RELIABILITY OF REGISTRATIONS OF DAILY LIFE ACTIVITIES MONITORED WITH MULTIPLE BODY WORN SENSORS

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Introduction and Objectives: Stroke patients or (children with) cerebral palsy often encounter arm-hand problems in daily life, assessment of which is important. Whereas many instruments are available to assess capacity or perceived performance, tools gauging actual skill performance are scarce (Lemmens et al., 2012). Body worn sensors quantifying specific movement patterns associated with specific activities may be used to assess actual performance. However, signal reliability during execution of activities of daily living should be determined first.

Aim of this study is to determine to what extent standardized arm-hand skill performance of both healthy adults and children can be recorded reliably using multiple body worn sensors.

Methods: Thirty healthy adults (aged > 50years, 14 women, 16 men, mean age 58.0 ± 5.1 years) and 32 healthy children, i.e. 16 aged between 6-11 years (9 girls, 7 boys, mean age 8.5 ± 1.7 year) and 16 aged between 12-18 years (8 girls, 8 boys, mean age 14.6 ± 1.5 years) performed the activities 'drinking', 'eating' and 'combing' 5 times in a standardized setting. Tasks were first performed without, and subsequently with extensive instructions on how to perform the task. Sensor devices, each containing a triaxial accelerometer, gyroscope and magnetometer were attached to the arms, hands and trunk, i.e. four devices to the dominant arm-hand and chest of the adults and seven devices to both arms and hands and the chest of the children. Signals were filtered with a 4th order zero-time lag low-pass Butterworth filter (cut off freq.: 1.28 Hz). Repetitions of each specific task were identified and intra-class correlation coefficients (ICC) for each sensor and signal type were determined as a measure of reliability, both within and between subjects. For every person, a mean ICC was calculated. Boxplots of the results are presented (Fig. 1). The ICCs were classified as very good (0.8-1.0); good (0.6-0.8); moderate (0.4-0.6); fair (0.2-0.4) and slight (<0.2).

Results: As to within-subject reliability (Fig. 1), the median ICC's were good to very good for all activities. Reliability was better in the instruction conditions than in the no-instruction conditions, especially for the skill eating. Children aged between 12-18 years showed a slightly higher reliability compared to children aged between 6-12 years.

Between-subject reliability was also good to very good for all activities performed by adults. The activity drinking performed by the children had a very good reliability, the activity combing had a good reliability whereas the activity eating had a fair to moderate reliability in the youngest children, and a good reliability in the older children. Especially for the skill eating, a large difference in reliability was seen between the instruction and no-instruction conditions. For the activities drinking and combing, reliability was comparable between younger and older children. For the skill eating, reliability was higher in the older children.

Figure:
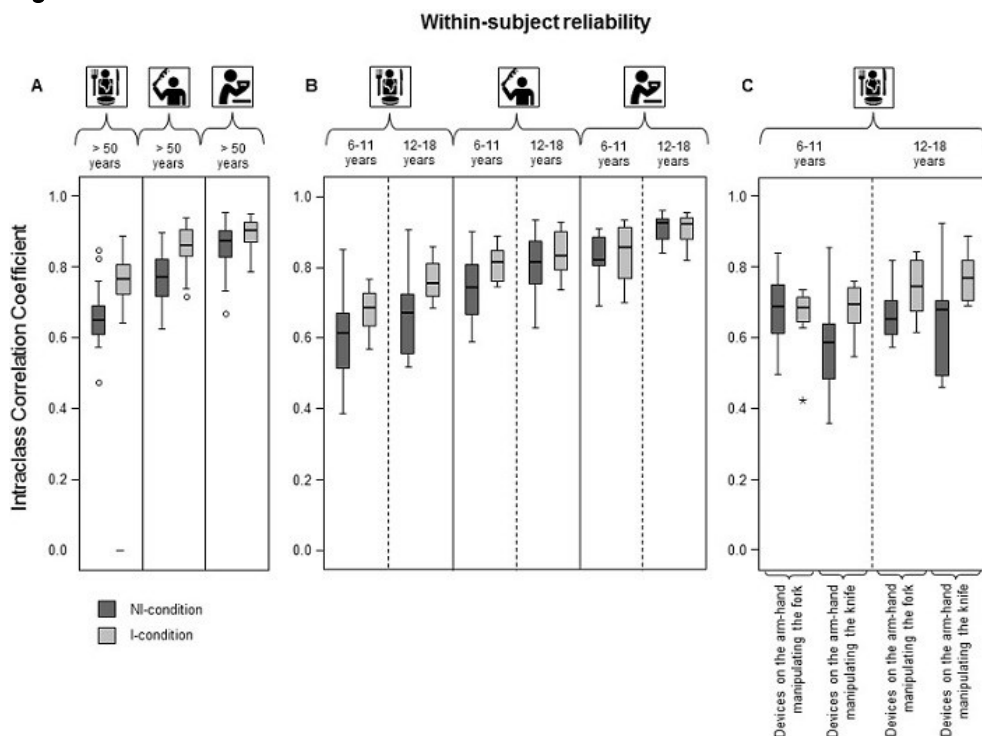
Caption: Figure 1: Within-subject reliability (ICCs) for the activities 'eating', 'combing' and 'drinking'. Dark grey bars: task performance without instruction. Light grey bars: task performance with instruction. A) performance by adults, boxplots representing the devices on the chest and arm-hand manipulating the knife, comb and cup; B) performance by children, boxplots representing the devices on the chest and arm-hand manipulating the knife, comb and cup; C) performance by children, boxplots representing the devices on each arm-hand.

Conclusion: Overall, the activities drinking, eating and combing had a good to very good within-subject reliability in both adults and children. By giving instructions about how to perform the task, the variability in execution of the task was reduced, thereby increasing reliability.The performance of the skill drinking had a higher reliability compared to the skill eating, the main reason being that drinking is a rather simple skill, which cannot be performed in many ways, whereas the skill eating consists of more sub movements and may be performed in many different ways. Between-subject reliability of the skill eating was relatively low, especially for the performance without instruction in the youngest children, the reason being that many children did not use the knife to cut the food, whereas other children had difficulties manipulating the knife. In the instruction condition, they were told how to use the knife. In conclusion, using multiple body worn sensors enable us to reliably record activities of daily life in healthy adults and children. Future research will focus on signal reliability during activities of daily life performed by *patients* and in *daily life settings*.

References: LEMMENS, R., TIMMERMANS, A., JANSSEN-POTTEN, Y., SMEETS, R. & SEELEN, H. 2012. Valid and reliable instruments for arm-hand assessment at ICF activity level in persons with hemiplegia: a systematic review. *BMC Neurology,* 12, 1-17.

Disclosure of Interest: None Declared