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UDC **159.93** Sensations. Sensory perception

INVESTIGATING SEX DIFFERENCES IN THE PERCEPTION OF BIOLOGICAL MOTION ASSOCIATED WITH VISUOSPATIAL DECISION-MAKING MOVEMENT ACCURACY

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Abstract
The ability to perceive biological motion using point-light displays allows for differentiation in the evaluation of human movement. The purpose of the study was to examine sex differences in cognitive processing based upon a visuospatial decision-making accuracy task that utilized the perception of biological motion associated with a specific movement in ballet. The participants were 33 males and 36 females, Estonian citizens aged between 18 and 27 years. The ELITE Biomech 2002 movement analysis apparatus was used to generate point-light stimuli. The task involved distinguishing between point-light stimuli representations of digital video footage of a correct and incorrect turn from fifth position in ballet. Repeated measures Multivariate Analysis of Variance results revealed no significant differences between male and female decision-making accuracy scores. This result suggests that in relation to this type of specific visuospatial processing task it may be that social factors may also influence sex specific genetic predispositions associated with visuospatial ability.

Keywords: biological motion, decision-making, visuospatial processing, point-light stimuli

Investigating sex differences in the perception of biological motion associated with visuospatial decision-making movement accuracy

1. Introduction

A continuing area of investigation in psychology is the description and determination of differences in human cognitive functioning through the exploration of abilities such as spatial visualization [1; 2]. Additionally, an important element of perceptual processing originally demonstrated by Johansson [3] is the capability of humans to visually recognize biological motion using only the illuminated joints of a walking person based upon the use of point-light displays to present motor movements. Researchers examining perception of biological motion have used this methodology to highlight variations in an individual's cognitive abilities to determine characteristics such as directions of motion [4], the type of motor action [5; 6], and styles of movement [7].

The examination of sex differences in human cognitive abilities remains an area of research that is studied extensively [8; 9; 10; 11]. Of particular interest to the current study are findings that have shown males tend to perform better than females in tasks associated with spatiotemporal ability [e.g., 12; 9]. Halpern [1] described this type of visual-spatial ability as cognitive processing involving "judgments about and responses to dynamic (i.e., moving) visual displays" (p. 101). Herlitz and Loven [13] suggested that although men consistently outperform women on visuospatial tasks the common pattern observed is that large differences are typically found in mental rotation tests, smaller differences for spatial perception tasks, and considerably smaller differences in spatial visualization assessments. A recent study by Wolf et al. [11] evaluated sex differences in

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visuospatial skills used in a real-life context. The results indicated that men outperform women in spatial cognition associated car parking maneuvers; however, the researchers did suggest that social factors might affect performance in these types of task. It has also been noted, that although there is consistent acknowledgement of sex differences in visuospatial processing the magnitude of the differences is task dependent and modulated by the specific characteristic being evaluated [14].

Currently, only a limited number of studies have considered attributes such as sex of the observer in the evaluation of individual differences in the ability to perceive biological motion [15; 16; 17]. Thomson et al [16] investigated the effect of the sex of the observer as a discriminating factor in the recognition of human or object movement generated from point-light displays. Significant differences were reported between the sexes in their ability to correctly identify point light images of a person running or a rolling basketball. Women made fewer errors; however, the difference was smaller when considered in relation to their being involved in sport. The basic differences highlighted by Thomson et al. [16] highlighted a need to investigate the possibility of sex differences in tasks associated with the discrimination of biological motion representative of human movement.

Very few studies have focused on comparing skills in the visuospatial domain using the perception of biological motion as the discriminating variable [e.g., 18]. Bidet-Ildei et al. compared the skills of males and females in distinguishing between point-light images of a runner moving to the left or right. Results indicated that no differences existed in a non-primed condition; however, males had a greater number of correct recognitions in the condition in which they were provided with a video sequence of a runner prior as a primer prior to viewing the point-light displays. Pavlova [19] recently proposed that additional research into sex differences in the visual processing of biological motion would be valuable.

