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BRIEF REPORTS

Effects of Adult Age and Level of Skill on the Ability to Cope With High-Stress Conditions in a Precision Sport

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Younger and older highly skilled and moderately skilled miniature golf players were studied in training and competition. All of the players showed an increase of heart rate and rated anxiety from training to competition. A performance decline in competition was observed for both older players and less accomplished players. Results from a cognitive task (incidental recall of shots) suggest that older players are less proficient in coping with the high-stress conditions in competition, due to an age-related decline in task-relevant cognitive abilities.

In a recent field study, Bäckman and Molander (1986) examined highly skilled miniature golf players varying in age in training, minor competitions (MCs), and large competitions (LCs). Results showed that older adult players deteriorated markedly in LCs, whereas youth players, junior players, and younger adult players performed equally well in all three activities. In addition, all groups showed a similar increase of arousal from training and MCs to LCs, as indicated by measures of heart rate and ratings of anxiety.

In agreement with Broadbent's (1971) theory of arousal and performance, it was suggested that younger players may compensate for the nonoptimal levels of arousal during LCs through self-initiated efforts such as concentration and narrowing of attention. Older players, on the other hand, may have a deficit in this compensatory mechanism, due to an age-related decline in task-relevant cognitive abilities. There are several cognitive abilities that are critical to successful miniature golf performance: (a) memory of which shots were good and which shots were bad in previous rounds, in order to maintain the shot if it was good (or to adjust it if it was a miss) on a later round; (b) decisions about the swing and estimation of angles; (c) encoding and interpretation of the visual feedback from a miss, so that motor behavior could be changed for the next shot; and (d) focusing of attention on the game, while closing out distracting information.

It is well-known that the aging process is associated with deficits in many of these task-relevant abilities: attention, memory, and decision making (Kausler, 1982). Age-related deficits in these basic capacities may hinder older players from compensating efficiently for the high-stress conditions in LCs. Specifically, older players may catch up in training and MCs by investing more of their capacity in the task, but when task difficulty increases (through increased stress) they are no longer able to invest more of their already taxed capacities (cf. Crowder, 1980).

In the present laboratory study, we sought to qualify this interpretation by measuring one task-relevant cognitive ability: remembering the nature of one's own shots. Younger and older players were studied in training and competition. In addition to the cognitive task, number of shots, heart rate, and subjective ratings of anxiety were registered. We reasoned that an outcome showing a similar deterioration of older players in the cognitive task and in motor performance under high-stress conditions would support the preceding interpretation. Also, we extended the generality of previous findings by examining both highly and moderately skilled players varying in age. Finally, the present study enabled a comparison between laboratory data and previous results from the field.

Method

Subjects

The subjects were 12 younger adults and 12 older adults, all of them community residents in Umeå, Sweden, with comparable socioeconomic background. Each age group comprised six highly skilled players and six moderately skilled players. In the highly skilled group the mean age of the younger subjects (4 men and 2 women) was 25.5 years (SD = 4.72), and the mean age of the older subjects (3 men and 3 women) was 50.7 years (SD = 4.18). In the moderately skilled group the mean age of the younger subjects (all men) was 27.7 years (SD = 4.55), and the mean age of the older subjects (5 men and 1 woman) was 51.5 years (SD = 3.51). Participation in the experiment was voluntary, and none of the subjects was on medication.

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Table 1
Mean Heart Rate, Mean Rated Anxiety, Mean Number of Shots, and Mean Number of Shots Recalled as a Function of Age, Level of Skill, and Type of Activity

Group	Training HR	Training RA	Training NS	Training SR	Competition HR	Competition RA	Competition NS	Competition SR
Highly skilled								
Young	72.12	2.37	21.60	9.00	88.98	4.43	20.68	9.33
Old	89.33	3.77	25.02	8.33	95.10	5.70	26.12	7.00
Moderately skilled								
Young	73.17	3.38	29.50	7.67	88.10	4.77	30.72	9.03
Old	92.38	3.38	33.02	6.33	102.85	3.98	38.07	4.67

Note. HR = heart rate (beats per min); RA = rated anxiety; NS = number of shots; SR = shots recalled.

Procedure

The experiment took place in a laboratory equipped with two miniature golf tracks of the textile surface type (cf. Bäckman & Molander, 1986). By changing the obstacles on the two tracks, 10 out of the 18 ordinary types of obstacles could be arranged. A round consisted of playing the two tracks five times, each time with different obstacles.

Training phase. In the training phase subjects in each age group and skill level were randomly assigned to two subgroups. In each subgroup subjects practiced together during four rounds. The first of the four rounds served as warm-up; that is, here the players acquainted themselves with the 10 "tracks" and the procedures of measuring heart rate and subjective anxiety (see Bäckman & Molander, 1986). The arousal measures were registered after the fifth track in each round had been played. Between the second and the third round there was a 10-min pause, during which a self-paced memory task was administered.

