Acta Psychologica 153 (2014) 28–38

Contents lists available at ScienceDirect

Acta Psychologica

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

Same, same — but different: On the use of Navon derived measures of global/local processing in studies of face processing

Christian Gerlach *, Julie R. Krumborg

Department of Psychology, University of Southern Denmark

ARTICLE INFO

Article history:
Received 4 May 2014
Received in revised form 5 September 2014
Accepted 13 September 2014
Available online 1 October 2014

PsycINFO classification:
2323
2520
2820
3250
3297

Keywords:
Compound stimuli
Face processing
Global/local processing
Navon's paradigm
Prosopagnosia

ABSTRACT

Some studies have reported a significant correlation between face discrimination/recognition ability and indexes of global/local processing derived from the Navon paradigm. Other studies, however, have failed to find such a relationship. In this paper we examine three aspects related to the Navon paradigm that may have contributed to this discrepancy but which have been largely neglected: (i) the use of different types of compound stimuli across studies, (ii) differences between studies in the type of index derived from the Navon paradigm, and (iii) the reliability of these indexes. In a Navon experiment comparing performance with compound letters and compound shapes in normal participants, we find little consistency both within and across participants in how they perform with these stimulus types, despite the fact that both stimulus types give rise to the typical effects. In addition we find that many of the Navon derived indexes of global/local effects used in studies examining face processing have low reliability and do not measure the same aspects of global/local processing. Echoing the results from the normal participants, we also find little consistency in how a congenital prosopagnosic performs in the Navon paradigm. With compound letters, she responds much faster to local than to global aspects of the stimuli; a pattern not seen in a single of the normal participants. With compound shapes, however, she exhibits no such abnormality. These findings question the validity of the conclusions in studies relating Navon derived indexes of global/local processing to face processing.

1. Introduction

Navon's paradigm (Navon, 1977) is one of the most widely used approaches to study allocation of attention to different spatial scales. It involves the presentation of compound stimuli; typically large letters (global level) composed of smaller letters (local level) in which the global and the local letters may be the same (consistent) or different (inconsistent). While different effects may be obtained with this paradigm depending on exposure duration, masking, letter spacing, stimulus clarity, eccentricity, attentional demands (divided or selective) etc. (for reviews see Kimchi, 1992; Navon, 2003; Yovel, Yovel, & Levy, 2001), three effects are usually found: (1) a *global precedence effect* with faster judgements of the identity of global compared with local elements, (2) a *consistency effect* with faster responses to consistent than inconsistent stimuli, and (3) an *inter-level interference effect* with greater effects of consistency on local compared with global identity trials.

The Navon paradigm is often used to examine the neuropsychological consequences of brain damage for example in relation to visual object recognition deficits (e.g., Behrmann & Kimchi, 2003; Gerlach, Marstrand, Habekost, & Gade, 2005). Recently, the paradigm has also been used in the study of face perception in neurologically intact participants and in congenital prosopagnosics (or as they are also referred to "developmental" prosopagnosics), i.e. people with severely impaired face recognition but with no known brain damage. The rationale has been that face perception rests not only on processing of features but also – and maybe in particular – on the spatial relations between these features (the configuration). Hence, if face recognition is compromised due to impaired configural processing, this deficit may extend to other stimuli that require configural processing such as the compound stimuli used in the Navon paradigm (Avidan, Tanzer, & Behrmann, 2011; Behrmann, Avidan, Marotta, & Kimchi, 2005). If it does, this would imply that the deficit underlying impaired face recognition may not be domain specific.

Before examining the studies which have compared face processing ability and performance in the Navon paradigm, it is worthwhile to consider in more detail what exactly is meant by "configural processing" in face perception, and how it may relate to the type of processing that compound stimuli are subjected to. After all, faces and compound stimuli seem quite different.

In the face processing literature three types of configural relations are often distinguished: (i) first-order relations among elements (the

* Corresponding author at: Department of Psychology, University of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark. Tel.: +45 65 50 28 17.
E-mail address: cgerlach@health.sdu.dk (C. Gerlach).

