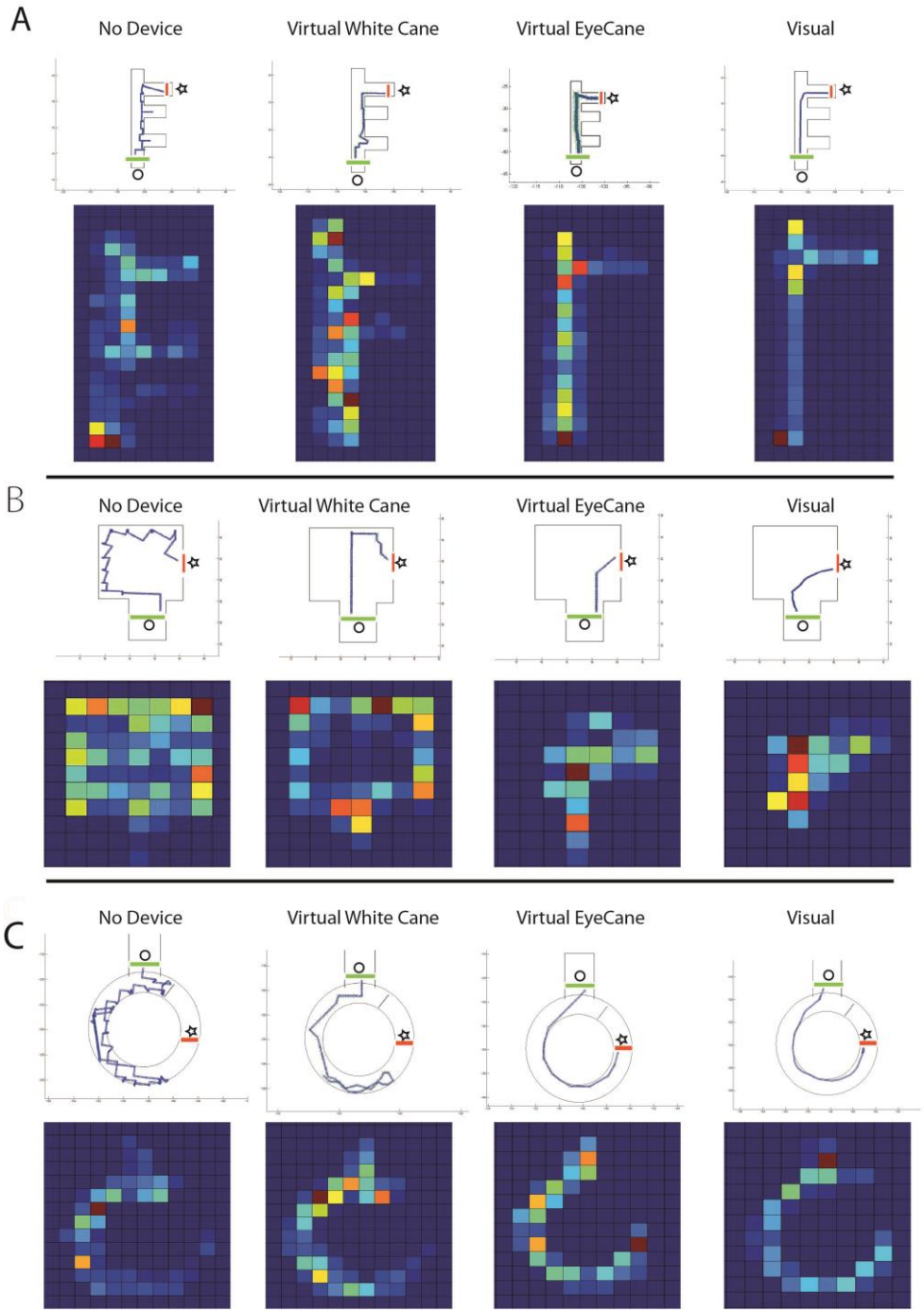
Blind


A
No Device
Virtual White Cane
Virtual EyeCane
Visual
B
No Device
Virtual White Cane
Virtual EyeCane
Visual
C
No Device
Virtual White Cane
Virtual EyeCane
Visual