It is important to clarify that the terms sex and gender will both be used, as will the terms visual-spatial and visuospatial. In specific reference to the data and findings of the current study, the terms sex and visuospatial are the preferred terms to describe the sample sub groups and the cognitive processing task. In references to several of studies reviewed the original terms selected by the authors (i.e., gender and visual-spatial) will utilized. Halpern et al. [20] provide a valuable insight into the current use of the terms sex and gender. They stated that individuals “who oppose the restrictive use of sex for biological distinctions and gender for social or environmental ones further note that the dichotomy is often artificial” (p. 1). Additionally, Halpern [1] consistently refers to term visual-spatial but in a later article [20] only refers to the term visuospatial in discussing the same set of cognitive processing abilities.

The main purpose of the present study was to examine possible sex differences in visuospatial processing as related to a task incorporating the perception of biological motion. This involved the discrimination of point-light images associated with a specific movement in ballet. As an outcome of evaluating if sex differences are present in the perception of biological motion, additional information may be gained that assists in clarifying sex difference questions associated with the visuospatial processing on which it is reliant. Furthermore, this study may facilitate a better understanding of the processes that individuals use to decode spatiotemporal information associated with perception of biological motion.

2. Method

2.1 Participants

The convenience sample comprised 69 citizens of Estonia drawn from a university student cohort ranging in age from 18-27 years (*M* = 21.91, *SD* = 2.39). The participant group included 33 males (*M* = 21.76, *SD* = 2.33) and 36 females (*M* = 22.06, *SD* = 2.46). All participants had normal or corrected-to-normal visual acuity, reported they had no experience in ballet, and were aware that the specific aim of the investigation was in relation to the examination of a specific cognitive processing skill. Approval to recruit participants and collect data was given by the Tallinn University ethics committee.

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2.2 Apparatus and stimuli

Point-light stimuli representing the performance of the ballet dancer were generated using the ELITE Biotech 2002 optic-electronic apparatus. The ELITE Biomech 2002 system (BTS – Bioengineering Technology and Systems, Italy) includes six cameras that have an infrared illuminator and contacts, reflecting markers covered with aluminum powder that are attached to the participant's body, and analysis software. The markers were seen on the screen as white dots on a black board. It is possible to show the sensitivity to biological motion by increasing/decreasing the number of illuminated joints [21]. In the current study we attached 20 markers to the ballet dancer's body by using the Davis body model [22]. All stimuli were presented to participants on a portable laptop using the ELITE Biomech 2002 software to present the stimuli.

2.3 Procedure

The point-light stimuli were created from the video imaging of ballet dancers in motion. The major movements in ballet involve dancers using standardized foot and arm placements: first, second, third, fourth, and fifth positions. The fifth position is the toe-to-heel position. It involves the movement of both feet while the dancer maintains a 180° vertical-angle with the left foot forward. The heel of one foot lines up with the toe of another foot. In this version of the pirouette, the head moves first during rotation, one arm in the first position, and contralateral arm (same as the support leg) is in the second position (See Figure 1). For this study, point-light images of a ballet dancer performing a correct turn (balanced) and an incorrect turn (off balance) from the fifth position were used as the basis, of the visuospatial processing task. Participants were presented 20 pairs of the stimuli that included correct and incorrect turns. Within the pairs of experimental stimuli the characteristic of the image that differentiated if the turn was correct or incorrect was whether the balance line of the dancer during the movement was in a direct 180^{o} vertical position or off to the left or right side by 15 to 20 degrees. Each pair had the combination of stimuli presented in a random order equally represented from the following possibilities (i.e., correct/correct; correct/incorrect; incorrect/correct; incorrect/incorrect), with interstimulus intervals that were constant (5000 ms). Participants were then asked whether the second stimulus of the pair was the same or different from the first stimulus of the pair. Right and wrong answers were registered according to whether the participant did or did not correctly recognize a difference or similarity within the pair of stimuli. The experimental task was completed on two occasions separated by a 2 day interval depending on participant availability. The tasks were completed in relaxed conditions in a quiet room. SPSS version 17 was used for the data analysis.

