

# RESOLVING CONFLICTS IN TASK DEMANDS DURING BALANCE RECOVERY: DOES HOLDING AN OBJECT INHIBIT COMPENSATORY GRASPING?

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## Introduction:

Ability to use the arms to reach and “grasp” (grip or touch) external structures for support in reaction to instability is an important element of the postural repertoire<sup>1</sup>. It is unclear, however, how the central nervous system (CNS) resolves the conflict in task demands that arises if an object is held in the hand, particularly if that object is perceived to provide stabilization, i.e. an assistive device. This study examined how initiation of “compensatory grasping” is affected when holding an object, and the influence of: 1) the nature of the held object, 2) prior activation of arm muscles, and 3) direction of the falling motion (forward or backward “loss of balance”, LOB).

## Methods:

Postural reactions were evoked in 16 healthy, right-handed young adults (23-34) via sudden, unpredictable platform translation. A handrail was mounted on the platform to the right of the subject. Subjects held: 1) no object, 2) a cane (instrumented to monitor loading), or 3) a “neutral” object (the top handle portion of a cane). The cane was either unloaded or loaded (10% body weight) prior to perturbation, and held in either the right or left hand. To create a clear conflict in task demands, foot motion was constrained by barriers and subjects were told not to move the feet. The intention was that successful balance recovery would

require the held object to be released in order to use the right hand to contact the rail, in trials involving the largest perturbations, and that failure to do this would cause the subject to fall against a safety harness or padded barriers. Video recordings and biceps EMG latency and amplitude (first 100ms of initial burst) used to characterize the arm reactions evoked by the largest perturbations.

## Results and discussion:

Right-arm grasping reactions were commonly used to recover balance when the right hand was free (70% of trials); however, holding an object in the right hand had a potent modulating effect. In reacting to backward LOB, subjects contacted the rail in only 41% of cane-top trials and 34% of cane trials. For forward LOB, the rail was contacted in just 19% of cane-top trials and only 7% of cane trials. Subjects released and dropped the cane or cane-top before contacting the rail in 39% of cases but more commonly (61% of cases) released the object partially (freeing 1-3 fingers to contact the rail). Although non-contact trials typically showed little evidence of any overt effort to reach toward the rail (93% of cases), the arm reaction was seldom completely inhibited. In fact, a reaction in right biceps was recorded in 96% of trials. There was, however, a substantial reduction in amplitude of biceps activation (27-36%), as well as a small delay in latency (13-

15ms), when the cane or cane-top was held in the right hand versus when that hand was free ( $p's < 0.001$ ). Prior contraction (loading the cane) did not influence any of the findings.

The results indicate that holding an object can have a profound effect on the control of upper-limb balance reactions. Although arm reactions were seldom completely inhibited, arm-muscle activation was reduced and delayed and reaching movements to contact the rail became much less frequent when holding an object. In some trials, complex strategies (e.g. partial release of object) were adopted to allow the hand to contact the rail without dropping the object. It appears that the CNS may prioritize the ongoing task of holding an object, even when it has no stabilizing value (cane during backward LOB) or any intrinsic value whatsoever (cane-top). It seems remarkable that the CNS would prioritize this task, given the potential consequences (e.g. relying on a safety harness to prevent falling). The findings may have implications for fall prevention (e.g. guidelines for safer use of canes).

### **Summary:**

Our findings indicate that holding an object has a significant effect on compensatory grasping. While grasping was used frequently to recover balance when the subject was not holding an object, it was often delayed or inhibited when the subject was holding an object. Our results indicate that, regardless of an object's usefulness, the CNS prioritizes the task of holding an object over the task of compensatory grasping in challenging balance situations.

### **Reference:**

1. Maki BE, McIlroy WE. Phys Ther 1997;77:488-507.