

## CONSTRAINTS ON GRIP-SELECTION: MINIMIZING AWKWARDNESS<sup>1</sup>

MARK G. FISCHMAN

*Motor Behavior Center, Auburn University*

*Summary.*—In picking up and manipulating an object, the selection of an initial grip (overhand versus underhand) often depends on how comfortable the hand and arm will be at the end of the movement. This effect has been called “end-state comfort” and seems to be an important constraint in grip-selection. The present experiment further explored this effect by selecting a task that would ensure a comfortable ending position regardless of the initial choice of grip. 206 undergraduates picked up a cardboard paper-towel roll from a horizontal position and placed one end down on a table. Analysis showed a clear preference for the overhand grip, as 78% of the participants chose this grip. In addition, more women preferred the overhand grip than men. The findings indicate that people may be sensitive to minimizing awkwardness in both terminal and initial positions.

Consider a wooden dowel, approximately a foot long, resting horizontally across two supports on a table. If instructed to approach the table and pick up the dowel with the right hand and place one end straight down on the table, the selection of a grip (overhand versus underhand) will depend on which end of the dowel must be placed down. In 1990 in Exp. 1 Rosenbaum and colleagues (3) found that all 12 subjects used an overhand grip when placing the right end down, and an underhand grip when placing the left end down. These grip choices would be mirror images were the left hand used. Grasping the dowel with these initial postures ensures that the task can be completed with the hand and arm in a comfortable posture rather than an awkward one. For example, were an overhand grip used to place the left end of the dowel on the table, the arm would be twisted into an uncomfortable position of extreme pronation. The desire to minimize awkwardness at the end of simple manipulation tasks was called the “end-state comfort” effect (3). The effect has also been shown to apply to handle-rotation tasks (4, 5, 6) and to sequential movements of an object to targets that vary in height (1, 2, 7).

The present experiment further explored the end-state comfort effect. The task selected ensured a comfortable ending posture regardless of the initial choice of grip. Participants were asked to pick up a bar supported horizontally and place either end down on a table. Interest lay in which ini-

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tial grip individuals would choose when end-state comfort is independent of this choice. Were the desire to minimize awkward limb postures a more general constraint on grip selection, then it was predicted that people would prefer an overhand grip. This prediction is based on another finding from Rosenbaum, *et al.*'s study (1990), in which people grasped and held a bar in a static horizontal position. An underhand grip was rated as more awkward than an overhand grip. Thus, the present purpose was to assess whether, given two ways to grip an object and arrive at the same comfortable ending posture, people choose a grip that minimizes awkwardness at the beginning of the movement.

*Method.*—Undergraduate students ( $N=206$ ) participated as part of a course requirement. There were 90 men and 116 women. Each provided informed consent prior to performing the task.

A pair of metal bookends, 22.9 cm high, spaced 26.04 cm apart, were placed on a standard table. A cardboard insert from a paper-towel roll (31.1 cm long  $\times$  3.8 cm diameter) rested horizontally across the top of the two bookends. Centered between the ends of the paper-towel roll and slightly in front of it on the table was a dime. The following instructions were taped to the edge of the table, just in front of the dime: "Please pick up the paper-towel roll and stand it on end so that it covers the dime. You may use either hand you prefer. Please grip the roll in the center."

Participants stood in the doorway of the testing room, about 1.5 m from the table. They then approached the table, read the instructions, and then picked up the paper-towel roll and stood it on end, covering the dime. Each participant performed the task once. The experimenter recorded the data and replaced the paper-towel roll on the bookends. Data consisted of the hand chosen (left or right), the grip used (overhand or underhand), and which end of the paper-towel roll (left or right) was placed on the dime. Regardless of which hand or grip was chosen, the task could be completed in a comfortable thumb-up posture. The chi-squared statistic was used to test for differences in grip preference.

*Results and discussion.*—An overwhelming majority of the participants, 187, performed the task with the right hand; only 19 used the left hand. There was a clear preference for the overhand grip, which 78% of the participants selected; only 22% selected the underhand grip ( $\chi_1^2=63.08$ ,  $p<.001$ ) which supports the prediction that participants would choose to minimize awkwardness at the beginning of the movement. It is also important to note that, although it was possible to do so, no one completed the task in an awkward thumb-down posture. Thus, awkwardness was minimized at the end of the movement.

There were also significant sex differences in choice of grip, as more women clearly preferred the overhand grip than men ( $\chi_1^2=11.39$ ,  $p<.001$ ).

For example, 86% of the women used the overhand grip, whereas 67% of the men used it. These sex differences are striking and certainly deserve further study. At this point, there appears to be no theoretical, anatomical, or mechanical reason to account for these results.

Recently Rosenbaum, *et al.* (4) reported that, when a hand-held stick had to be oscillated back and forth in central, medial, and lateral portions of the pronation-supination range, pronation movements were faster than supination movements. If the current participants maximized the speed of their movement (although they were not instructed to do so), then a preference for the underhand grip should have been found, since the underhand grip would allow the task to be completed by pronating the arm. By contrast, the overhand grip requires that the arm supinate to complete the task, so the hypothesis that movement speed may have driven participants' grip selection may be rejected. Taken together, the present findings suggest that people are sensitive to minimizing awkwardness both in terminal positions and in initial positions. Such sensitivity acts as a constraint that helps limit choices of movement.

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