8. Workshop Automatisierungstechnische Verfahren für die Medizin vom 20.-21. März 2009 in Berlin

„Virtual Audience and Rowing - A Pilot Study“

Mathias Wellner, Roland Sigrist, Joachim von Zitzewitz, Peter Wolf, Robert Riener
Sensory-Motor Systems Lab, Institute of Robotics and Intelligent Systems (IRIS), ETH Zurich, Switzerland

Robert Riener
Spinal Cord Injury Center, University Hospital Balgrist, Zurich, Switzerland

Band: Fortschritt-Bericht VDI Reihe 17 Nr. 274 „Automatisierungstechnische Verfahren für die Medizin, 8. Workshop, Tagungsband“
Editors: Thomas Schauer, Henning Schmidt, Marc Kraft
ISBN: 978-3-18-327417-8
Pages: 41-42

Virtual Audience and Rowing - A Pilot Study

Mathias Wellner[1], Roland Sigrist[1], Joachim von Zitzewitz[1], Peter Wolf[1], Robert Riener[1,2]
[1] Sensory-Motor Systems Lab, Institute of Robotics and Intelligent Systems (IRIS), ETH Zurich
[2] Spinal Cord Injury Center, University Hospital Balgrist, Zurich

Introduction

The performance of athletes is often influenced by environmental conditions [1]. Especially the presence of audience can lead to increased motivation, which occurs mainly for effort-dominant tasks, or choking, which occurs mainly for skill-dominant tasks [2–4]. Choking was defined as "occurrence of suboptimal performance under pressure conditions" [5].

To identify motivational or choking effects, a variety of parameters can be correlated with performance, for instance in rowing research. Rowing performance was found to correlate with stroke rate, drive time, stroke length, and oar force rising time [6, 7]. Rowers of different skill levels could be classified based on propulsive power output per kilogram of body mass, stroke-to-stroke consistency, and stroke smoothness [8].

Out hypothesis was that choking/motivational effects occur in a virtual environment with audience and for rowing. In this pilot study, one expert was rowing to evaluate the setup and explore the feasibility of the study.

Methods

Experimental Setup

The participant (27 years, male) was sitting in an immobile racing boat for one person (skiff), which was trimmed on both sides. He was holding an oar, which was also trimmed. The end of the oar was connected to a rope leading to an actuated winch on one side and to an elastic rope on the other side [9]. The participant was encompassed by three screens sized 4.44 m $\times$ 3.33 m (Figure 1). Three projectors[1] displayed a rowing scenario on the screens. The participant's head was positioned in the middle of the screen height. On the same height, a closed ring of 112 speakers and four sub woofers surrounded the participant. Using the wave field synthesis method, up to 16 sound sources could be arbitrarily positioned and moved within the plane of the speaker ring.

The participant saw a river scenario with water, trees, hills, and sky displayed on the three screens . The boat stern was also visible on the center screen. On the river sides, wooden tribunes appeared in regular intervals with audience in positive, neutral, or negative mood (Figure 2). The audience was implemented with photos of nine lab members, each person was photographed in three to four different poses per mood.

Five rope-based position sensors[2] measured distances and were used to compute the oar angles θ (horizontal), δ (vertical), and ϕ (rotation around oar axis) and to assess the seat and shoulder position. A combined motor-spring system rendered forces in horizontal direction, namely the water resistance, which was calculated with a hydrodynamic model and inputs from the oar and seat movements. The maximum force was applied for complete immersion and vertical blade alignment, as expected for rowing movements. In addition model-based compensation was applied in the motor control algorithm.

Physiological signals were measured with the g.USBamp and the g.GSRsens[3]. To measure the electrocardiogram (ECG), five electrodes were pasted on the thorax and a ground electrode was pasted above the right lateral ankle. Because the oar was gripped by both hands while rowing,

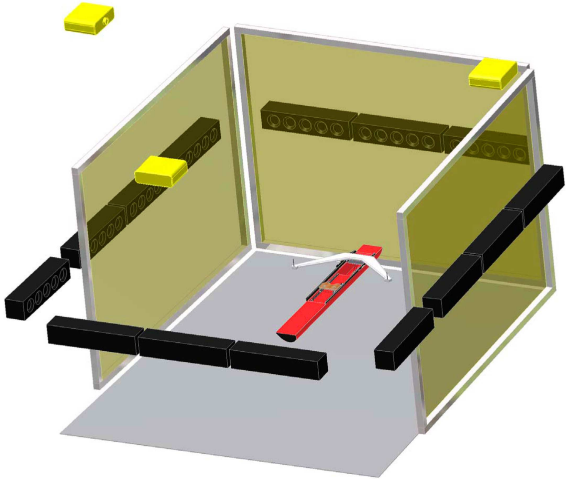

Figure 1: Cave setup with projectors, screens, speakers, and trimmed boat.

Figure 2: Graphical rowing scenario with audience stands.

[1] Projectiondesign F3+, 5500 ANSI Lumen, resolution 1400×1050
[2] Micro-Epsilon, models WPS-1250-MK46 and WPS-2100-MK77.
[3] g.tec medical bioengineering GmbH, Graz, Austria

the electrodes for measuring galvanic skin response were placed on the medial site of the left foot at the intersection to the plantar [10].

