Neuroscience and Biobehavioral Reviews 65 (2016) 195–207

Contents lists available at ScienceDirect

Neuroscience and Biobehavioral Reviews

journal homepage: www.elsevier.com/locate/neubiorev

The genesis of errors in drawing

Rebecca Chamberlain*, Johan Wagemans

Laboratory of Experimental Psychology, KU Leuven, Belgium, Belgium

ARTICLE INFO

Article history:
Received 24 September 2015
Received in revised form 29 March 2016
Accepted 5 April 2016
Available online 9 April 2016

Keywords:
Drawing
Perception
Top-down
Visual attention

ABSTRACT

The difficulty adults find in drawing objects or scenes from real life is puzzling, assuming that there are few gross individual differences in the phenomenology of visual scenes and in fine motor control in the neurologically healthy population. A review of research concerning the perceptual, motoric and memorial correlates of drawing ability was conducted in order to understand why most adults err when trying to produce faithful representations of objects and scenes. The findings reveal that accurate perception of the subject and of the drawing is at the heart of drawing proficiency, although not to the extent that drawing skill elicits fundamental changes in visual perception. Instead, the decisive role of representational decisions reveals the importance of appropriate segmentation of the visual scene and of the influence of pictorial schemas. This leads to the conclusion that domain-specific, flexible, top-down control of visual attention plays a critical role in development of skill in visual art and may also be a window into creative thinking.

Contents

1. Introduction

The difficulty adults find in drawing objects or scenes from real life is puzzling. Intuitively, individuals should be able to commit their perceptual experience to a graphic representation, assuming that there are few gross individual differences in the phenomenology of visual scenes and in fine motor control in the neurologically healthy population. However, the majority of adults are rarely able to put down a passable likeness of their visual experience onto paper. Drawing behaviours are commonly observed in children and are often regarded as indicators of emotional and cognitive

* Corresponding author at: Laboratory of Experimental Psychology, KU Leuven, Tiensestraat 102, Leuven 3000, Belgium.
E-mail address: rebecca.chamberlain@kuleuven.be (R. Chamberlain).

http://dx.doi.org/10.1016/j.neubiorev.2016.04.002
0149-7634/

development, but very few individuals go on to draw regularly in adulthood. Many visual artists find that drawing is an important technical and exploratory tool. The development of high-level drawing skill has been found to be underpinned by practice and a flexible approach to drawing techniques (Chamberlain et al., 2015). As a result, artists are often searching for techniques that improve their drawing skills and reduce the number of errors they make.

1.1. The psychological study of drawing

The use of drawing as a vehicle for the investigation of perceptual processing, expertise and manifestations of creativity by cognitive scientists and neuroscientists has proliferated in the last two decades. Some researchers have used drawing as a window into visual perception, emotion, development and cognition (Cavanagh, 2005; Jolley et al., 2013; Karmiloff-Smith, 1990; Tversky, 1990), while others are interested in the artistic process itself (Cohen and Bennett, 1997; Edwards, 1989; Kozbelt, 2001; Mitchell et al., 2005).

In a paper entitled 'Why can't most people draw what they see?' Cohen and Bennett (1997) addressed the title question of the article by proposing four psychological sources for drawing errors:

1. Misperception of the object.
2. Misperception of the drawing.
3. Motor skills.
4. Representational decisions.

The authors constructed a series of drawing experiments to isolate these aspects of the drawing process. The various conditions participants underwent included: tracing a photograph, drawing a photograph, drawing a tracing, and tracing a tracing. By comparing performance on these conditions the authors intended to determine which process best predicted the generation of drawing errors. They concluded that misperception of the object was at the heart of drawing inaccuracy due to the fact that the largest drawing errors were made in the drawing conditions relative to the tracing conditions. In addition, they acknowledged smaller contributions by poor representational decisions and misperception of the drawing and a very minor contribution by fine motor skills. Despite some methodological limitations, this early study provided the impetus for more controlled investigations into the basis of drawing errors and is a useful tool for decomposing the different aspects of cognitive and perceptual function underpinning drawing ability.