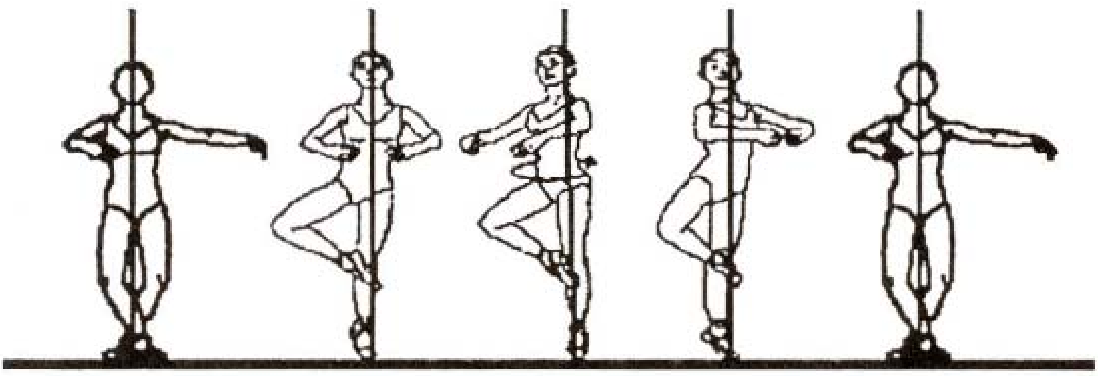

Figure 1. Example of the correct ballet movement used as the point-light stimulus

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3. Results

The visuospatial decision-making accuracy scores for the point-light stimuli test for the male and female groups are presented in Table 1. The descriptive analysis details for decision-making accuracy at occasion 1, occasion 2, and the difference score between occasions are presented in Table 1.

Table 1
Means and standard deviations of decision-making accuracy in biological motion perception for males, females, and total participants.

Variable	Mean Total (*n* = 69)	SD	Mean Males (*n* = 33)	SD	Mean Females (*n* = 36)	SD
Errors occasion 1	3.65	1.67	3.67	1.88	3.64	1.48
Errors occasion 2	3.57	1.66	3.39	1.87	3.72	1.45
Errors difference score	0.09	2.34	0.27	2.66	-0.08	2.03

A repeated measures Multivariate Analysis of Variance (MANOVA) was conducted to evaluate differences between the males and females in relation to test occasion. No significant differences were found between the male and female groups in decision-making accuracy, $F(1,67) = 0.39$, $p = .532$. The within subjects analysis also indicated no significant difference across test occasions, $F(1,67) = 0.27$, $p = .601$. A *t*-test was completed to compare test occasion change scores for males and females. No significant difference was found, $t(67) = 0.63$, $p = .53$. The pattern of change as shown in Figure 2 indicated that the males made fewer errors across test occasions whereas the females demonstrated a very small increase in errors made.

