3. OUTLINE OF THE PRESENT STUDY

The primary goal of the present study was to investigate how children and young adults allocate resources when performing a cognitive and a sensorimotor task concurrently. The study design took the concerns of the ecological approach to dual-task research into account (K.Z.H. Li, Krampe, & Bondar, in press), by using a combination of tasks that mimics everyday processing demands in multi-tasking. Furthermore, single- and dual-task performances for every component task were assessed repeatedly, such that dual-task costs could be calculated for each of the two task domains. Task difficulties were manipulated within individuals for the two cognitive tasks in order to challenge individuals' potential at an age-appropriate level. Finally, a differential-emphasis instruction was included in the study by instructing participants to focus more strongly on one task than on the other in the dual-task situation. The outcomes of that manipulation indicate whether participants can actually exert control over their resource allocation.

In the present study, two different cognitive tasks were used, the Method-of-Loci memory strategy measuring episodic memory, and the N-back task, which measures working memory performance. It was assumed that patterns of dual-task performance would generalize across these two cognitive tasks. Balancing on the ankle-disc board was the sensorimotor task of the present study. Participants were initially trained in each component task. Additionally, difficulty manipulations were administered for the two cognitive tasks by individually adjusting task presentation parameters to each individual's performance level. This procedure was assumed to equate the amount of cognitive resources that had to be invested into the task under single-task conditions, and to assure that the task was demanding for every participant. In addition, different difficulty levels were used for the balance task by placing the ankle-disc board either on a stable or moving platform. Whereas the difficulty manipulation of the cognitive tasks was tailored to individual performance levels, fixed task difficulty levels were used for all participants in the balance task. Children were therefore assumed to be operating closer to their stability boundaries than young adults when balancing on the moving platform.

In previous studies with young and older adults, older participants had often focused their attention more strongly on the sensorimotor task, especially in situations with increased task difficulty, when operating at their performance limits (K.Z.H. Li et al., 2001; Bondar et al., in preparation). This was interpreted as an adaptive pattern of behavior because it enabled

older participants to protect their sensorimotor functioning. The balance domain is assumed to be particularly sensitive to shifts in resource allocation between two concurrent tasks.

One basic assumption of the present study was that children – just as older adults – have fewer resources available in the first place. When tasks are administered under single-task conditions, children's performance in cognitive or sensorimotor tasks was therefore expected to be worse than the performance of young adults. In addition, because the dual-task situation was designed to tax the resources of all participants, all three age groups were expected to show some dual-task decrements in their performance. According to the SOC model (Baltes & Baltes, 1990) the processes of selection, optimization, and compensation can influence the behavior in dual-task situations, potentially leading to a trade-off pattern between two task domains, with higher dual-task performance decrements in one task as opposed to the other. In the present study, children were expected to show such a trade-off pattern in favor of the balance task, with lower dual-task costs in the balance domain as opposed to the cognitive domain. Since children tend to sway more than adults when balancing on the ankle-disc board, they were believed to be operating closer to their stability boundaries already under single-task conditions. In a dual-task situation, they were expected to preserve a sufficiently large safety region for controlling their postural stability by focusing their attention on the sensorimotor domain to maintain the equilibrium on the ankle-disc board. This behavior would be interpreted as an example of selection according to the SOC model. Young adults, on the other hand, were expected to show a more even distribution of dual-task costs across the two domains, without significant differences between cognition and balance.

In addition, task difficulty of the balance task was expected to influence the pattern of dual-task costs. Balancing on the moving platform was considered to be more difficult because movements of the platform had to be counteracted by well-coordinated body movements on the board, and because a larger part of each individual's base of support had to be used when stabilizing the body's equilibrium. The increase in balance difficulty was expected to result in more pronounced performance trade-offs in the children, with even bigger differences between the dual-task costs in the cognitive and the balance domain. The underlying assumption was that a more difficult balance task forces children to invest more of their resources into the sensorimotor domain in order to stabilize the body's equilibrium, while even fewer resources remain to be invested into the cognitive domain. The young adults were expected to distribute their resources equally among the two tasks, even when the

difficulty of the sensorimotor task was increased, again showing no performance trade-off between the two tasks.

In a final session, a differential-emphasis instruction was used. Participants were instructed to focus more strongly on the performance of one task as opposed to the other in the dual-task situation. A reinforcement scheme was used to encourage people to keep up or even improve their performance in the emphasized task domain. The differential-emphasis manipulation was expected to distinguish between the processes of elective selection versus loss-based selection: If children were able to allocate their attention flexibly according to instruction, and to focus more strongly on the cognitive domain when instructed to do so, the selection process occurring in previous dual-task situations would be interpreted as an incidence of elective selection. However, if children were not able to shift their attention away from balance, and continued to show lower dual-task costs in the balance domain even when instructed to focus on the cognitive domain, their trade-off pattern would be more likely to be caused by loss-based selection processes. Due to the importance of maintaining the body's equilibrium when resources are taxed, children were expected to keep on focusing on the sensorimotor task domain, therefore showing a pattern of loss-based selection. Young adults were expected to be more flexible in cognitive-sensorimotor dual task situations, and to adjust their dual-task performance patterns according to instructions.

The following section gives a short overview on the central hypotheses of the present study.

1) Children show a dual-task performance trade-off in favor of the balance task, while young adults show no trade-off pattern.

Children were expected to have to invest more of their cognitive resources into the sensorimotor domain, and to prioritize balance performance over cognitive performance in situations in which the body's equilibrium is challenged. In the present study, children were therefore expected to show higher cognitive dual-task costs than sensorimotor dual-task costs. For young adults, the differences between the two task domains were assumed to be less pronounced.

2) Children's trade-off pattern becomes more pronounced when balance difficulty is increased, while young adults continue to show equal dual-task costs in both domains.

It is predicted that increases in the difficulty of the balance task (moving platform) lead to a more pronounced prioritization of the balance performance in children, but not in adults.

3) Children cannot shift their attention away from the balance task, even when instructed to do so, while young adults can flexibly allocate their resources.

Under differential-emphasis conditions, children should not be able to shift their attention away from the balance task, even when they are instructed to focus more strongly on the cognitive task. They are assumed to continue showing higher dual-task costs in cognition as opposed to balance, independent of the instruction-condition. Young adults are expected to be able to flexibly adjust their dual-task performances according to task instructions, by showing lower dual-task costs in the domain that they should focus on, and higher dual-task costs in the alternative domain.