http://dx.doi.org/10.1016/j.actpsy.2014.09.004
0001-6918/

relative position of elements with respect to one another: the nose is positioned below the eyes but above the mouth), (ii) second-order relations among elements (the absolute or metric distance among the elements), and (iii) holistic relations; the position of local elements with respect to the global shape (e.g., the position of the eyes, the mouth, etc. with respect to the contour/outline of the face) (Maurer, Le Grand, & Mondloch, 2002). Are these types of configural processing important for successful performance in the Navon paradigm? With respect to derivation of first-order relations – the relative position of the local elements with respect to each other – this does seem important for driving the global precedence effect. Hence, the global precedence effect is still present – albeit diminished – when low-spatial frequency components are eliminated (Lamb & Yund, 1996), suggesting that the presence or absence of a global precedence effect is not simply a question of spatial (in)sensitivity to low frequency components. In comparison, derivation of second-order relations is probably not important in the Navon paradigm because the absolute distance between the local elements (within certain limits) is not critical for the global precedence effect to appear. It is harder to tell whether the paradigm is sensitive to holistic relations because compound stimuli – in a sense – have no independent global shape; the global shape is a product of grouping of first-order relations. This differs from faces where the outline of the face (its global shape) is to some degree independent of features such as eyes, mouth, nose etc. Despite there being no independent global shape in compound stimuli, identity judgments regarding the local elements are nevertheless affected by the configuration of the local elements themselves (the global shape). Was this not the case, there should be no interference effects in the Navon paradigm. In this sense, compound stimuli are subjected to a sort of holistic processing because judgments are affected by shape information derived from different spatial levels. Moreover, this appears to happen automatically (pre-attentively) because individuals cannot decide to process information from one spatial level only. Indeed, on some accounts the interference effect(s) seen in the Navon paradigm is assumed to reflect active inhibition (e.g., Poirel et al., 2014). Another possibility is that information regarding identity and spatial level is in fact not bound early on in processing – which seems to be the traditional view (Navon, 1977) – but rather is resolved later on in processing if there is any ambiguity (Flevaris, Bentin, & Robertson, 2010). On this account, the individual is initially unaware of whether the ambiguity on local inconsistent trails is due to the global shape sharing the identity of the target (e.g., "H") or whether it is the local elements which do so. This can only be resolved if shape identity and spatial level is explicitly bound in the representation, which arguably is a type of holistic processing. On this account, the prolonged RTs on inconsistent trials do not necessarily reflect inhibition but rather the time added by holistic processing. Regardless of whether the prolonged RTs on inconsistent trials in the Navon paradigm reflect inhibition, holistic processing or both, the inconsistency effect is likely to reflect some sort of integration of local and global information. Whether this is the same type of holistic processing that faces undergo partly depends on how "holistic" is defined. If holistic processing is reserved for instances in which parts are so intimately integrated and interdependent that a change in one part will affect the perception of the rest of the stimulus (its gestalt) (Rossion, 2013), the holistic processing occurring in the Navon paradigm is probably not identical with the sort of holistic processing that faces undergo. It is simply unlikely that changing a couple of parts (local elements) in a compound stimulus will alter the perception of this stimulus to the same degree as changing parts in a face does (cf. the strong perceptual illusion induced in the face composite paradigm). If, on the other hand, "holistic" is used in a broader sense, as the integration of information derived at different spatial scales, as we suggest above, it is more likely that the Navon paradigm actually does tap – at least to some degree – the holistic processes that faces normally undergo. In other words, even if the holistic processing occurring in the Navon paradigm is not completely identical to the holistic processing of faces, it seems reasonable to assume that if a person cannot even integrate information derived at different spatial scales (holism in the broad sense), this person will not be able to build up a representation in which the individual parts cannot be altered without affecting the perception of the whole stimulus (holism in the narrow sense). Hence, if an individual is not affected by inconsistency in the Navon paradigm – as is the case for some patients with integrative agnosia (Gerlach et al., 2005) – is seems quite likely that impaired face recognition in the same individual could reflect the same problem (impaired integration of shape information derived from different spatial scales).

Based on the considerations presented above, a lack of a consistency effect in the Navon paradigm may reflect impairments in either of two types of configural processing: (i) first-order relations, and (ii) holistic relations (the binding, or at least simultaneous processing, of shape information derived from different spatial levels). If the impairment is at the level of first-order relations, the "normal" global precedence effect should perhaps also be diminished or abolished because it partly depends on grouping of first-order relations. On the other hand, it should be possible to have an impairment at the level of holistic processing even if first-order relations can be derived. As an example, the integrative agnosic reported by Gerlach et al. (2005) exhibited the normal global precedence effect in the Navon paradigm but was unaffected by whether the compound stimuli were consistent or not, suggesting that shape information derived from different spatial levels was not automatically integrated. Not surprisingly perhaps, this patient also suffered from impaired face recognition.

While a lack of a consistency effect in the Navon paradigm may be diagnostic of impaired configural processing, processing in the Navon paradigm seems somewhat artificial compared with normal object processing: In natural circumstances it is probably never the case that the global shape of an object will be indicative of another identity than will its constituent parts. On the contrary, in many accounts of visual object processing, global shape information is assumed to facilitate recognition (e.g., Bar et al., 2006). An example of such an account is the PACE model (Gerlach, 2009). PACE assumes the existence of two operations in visual object recognition: *shape configuration* and *selection*. Shape configuration refers to the binding of visual elements into elaborate shape descriptions corresponding to whole objects or large object parts; descriptions in which relationships between the parts are specified. The configured shape representation is a description that can be matched with structural representations of whole objects or large object parts stored in visual long-term memory (VLTM). In this model, shape configuration does not precede access to stored visual knowledge. Rather, shape configuration follows a first pass access to VLTM representations based on processing of global shape information (outline shape). This first pass yields initial hypotheses concerning the likely identity of the stimulus. These hypotheses are then used in a top-down manner to augment the buildup of a more detailed description of the stimulus (i.e. shape configuration), which again serves as input for a more specific match with VLTM representations (Gerlach, 2009; Gerlach & Toft, 2011; Gerlach & Marques, 2014). From this description it is clear that (fast) derivation of global shape information is rather important in the recognition process as it facilitates the matching process proper (by narrowing down the scope of likely VLTM candidates), but also because it provides the initial frame in which local details can later be embedded (Sanocki, 1993, 2001). This type of global shape impairment is likely to be reflected in the Navon paradigm as a lack of a global precedence effect. Furthermore, such a deficit may be present even if interference effects are still found. In this case it will suggest that first-order relations are derived, but that they – unlike what is normal – are derived later or simultaneously with recognition of the identity of the local elements.

In summary, while there are obvious differences between faces and compound stimuli per se, and likely differences in how they are processed, it seems reasonable to assume that deficits in face processing will be reflected in the Navon paradigm in so far as they concern fast derivation of global shape or derivation of first-order or holistic