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POSTER

The influence of expertise level on the visuo-spatial ability: differences between experts and novices in imagery and drawing abilities

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Abstract This study analyzed the spatial skills of experts in visual art. Empirical evidences suggested that drawing training involves changes in perceptual, spatial and imagery abilities of artists. Several studies investigated cognitive abilities of individuals that carry on artistic activities comparing them with non-artists. These studies provided results indicating artists advantage in imagery processing. Studies on non-experts samples analyzed the relationship between imagery and artistic involvement and the contribution of cognitive and motor components in drawing ability. This study will explore imagery and drawing abilities of expert artists, adding to commonly used imagery performance tasks (objective tests of mental imagery), self-reports of imagery and various drawing tasks. We considered imagery ability as a multifactorial component and the drawing ability as dependent on both cognitive-perceptual and motor skills. The results showed that: (a) there were no significant differences between artists and non-artists on self-reported imagery vividness measures; (b) on imagery performance and drawing tasks the artists' performance was undoubtedly superior compared to non-artists performance; (c) in the drawing conditions, involving different perceptual and motor processes, experts equally showed a better performance compared to non-expert subjects. These results were interpreted as an overall advantage in perceptual and imagery abilities for visual art experts, both on tasks involving graphic rendering (drawing tasks) and on tasks where it was not requested (imagery tasks). Furthermore, artists' abilities were interpreted as not limited to a cognitive domain, but different cognitive-motor and essentially motor skills were equally relevant in expert's drawing.

Keywords Expertise · Individual differences · Imagery · Spatial ability · Visual art

Introduction

Several studies demonstrated that artists or experts in visual arts showed high ability on visual processing of objects. Winner and colleagues (Winner and Casey 1992; Winner 1996) found that art students show superior performance compared to students on other domains on generation and transformation of mental images tasks, as well as on preference for imagery processing style in visuo-spatial tasks. Kozbelt (2001) reported an advantage for perception and drawing tasks.

Studies conducted with non-expert subjects in visual art analyzed the relationship between imagery, creativity and art involvement (Morrison and Wallace 2001) and the contribution of cognitive and motor components on drawing ability (Cohen and Bennett 1997). Cohen and Bennett (1997) proposed a model for drawing process considering four abilities and their sources of drawing inaccuracies: object perception (''to perceiving a model as it exists in space''), to take good representational decisions (''to deciding which areas of model to represent and how to represent those areas''), motor ability (''have the motor coordination to

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translate those decisions into physical marks on the paper'') and drawing perception (''objectively assess the accuracy of those marks and correct any inaccuracies, which involves all of the previous abilities'').

Considering results obtained by Kozbelt (2001) and Cohen and Bennett (1997) in relation to the contribution of manual component on drawing accuracy, we used the same methods of these authors in order to perform a deeper analysis of cognitive and motor components of drawing.

The aim of this study was indeed to evaluate spatial skills (perceptual, imagery and motor) of people carrying on an artistic activity. Particularly, we would show artist's performance on imagery production tasks (measured using vividness of imagery, mental rotation, spatial imagery and mental synthesis) and drawing production tasks.

Moreover, we expect that training in visual arts affects significantly the performance on these tasks, and that artists, compared to non-artists, should perform better in the drawing tasks involving perceptual ability, ability to make good representational decisions and visuo-motor skills (Cohen and Bennett 1997).

Method

Subjects

Thirty students of the ''Accademia delle Belle Arti'' of Rome, considered as ''artists'' (15 male and 15 female, average age 23.72), who received a training in drawing and painting for several years. Thirty students of the University of Rome ''La Sapienza'' from non-artistic faculties, considered as ''non-artists'' (15 male and 15 female, mean age 23.15). They were recruited at the Psychology, Sociology and Humanities department, and they never practiced any artistic activity, neither at a dilettantish level.

Material

Questionnaire Upon Mental Imagery (QMI; Sheehan 1967), Vividness of Visual Imagery Questionnaire (VVIQ; Marks 1973), Mental Rotation Test (MRT; Vandemberg and Kuse 1978), ''Bricks'' task (S(MA), BCR Batterie Centre Recherche; Reuchelin and Valin 1952; Remondino 1974), Directed Mental Synthesis Task (DMS; Finke et al. 1989; Morrison and Wallace 2001), Creative Mental Synthesis Task (CMS Finke and Slayton 1988; Morrison and Wallace 2001).