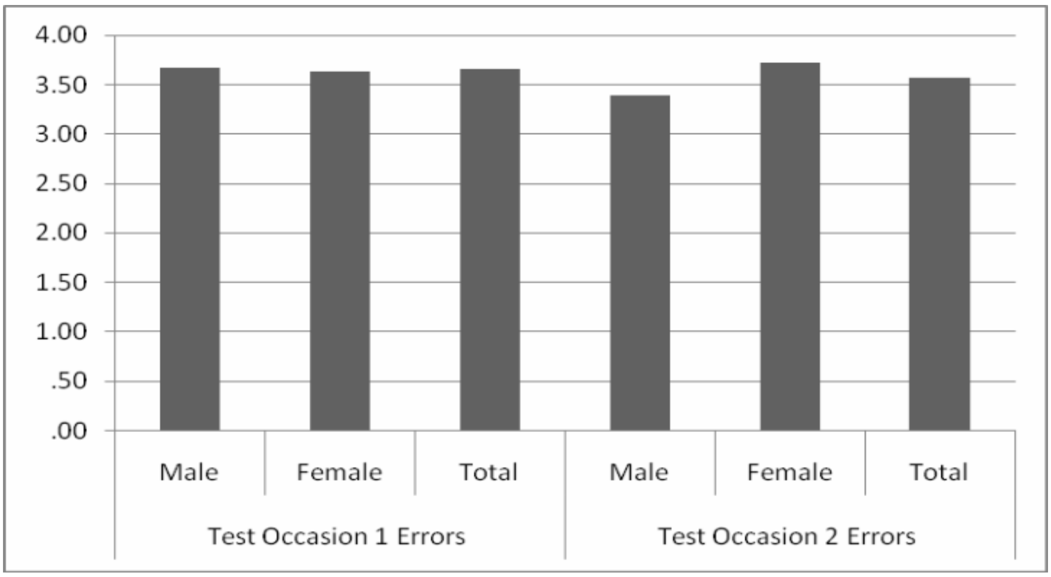

Figure 2. Mean number of errors as a function of sex and test occasion

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4. Discussion

The aim of this study was to compare female and male decision-making accuracy in discriminating between variations in a point-light stimuli representation of a ballet dancer's correct and incorrect turn in the fifth position. The point-light stimulus format for exemplifying biological motion served as the basis of the task used to compare the visuospatial processing skills of the participants. Previous studies concerning sex differences in similar visuospatial tasks such as object location memory [12] and spatial functioning [10] highlighted between sex variations. Only very limited prior research could be found that utilized the point-light stimulus approach as a type of visuospatial processing task [e.g., 18]. On the basis of the preceding information, we assumed that there could be sex differences in decision-making accuracy in relation to perception of biological motion.

The current findings did not reveal any significant differences between males and females in relation to the point-light discrimination task. Results from a previous investigation examining perception of biological motion using point-light displays, showed a significant difference was evident between the sexes in relation to the recognition of biological motion and object motion [16]. Differences between the pattern of responses found in the present experiment and the Thomson et al. study were possibly due to the focus of the later study being on the discrimination of human and non-human movement point-light stimuli. Bidet-Ildei et al. [18], using a similar protocol to the current research, found no significant overall differences between genders in discriminating between the directional movements of point light images of a male runner. Bidet-Ildei et al did find however, that in relation to the condition in which the participants were primed using actual video of the male runner that males had a greater number of correct responses in the subsequent point-light image task. Results of the current study and previous research indicate that additional investigation is required to clarify the strength and pattern of sex differences related to the discrimination of human movements represented using point-light images.

In considering the experimental task of the current study within the visuospatial processing domain, results appear to be inconsistent with the typical representation of sex differences. Broad overviews of research in the field of cognitive functioning [e.g., 1; 13; 2; 8] have all concluded that males outperform females on tasks associated with visuospatial processing. There is however, an acceptance in the field that the strength of these differences is dependent on the type of task being completed, with the smallest effect size reported in relation to sex differences found in tests associated with spatial visualization [13; 2]. Experimental studies associated with spatial cognition involving both laboratory visuospatial functioning [10] and real-life representations of visuospatial ability such as car-parking [11] have found significant sex differences favoring males but in both types of task conditions the effect sizes were small. Interestingly, Weiss et al. [10] and Wolf et al. [11] suggested that social factors that relate to the types of visual spatial tasks being utilized in much of the sex difference research in this field incorporate tasks that could be better suited to the response skills of males. The lack of difference observed in the current study could be in part due to the fact that a female oriented movement associated with ballet was used as the basis of the point-light image, and possibly better understood and interpreted by the female participants than other types of visuospatial processing tasks. It may be an important consideration, therefore, in the selection and development of visuospatial processing tasks of any format (e.g., point-light, paper-pencil, real-life) to work towards a neutral sex representation of the stimulus in regards to both the broader social influences affecting the task and indeed to specific elements of the actual task (e.g., footballer versus ballet dancer).

The major limitation of the current study was the use of only a small convenience sample. Data collection was undertaken to pilot the point-light procedures and therefore a larger sample of participants from a broad range of ages was not sourced. Additional limitations relate to the point-light task and whether it served as a strong indicator of visuospatial processing. The novel nature of the task may not have allowed participants to focus successfully on the discriminatory requirements of the task but rather time was directed towards familiarizing themselves with the point-light process. Future research would benefit greatly from more structured selection of the sample and the

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inclusion of a larger number of male and female participants. The experimentation procedure should also incorporate a familiarization and rehearsal phase prior to the scoring of the discrimination tasks. Future research could also focus on sex differences in the decision-making accuracy of experts in ballet and compare these results with those of novice sample. In summary, it can be concluded that sex differences do not appear to constitute constraints which affect the perception of biological motion when considered in terms of visuospatial processing. Further consideration of the use of point-light stimulus as a valid representation of visuospatial abilities from which sex differences could be assessed is warranted but would necessitate the design and implementation of an experiment in which the aims are more focused on visuospatial processing rather than perception of biological motion.

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