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Understanding Provoked Overt Recognition in Prosopagnosia: a modification to Morrison, Bruce and Burton (2001)

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Running Head: Modification to Morrison et al (2001)

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Abstract

Morrison, Bruce and Burton (2001) report a simulation of the phenomenon of provoked overt recognition (POR) of known faces in prosopagnosia using the IAC model. We note that the simulation demonstrates *person* recognition but requires modification to clearly demonstrate *face* recognition. The simulation requires the introduction of the concept of an attentional mechanism, a concept that is under-specified and not fully integrated into the IAC model. A modification to Morrison et al's (2001) explanation of POR is proposed which is consistent with existing concepts of the IAC model, accounts for the relevant clinical phenomena, and removes the need to introduce the attentional mechanism.

Introduction

The IAC model, originally developed by Burton, Bruce and Johnston (1990) as an account of normal face recognition, has been further developed to account for many examples of covert face recognition in prosopagnosia (eg Burton, Young, Bruce, Johnston & Ellis 1991; Young & Burton 1999). The model proposes that face recognition units (FRUs) match perceptual input to stored representations of familiar faces. There is one FRU for each known face. If a match is made the FRU passes activation to the corresponding person identification node (PIN), responsible for the feeling of familiarity. The PIN passes activation to semantic information units (SIUs) containing information relating to the individual, e.g. occupation or name. The links between a FRU and its corresponding PIN, and between a PIN and relevant SIUs, are bi-directional. Between-pool links are excitatory and within-pool links are inhibitory. Awareness of a face's familiarity is achieved when the activation level of a PIN reaches a threshold level. Awareness of related semantic information is achieved when the activation level of a SIU reaches threshold. The deficit in prosopagnosia is theorised to be a partial disconnection of FRUs from PINs. This partial disconnection results in a below-threshold level of activation in the PIN insufficient to enable a familiarity decision, and a below-threshold level of activation in SIUs insufficient to enable the conscious retrieval of semantic information. Morrison et al (2001) provides a fuller description of the model.

The phenomenon of provoked overt recognition (POR) was first discovered in patient PV by Sergent and Poncet (1990) and later replicated in other prosopagnosics PH (de Haan, Young & Newcombe 1991), PC (Sergent & Signoret 1992) and ET (Diamond, Valentine, Mayes & Sandel 1994). As Morrison et al (2001) have noted, POR offers the best hope of rehabilitation for prosopagnosic patients, and so it is important to understand the phenomenon. In POR, a prosopagnosic patient presented simultaneously with a set of faces of people sharing a common occupation can identify the common occupation and name some of the faces.

Morrison et al (2001) simulated the situation of a prosopagnosic presented simultaneously with eight faces of people sharing a common occupation. The simulation showed below-threshold, but above resting levels of activation at the PINs corresponding to the seen faces. The PINs passed activation to the SIU representing the shared occupation, which, because it received activation from multiple PINs, reached threshold. The concept of an attentional mechanism was introduced to explain why, with the shared SIU above its threshold level of activation, a prosopagnosic does not spontaneously name that occupation. Morrison et al (2001) theorised that attention is focused on the attempt to retrieve *names* to match the faces and this imposes attentional inhibition on the occupation SIU, preventing it from reaching threshold. When the experimenter prompts the prosopagnosic to identify the shared occupation this lifts the attentional inhibition and the occupation can be retrieved. With the activation level at the shared occupation SIU now above threshold, the simulation showed that sufficient activation was passed back to the PINs to enable them to reach threshold. This enabled a sense of familiarity and, via

more activation passing to SIUs, name retrieval. Morrison et al (2001) concluded that this demonstrated face recognition.

There are two main problems with this account and simulation. First, the simulation demonstrates *person* recognition but this is not quite the same thing as *face* recognition. Second, the attentional mechanism is under-specified and not fully integrated into the IAC model. A proposed modification addresses both these shortcomings.

The simulation achieves person recognition, but not face recognition

POR of previously familiar faces requires a clear demonstration that a PIN receives above-threshold activation as a direct response to the presentation of the associated face. The PIN would have to reach its threshold level of activation in such a way as to enable the name to be linked to the correct face and no other. As noted by Sergent and Signoret (1992) "subjective experience of recognition requires not only the coincidental activation of related sets of information, but the activation of the connections that relate these sets" (p399). This is not precisely what Morrison et al (2001) have demonstrated. They have shown that the activation levels of a set of PINs rise above threshold in response to the presentation of a set of faces, but this does not fulfil the requirement that a single PIN should be clearly linked to a single seen face.

Consider what would happen if this were achieved by a prosopagnosic patient. Some prosopagnosics (e.g. those investigated by de Haan et al 1991; Diamond et al 1994; Sergent & Poncet 1990) have been able to perform at above chance in a forced-choice test of selecting one of two or three names to match to a seen familiar face which they could not recognise if it was shown alone. However, the task of matching one of two faces to a single name, attempted only by patient PC, was not successful (Sergent & Signoret 1992). It seems unlikely that a prosopagnosic viewing a set of 8 faces, and with 8 PINs activated internally, would be able to match names to faces. Hence it is not clear that the performance of the simulation amounts to face recognition.