Procedure

After subjects performed all imagery questionnaires and tasks, they were asked to perform drawing tasks used in the Kozbelt's study (2001).

The tasks were: *Scissors* (copy a photo of scissors or an actual pair of scissors), *Three-lines* (copy three wavy lines, either upright or rotated), *Letters* (B-copy a ''B'' in a box without correction, AC-draw the composed shape of ''A'' and ''C'' without corrections, AB-draw the areas of overlap of ''A'' and ''B'' without corrections), *Face* (copy a line drawing of a face in profile, upright, inverted, tilted or rotated) and *One-line* (copy a complex one-line picture without corrections).

Participants were then divided in three different groups and they had to make some drawings according to three different methods: the first group used the ''traditional rendering'', the second group the ''tracing from photo'' and the third group the ''tracing from drawing'' (Cohen and Bennett 1997).

The drawings performed using the three methods were evaluated by 90 independent ''non-expert'' judges, whereas 3 independent ''expert'' judges had to evaluate the subjects drawings performed according to the method proposed by Kozbelt.

Results

A one-way ANOVA was carried out considering group (artists, non-artists) as between factor and performance on imagery self-reports, imagery and drawing abilities. No significant differences between group's scores on the imagery self-reports were found ($P > 0.05$). A main effect for group was obtained in all imagery performance tasks ($P < 0.05$). No significant difference for the MRT was found ($P = 0.06$).

A significant effect was found for group in all Kozbet's drawing tasks ($P < 0.05$), except for three-lines-rotate task ($P = 0.13$).

Differences between groups were significant on accuracy measures in Kozbelt's drawing tasks ($P < 0.05$).

Non-parametric test Mann–Whitney showed a significant difference between the two groups and the drawing conditions: respectively, for the traditional rendering ($U = 353.50$, $P < 0.01$), for the tracing from drawing ($U = 636.50$, $P < 0.01$) and for the tracing from photo ($U = 119.50$, $P < 0.05$). Therefore, drawings evaluated according to judges' ranks showed differences between experts and non-experts in drawing abilities. Altogether, experts performed better than non-experts.

Discussion

Results obtained by expert and non-expert subjects on imagery and drawing tasks showed significant differences between the two groups, except for imagery self-report questionnaires. Many studies showed that subjective imagery components, like vividness, are functionally distinguishable from imagery measured by spatial ability tests.

Moreover, according to our previsions, artists had particular cognitive abilities for spatial imagery both in tasks involving only imagery activity (in S(MA) mental rotation, in DMS and CMS guided or spontaneous generation, maintenance and transformation of mental images i.e. adding or subtracting parts, rotating whole or parts) and on mental imagery transformation using the Kozbelt's procedure for drawing. Some drawings tasks were considerably difficult, in fact when subjects were asked to generate a high quality image from complex stimulus, as well as to retain an image in order to draw it, most of non-experts subjects gave up.

In literature two kinds of abilities were described: cognitive abilities (perceptual, imagery, memory or ''schemata'') that are required for the model ''observation'' and motor abilities required for the executive phase. Other intermediate phases could be important for a good representational decisions making (Cohen and Bennett 1997) such as van Sommers' depiction strategies and process, graphic segmentation and graphic planning (van Sommers 1984, 1989).

The motor component of artist's drawing ability pointed out in all Kozbelt's tasks and in the tracing from drawing condition, where this component was specifically isolated.

Artists were more efficient in all three drawing conditions (in which different drawing skills are involved: in traditional rendering all the four abilities of Cohen and Bennett, in tracing from photo the ability to make good representational decisions and motor coordination and in tracing from drawing only the last).

Nevertheless our expert subjects showed a worst performance in two tasks: the three-lines drawing and the MRT tasks. Both tasks involved mental rotation processes on complex and abstract stimuli, probably unfamiliar in everyday experience of participants (Ericsson and Smith 1991; Ericsson 1996; Winner and Casey 1992).

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