Study Design

After placing the electrodes, testing the signals, determining the resting heart rate, and instructing the participant, the measurements started. The participant had to row four runs of 1000 m. The first run was to warm up at low intensity of 14-18 strokes/min and to get used to the simulator. In the subsequent runs the participant was asked to row fast but not maximally to assure that he was able to row all three runs similarly without fatigue.

The virtual audience appeared in the runs 2, 3, and 4. In each run, three types of virtual audiences appeared after 360, 600, and 840 m over a distance of 80 m. The order of appearance was randomized. The audience stands were placed 25 meters away from the rower on both river banks. The positive audience characters encouraged the participant by shouting loudly and waving their arms. Additionally, the name of the participant was called. The neutral audience included background chat and little movements. The negative audience was characterized by loud booing. Notice that negative audience is not common in rowing competitions but relevant for replicating choking research conditions.

Data evaluation

The runs 2 to 4 were divided into blocks. In the beginning of a run the participant needed time to find his rowing rhythm. Therefore, the first block from 0 to 280 m of the racetrack was not evaluated. Furthermore, pretests showed that heart rate and galvanic skin response stabilized or drifted constantly within 280 m.

After 280 m, nine blocks followed, each with a length of 80 m. Blocks 3, 6, and 9 included virtual audience. Each block with virtual audience was surrounded by two blocks with no audience for comparison. Comparing kinematic, kinetic, and psychophysiological variables of the audience blocks with the blocks directly adjoining them excluded effects of fatigue. It was assumed that the participant did not change his fitness level considerably during three blocks.

To assess the influence of the virtual audience on the rower the most relevant variables which describe the rowing stroke were extracted of the measured variables. Each extracted variable was assigned to one of the three categories *change of movement*, *variability of movement*, or *effort, boat velocity, and efficiency*.

Galvanic skin response was analyzed visually and checked for interpretable reactions. Typical values for skin conductance responses were found to be between 0.2 and 1.0 μS with a latency of 1 to 3 s [11], but the values are different for each person and depend on the stimulus. The signals were low-pass filtered with a Butterworth filter (4th order, cutoff frequency 0.25 Hz) to remove movement artifacts.

Results

The participant increased significantly his boat velocity for all three types of audience. For negative audience, the maximal oar force was also increased significantly. Neither heart rate nor heart rate variability did show any effect. The galvanic skin conductance of the participant showed an increase during the positive and neutral audience blocks in the runs 2 and 3. Additionally, observable effects in galvanic skin responses could be observed every time when the participant passed the negative audience. In non-audience blocks, the skin conductance of the participant responded twice in run 2 and twice in run 3 but never in run 4.

Discussion and Conclusions

We could observe some changes of movement and physiological variables in the pilot participant. But only some movement variables showed a significant change. This is in contrast to the expected changes in the majority of movement variables due to motivational or choking effects. More participants are needed to study these effects and draw reliable conclusions.

References

[1] SCHMIDT, R. A. ; WRISBERG, C. A.: *Motor Learning and Performance*. Human Kinetics Publishers, 2004. – ISBN 073604566X

[2] WANG, Jin: *Developing and Testing an Integrated Model of Choking in Sport*, Diss., 2002

[3] EHRLENSPIEL, Felix: *Choking under Pressure – Attention and Motor Control in Performance Situations*, Humanwissenschaftlichen Fakultät der Universität Potsdam, Diss., 2006

[4] LEWIS, Brian P. ; LINDER, Darwyn E.: Thinking about Choking? Attentional Processes and Paradoxical Performance. In: *Pers Soc Psychol Bull* 23 (1997), September, Nr. 9, S. 937–944

[5] BAUMEISTER, Roy F. ; SHOWERS, Carolin J.: A review of paradoxical performance effects: Choking under pressure in sports and mental tests. In: *European Journal of Social Psychology* 16 (1986), S. 361–383

[6] KLESHNEV, V.: *Estimation of Biomechanical Parameters and Propulsive Efficiency of Rowing*. Unpublished, 1998

[7] KLESHNEV, V.: Moving the Rowers: biomechanical background. In: *Australian Rowing, Carine, W.A.* 25 (2002), May, Nr. 1, S. 16–19

[8] SMITH, R. M. ; SPINKS, W. L.: Discriminant analysis of biomechanical differences between novice, good and elite rowers. In: *Journal of sports sciences* 13 (1995), October, Nr. 5, S. 377–385

[9] ZITZEWITZ, Joachim ; WOLF, Peter ; NOVAKOVIĆ, Vladimir ; WELLNER, Mathias ; RAUTER, Georg ; BRUNSCHWEILER, Andreas ; RIENER, Robert: A real-time rowing simulator with multi-modal feedback. In: *Sports Technology* (2008)

[10] BOUCSEIN, W.: *Electrodermal Activity*. New York: Plenum Press, 1992

[11] STERN, Robert M. ; RAY, William J. ; QUIGLEY, Karen S.: *Psychophysiological Recording*. 2. Oxford University Press, Inc., 2001