The key point is that face recognition is not precisely equivalent to above-threshold activation at a PIN. The latter is equivalent to the retrieval of a *person* concept, and can be considered to amount to *face* recognition only if the PIN reaches its threshold in such a way as to enable the person concept to be linked to one and only one face.

The assumption of inhibition from an attentional mechanism

The introduction of the attentional mechanism to the IAC model is a new step required only for the POR simulation, for which there is no substantial a-priori justification and no supporting empirical evidence. The mechanism is under-specified and not fully integrated into the IAC model – if the attentional mechanism operates in the context of POR, why not in the context of all the other effects successfully simulated by the IAC model? Before a new mechanism can be safely introduced into a model, its impact on the whole model should be considered, and this has not been reported.

The introduction of the attentional mechanism was deemed necessary to explain two observed aspects of POR: that a prosopagnosic can produce the shared occupation of a set of faces when prompted to do so by the experimenter, and that a prosopagnosic does not do so spontaneously. Close examination of the studies reported by Sergent and Poncet (1990), de Haan et al (1991), Sergent and Signoret (1992) and Diamond et al (1994) suggests an alternative explanation that renders the introduction of the attentional mechanism unnecessary. This modified account of POR is detailed below.

Modified explanation of provoked overt recognition

When a prosopagnosic patient views a number of faces sharing an occupation, activation passes from FRUs to PINs and to the shared SIU, with the PINs and the SIU reaching activation levels above their normal resting state. At this point there are two possibilities: either the SIU achieves above-threshold activation or not. If activation at the SIU was above threshold then the prosopagnosic patient would be capable of naming the occupation unprompted. In the case of PH (de Haan et al 1991) it appears that the SIU was indeed activated above threshold – "Once he had spontaneously established the occupation…" (p2586). In another two cases (Diamond et al 1994; Sergent & Signoret 1992) it appears that the patient was not given the opportunity to demonstrate unprompted naming of the occupation. In these cases the researcher informed the patient that the faces shared an occupation as the faces were presented together as a set. Hence it is possible that in these cases, activation at the SIU was in fact above threshold.

Even more intriguing, it is possible that patients PH (de Haan et al 1992), ET (Diamond et al 1994) and PC (Sergent & Signoret 1992) may have achieved recognition of some of the individual faces as they became aware of the shared occupation. De Haan et al (1991) note that the occupation of one of the exemplars was spontaneously identified, suggesting a sense of familiarity for one of the faces. The prosopagnosics investigated by Diamond et al (1994) and Sergent and Signoret (1992) were not given the opportunity to demonstrate this.

In contrast, patient PV (Sergent & Poncet 1990) did not name the occupation unprompted. After being informed that the faces shared a common occupation, PV required 10 seconds to produce the occupation. There are two possible explanations for this delay. One, PV was so convinced of her inability to recognise the faces that she was reluctant to name the occupation. Note that PV provided the first demonstration of POR and so would have had no expectation of success. Two, the SIU was not activated above threshold and PV may have used a "generate-recognise" process. PV may have generated plausible occupations one at a time; the SIU representing each occupation would receive some extra activation as the occupation was generated; and this could raise the activation level of the shared SIU above threshold (since it was already above its resting level) enabling recognition. This explanation requires one assumption: that generating the shared occupation provides sufficient activation to raise the SIU above its threshold. The generate-recognise process is feasible because of the small number of occupations (and nationalities in the study by Diamond et al 1994) that a person is likely to guess.

It is possible that in some instances the SIU for the shared occupation does reach its threshold level of activation without prompting from the researcher, while in other instances it does not. This is an empirical question.

When the SIU reaches its threshold, regardless of whether this occurs spontaneously or as a result of a generate-recognise process, activation can be passed back to the PINs of all known people sharing this occupation. The PINs corresponding to the seen faces are already at a higher level of activation and will retain their relative advantage. These PINs will inhibit the activation levels of other PINs corresponding to people whose faces were not presented (within-pool inhibition). Now, as each face is examined individually, more activation will pass from one FRU to the corresponding PIN, which can then reach threshold. This is true face recognition because each PIN reaches threshold in response to the visual inspection of one and only one face.

The finding that POR occurs only when the prosopagnosic can name the occupation can be understood within the existing concepts of the IAC model. The key point to consider is the extent of preserved connection between FRUs and PINs. If little activation passes from FRUs to PINs, then little activation accrues at the shared SIU so the shared occupation cannot be detected, and the final step will also fail and the faces cannot be identified. This explanation is supported by the observation that the prosopagnosics capable of POR (investigated by de Haan et al 1991; Diamond et al 1994; Sergent & Poncet 1990; Sergent & Signoret 1992) were also capable of other covert recognition tasks, suggesting that the links between FRUs and PINs were partially active.

This modified explanation describes true face recognition, is consistent with existing concepts of the IAC model, and requires only one, plausible assumption: that generating the shared occupation provides sufficient activation to raise the SIU above its threshold. It also addresses the clinical finding that a shared occupation is sometimes named spontaneously and sometimes not.

Conclusion

Morrison et al (2001) come close to simulating POR but require new assumptions. Our modified account more clearly shows genuine face recognition, is more consistent with existing concepts of the IAC model, addresses the relevant clinical phenomena, and requires fewer additional assumptions.

Finally, it should be noted that the above observations do not undermine the many other impressive results of the IAC model (e.g. Burton et al 1991; Young & Burton 1999).

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