Competitive phase. Two weeks after the training phase, subjects returned for the competitive event. The winner in each group received a monetary prize equivalent of $20. The second and third best players received prizes equivalent of $12 and $6, respectively. The importance of the event was further enhanced by the presence of spectators and journalists. Before the start of the three competitive rounds, there was a 10-min warm-up period, during which the players were allowed to practice on the first two tracks. The procedures of measuring heart rate, rated anxiety, and memory performance were the same as in training.

Memory task. The qualitative nature of subjects' first shots on each of the 10 tracks was recorded (good shot: hole-in-one or not; miss: left or right, weak or hard) during the second round. In each group, 3 randomly selected subjects were observed during training and 3 during competition. In the pause between the second and third round, subjects were brought into an adjacent room in which incidental memory of their first shots was tested. This was done by handing out drawings of the 10 tracks, together with a response form on which subjects marked the nature of the shots.

Results and Discussion

The mean values for number of shots (NS), heart rate (HR), and rated anxiety (RA), calculated per subject over the three rounds in each activity, were entered into 2 × 2 × 2 (Age × Skill × Activity) analyses of variance (ANOVAs), with activity as a within-subjects factor. All reported effects were significant at a probability level of .05 or better. Group means for all measures are presented in Table 1.

The ANOVA on NS revealed that the younger players performed better than the older players, $F(1, 20) = 9.53$, $MS_e = 30.59$; the highly skilled players performed better than the moderately skilled players, $F(1, 20) = 35.19$, $MS_e = 30.59$; and that performance was better in training than in competition, $F(1, 20) = 8.02$, $MS_e = 3.89$. In agreement with Bäckman and Molander (1986), the Age × Activity interaction was reliable, $F(1, 20) = 6.60$, $MS_e = 3.89$. The fact that this interaction has been obtained both under restricted laboratory and field conditions may be taken as evidence for the reliability of the effect. Tukey tests showed that within both levels of skill, the younger players outperformed the older in competition, but not in training. There was also a Skill × Activity interaction, $F(1, 20) = 7.13$, $MS_e = 3.89$, indicating that the moderately skilled, but not the highly skilled players, declined from training to competition.

For HR, the ANOVA yielded significant main effects of age, $F(1, 20) = 5.12$, $MS_e = 481.09$, and activity, $F(1, 20) = 23.84$, $MS_e = 72.58$. However, in agreement with Bäckman and Molander (1986), there was no Age × Activity interaction: both age groups showed a similar increase of HR from training to competition.

Both age groups showed higher RA in competition than in training, $F(1, 20) = 56.90$, $MS_e = .47$. There were significant interactions of Age × Skill, $F(1, 20) = 5.91$, $MS_e = 1.50$, and of Skill × Activity, $F(1, 20) = 6.46$, $MS_e = .47$. Most important, as with HR, there was no Age × Activity interaction. The lack of Age × Activity interactions for both arousal measures suggests that a heightened arousal per se did not cause the older players' performance decline in competition.

The number of correctly recalled first shots of each subject was entered into a 2 × 2 × 2 (Age × Skill × Activity) ANOVA. As shown in Table 1, the younger players recalled more shots than the older players, $F(1, 16) = 26.19$, $MS_e = 1.08$, and the highly skilled players recalled more shots than the moderately skilled players, $F(1, 16) = 12.32$, $MS_e = 1.08$.

The Age × Activity interaction was also reliable, $F(1, 16) = 7.64$, $MS_e = 1.08$. Tukey tests showed that the younger players recalled as many shots from both activities, whereas the older recalled fewer shots from competition than from training. These data should, however, be treated with some caution due to a possible ceiling effect in the highly skilled younger players.

In sum, the results of the present study suggest that the adult aging process as well as a low level of skill is penalizing when precise motor action is required under high-stress conditions. It is most interesting that the performance decline of older players in competition was paralleled by a similar decline in a task-relevant cognitive ability, that is, to remember the nature of previous shots. This suggests that older players deteriorate in competition because of deficits in task-relevant cognitive operations; due to these deficits, older players may be less proficient than younger players in compensating for the negative effects of nonoptimal levels of arousal during competitive play.

The fact that the moderately skilled players did not exhibit a selective decline in shot recall from competition–although they played worse in competition than in training—suggests that the deterioration in motor performance caused by a lower level of skill is not mediated by the same factors as the decline caused by the aging process. Thus, the deficit in the compensatory mechanism may be uniquely associated with the aging process. Future research should examine the way in which level of skill interacts cognitively with the ability to cope with stress in this situation.

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