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A Peg Board with Photo-Reflectors to Detect Peg Insertion and Pull-Out Moments

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Abstract : Various kinds of pegboards have been developed and used widely in research and clinics of rehabilitation for evaluation and training of patient's hand function. A common measure in these peg boards is a total time of performance execution assessed by a tester's stopwatch. Introduction of electrical and automatic measurement technology to the apparatus, on the other hand, has been delayed. The present work introduces the development of a pegboard with an electric sensor to detect moments of individual peg's insertion and removal. The work also gives fundamental data obtained from a group of healthy young individuals who performed peg transfer tasks using the pegboard developed. Through trails and errors in pilot tests, two 10-hole peg-board boxes installed with a small photo-reflector and a DC amplifier at the bottom of each hole were designed and built by the present authors. The amplified electric analogue signals from the 20 reflectors were automatically digitized at 500 Hz per channel, and stored in a PC. The boxes were set on a test table at different distances (25, 50, 75, and 125 mm) in parallel to examine the effect of hole-to-hole distance. Fifty healthy young volunteers (25 in each gender) as subjects of the study performed successive fast 80 time peg transfers at each distance using their dominant and non-dominant hands. The data gathered showed a clear-cut light interruption/continuation moment by the pegs, allowing accurately (no tester's error involved) and precisely (an order of milliseconds) to determine the pull out and insertion times of each peg. This further permitted computation of individual peg movement duration (PMD: from peg-lift-off to insertion) apart from hand reaching duration (HRD: from peg insertion to lift-off). An accidental drop of a peg led to an exceptionally long (< mean + 3 SD) PMD, which was readily detected from an examination of data distribution. The PMD data were commonly right-skewed, suggesting that the median can be a better estimate of individual PMD than the mean. Repeated measures ANOVA using the median values revealed significant hole-to-hole distance, and hand dominance effects, suggesting that these need to be fixed in the accurate evaluation of PMD. The gender effect was non-significant. Performance consistency was also evaluated by the use of quartile variation coefficient values, which revealed no gender, hole-to-hole, and hand dominance effects. The measurement reliability was further examined using interclass correlation obtained from 14 subjects who performed the 25 and 125 mm hole distance tasks at two 7-10 days separate test sessions. Inter-class correlation values between the two tests showed fair reliability for PMD (0.65-0.75), and for HRD (0.77-0.94). We concluded that a sensor peg board developed in the present study could provide accurate (excluding tester's errors), and precise (at a millisecond rate) time information of peg movement separated from that used for hand movement. It could also easily detect and automatically exclude erroneous execution data from his/her standard data. These would lead to a better evaluation of hand dexterity function compared to the widely used conventional used peg boards.

Keywords : hand, dexterity test, peg movement time, performance consistency
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