Sensorimotor synchronization to auditory and visual cues in ageing and Parkinson’s disease

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About VERVE

Falls and fear of falling

Older adults with fear of falling one principal reason
30% of adults over 65 fall each year
• Fear of falling one principal reason
• Poor balance control
• Poor lighting conditions
• Poorly illuminated places
• Proximal surfaces (e.g., walkway outdoor variability)

Steps

• People walking
• Turning around
• Getting up from chair

Freezing of gait in PD

• Slow starting
• Mojarrabian
• Fatigue

Falling &/or history of falls

• No available cure for freezing of gait

• > 1 million persons with PD in Europe
• No available cure for freezing of gait

With Auditory Cues

No auditory cues

Background

Successful interventions for reducing freezing of gait and improving mobility

 Argentine Tango

RCT of tango vs no intervention in PD

Dramatic improvement in gait, balance, and reductions in freezing in PD patients after argentine tango classes

(Duncan & Earheart, Neurorehab. Neural Re., 2012)

Irish Set Dancing

2 hr/wk for 6 months dance vs physiotherapy

Improvement seen only in dance group:

• Falls, FOGQ, Timed Up & Go
• Stride length and stride speed

Völpe et al., Movement Disorders, 2012

Importance of rhythmic external cues for improving gait and reducing freezing

Questions

• Sensorimotor synchronization to multisensory cues is better compared to unisensory cues in young and older adults (Elliott et al., 2011). Is multisensory cue integration for synchronization affected in Parkinson’s disease?

• Although persons with PD show no deficits in synchronizing to simple metronome beat, rhythmality of compensation movements after cues are removed is impaired in PD, especially in those with FoG (Vercruyssse et al., 2012). Does the type of external cue (unisensory/multisensory) affect rhythmical movement performance in the continuation phase (i.e., after cue removal)?

Perception of timing in human motion

• Timing of moving objects is important in perceiving causality (Michotte, 1963)
• Motion perception declines with healthy ageing (e.g., Pilz et al., 2010, Roudaia et al., 2010)

Does healthy ageing affect perception of timing of complex motion?

Task 2 AFC: Did the person being pushed start moving before or after the push?

Natural timing

Delays reaction

Early reaction

Conditions: time mismatch of -0.40, -0.20, -0.10, -0.025, 0.0, 0.025, 0.05, 0.10, 0.20, 0.40 s

Results

Timing mismatch yielding 50% “Early” responses

Example: Time mismatch: Y = 52 ms, O = 129 ms

Older subjects require the target to move ~ 52 ms earlier than younger subjects to detect the anticipatory reaction.

Some follow-up experiments:

1. Will inclusion of “push” sound at t = 0 improve performance? In both groups?

2. Will subjects show similar deficits with simple moving stimuli such as discs?

Experimental paradigm

Task: bipedal synchronization/continuation

SYNCHRONIZATION

CUES ONLY + Tapping (20 s)

CONTINUATION

Tapping (20 s)

Cues: visual only, audio only, or audio-visual visual cues = discrete flashes on blank background or within VR corridor audio cues = metronome vs footsteps vs musical beat

Complexity: 3 speeds of rhythmic cues

normal walking pace, 10% faster than walking pace, 10% slower

Measures: degree of synchronization, variability in movement frequency in continuation phase EEG correlates in synchronization/continuation phases

References


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