1.2. Aims

This review will follow-up Cohen and Bennett's (1997) paper by synthesising lines of psychological and neuroscientific evidence on drawing that have emerged since its publication. In addition, the role of visual memory performance in drawing will be investigated. This aspect of the drawing process was conspicuously lacking in Cohen and Bennett's analysis, given the commonly held conception that drawing always involves some reliance upon visual memory systems in the transfer from subject to paper. Individual differences in visual memory fidelity and duration could account for the differences found between the tracing and traditional drawing condition in Cohen and Bennett's study and therefore it is worthwhile assessing relative contributions of visual perception, encoding and retention in the drawing process. The overarching aims of the review are to enable drawing teachers and practitioners to understand the best channels through which to improve drawing ability, to provide research avenues for psychologists and neuroscientists in the visual arts to focus on in the future, and to clarify the critical role drawing plays in artistic practice.

2. Defining drawing accuracy

In the majority of studies presented in this review drawing accuracy is defined by independent observers' ratings of accuracy, which commonly show between-rater reliability estimates of around $a = 0.80 - 0.90$. In other studies, drawings are compared directly with photographic stimuli. It has been found that subjective drawing accuracy rating correlates significantly with shape analyses of accuracy (Chamberlain et al., 2014a,b). However, both art historians and psychologists of the arts have highlighted that drawing accuracy does not map directly onto photographic accuracy. For example, in a series of studies comparing photographs of scenes in paintings by Paul Cezanne and drawings by art students, Pepperell and Haertel (2014) found that the region of the scene corresponding to the central visual field was enlarged in paintings and drawings compared with a photograph, while the peripheral region was compressed. In a complementary study, Baldwin et al. (2014) compared artists' depictions of space to a number of geometrical perspective projections and reported that the artists' renderings matched the perceptual experience of observers better than geometrical projections. On the basis of this evidence, studies reporting shape analysis as a proxy for drawing accuracy should be treated with caution, bearing in mind artists frequently introduce systematic distortions into their drawings.

3. Misperception of the object and the drawing

Cohen and Bennett (1997) concluded that misperception of the artists' drawing did not explain a large amount of variance in drawing errors in their original study. This was due to the fact that there was no correlation between how much an individual overestimated the accuracy of their drawing and their actual drawing ability. However, Perdreau and Cavanagh (2015) recently found that individuals who could identify changes in both their drawing and the to-be-drawn object subsequently produced better drawings. This suggests that misperception of one's drawing plays a greater role than Cohen and Bennett (1997) initially concluded and is worthy of further investigation. The majority of researchers in this domain conflate misperception of the drawing and the to-be-drawn object by testing participants on domain-general perceptual tasks which are then correlated with performance on drawing tasks (which invariably demand accurate perception of both the subject and the drawing). Given the scarcity of findings that speak to the distinction between perception of the subject and the drawing, the remaining discussion applies to perception of both stimuli.

When addressing how misperception accounts for drawing errors it is important to highlight the distinction between two kinds of perceptual phenomena: illusions and delusions. Illusions are defined as failures of *perception*, while delusions are framed as failures of *conception* (Gregory, 2003). This distinction was introduced by Cohen and Bennett's (1997) and is a useful way of carving up the evidence in this field. Whilst at first glance the distinction between illusions and delusions may be clear, it is probably more appropriate to consider illusions and delusions on a continuum, ranging from conception to perception (Fig. 1). More controversial examples in this field lie in the middle of this spectrum and include allocation of visual attention and the impact of stored canonical representations. In this review these phenomena are labelled as delusions rather than illusions, as they represent top-down influences on visual perception, often driven by conceptual knowledge about pictorial representation and object properties. However, it is clear that the categorisation of these phenomena is a continuing source of debate (see Firestone and Scholl, 2015).