

Running head: COPING WITH PROSOPAGNOSIA

Coping Strategies for Developmental Prosopagnosia

Amanda Adams¹, Peter J. Hills¹, Rachel J. Bennetts² & Sarah Bate¹

¹Department of Psychology, Bournemouth University, UK

²College of Health and Life Sciences, Division of Psychology, Brunel University, UK

Address for correspondence:

Professor Sarah Bate

Department of Psychology

Faculty of Science and Technology

Bournemouth University

Poole

BH12 5BB

UK

Email: sbate@bournemouth.ac.uk

Accepted for publication in Neuropsychological Rehabilitation (21/05/2019)

doi: 10.1080/09602011.2019.1623824

Abstract

Developmental prosopagnosia (DP) is a cognitive condition characterised by a relatively selective deficit in face recognition. Some adults and children with DP experience severe psychosocial consequences related to the condition, yet are reluctant to disclose it to others. The remediation of DP is therefore an urgent issue, but has been met with little success. Given that developmental conditions may only benefit from compensatory rather than remedial training, this study aimed to examine (a) the positive and negative effects of DP disclosure, and (b) compensatory techniques that may circumvent recognition failure. Qualitative questionnaires and interviews were carried out with 79 participants: 50 adults with DP, 26 of their non-affected significant others, and three parents of DP children. Findings indicated positive effects of disclosure, yet most adults choose not to do so in the workplace. Effective compensatory strategies include the use of extra-facial information, identity prompts from others, and preparation for planned encounters. However, changes in appearance, infrequent contact, or encounters in unexpected contexts often cause strategy failure. As strategies are effortful and disrupted by heavily controlled appearance (e.g. the wearing of uniform), disclosure of DP may be necessary for the safety, wellbeing and optimal education of children with the condition.

Keywords: Prosopagnosia; face recognition; coping; remediation.

Coping Strategies for Developmental Prosopagnosia

The ability to recognise faces is a fundamental skill that is essential for successful social interaction and wellbeing (Dalrymple et al. 2014; Murray, Hills, Bennetts & Bate, 2018; Yardley, McDermott, Pisarski, Duchaine, & Nakayama, 2008). Yet, it is estimated that ~2% of adults and children (Bowles et al., 2009; Bennetts, Murray, Boyce, & Bate, 2017) experience developmental prosopagnosia (DP) or ‘face-blindness’. DP is a cognitive condition that is characterised by a severe deficit in facial identity recognition, in the absence of any known lesion, neurological condition, or lower-level visual or intellectual dysfunction (Bate & Tree, 2017). The failure to develop normal face recognition skills may have a familial connection (Duchaine, Germine, & Nakayama, 2007), although many individuals do not report any other relatives with the condition (Duchaine, 2008).

The case histories and self-reports of individuals with DP suggest that the condition can severely impact everyday life. This may result in devastating consequences, such as avoidance of social interaction, issues with interpersonal relations, damage to career, and even depression (Barton, 2003; Bornstein, 1963; Dalrymple et al., 2014; Duchaine, 2000; Duchaine & Nakayama, 2005, 2006a; Murray et al., 2018; Yardley et al., 2008). For instance, in semi-structured interviews with 25 adults with DP, Yardley et al. (2008) found that face recognition failures can initiate social anxiety and feelings of inadequacy. Longer lasting consequences included avoidance of social situations, chronic stress or anxiety, and negative impacts on social relationships and career progression. In a similar study, Dalrymple et al. (2014) explored the effects of childhood DP in eight children and their parents. Most of the children reported a negative impact on their social lives, while parents commented on the emotional impact of the condition, highlighting feelings of helplessness and empathy for their child’s experiences (Dalrymple et al., 2014). Diaz (2008) reported

the cases of two individuals with DP: a mother (Elizabeth) and her 13-year old son (Steve). Elizabeth stated that her career progression had been limited by her wish to avoid interaction with the public. She was also concerned about Steve's safety and wellbeing, not only because she often fails to recognize him, but also because his own prosopagnosia makes it difficult for him to locate familiar others.

Collectively these findings reveal the serious negative impact that DP can have on interpersonal relationships and wellbeing in both adults and children. Thus, establishing methods of remediation is clearly an urgent issue. However, few studies have attempted to improve face recognition skills in individuals with prosopagnosia (for reviews see Bate & Bennetts, 2015; DeGutis et al., 2015), with most investigating the acquired form of the condition with varying success (e.g. Bate et al., 2015, Davies-Thompson et al., 2017). A small number of studies have attempted to improve face recognition performance in DP, more recently using perceptual training programmes (DeGutis, Bentin, Robertson & D'Esposito, 2007; DeGutis, Cohan & Nakayama, 2014). While gains in some aspects of face-processing were observed in a subset of individuals, they were not experienced by all participants and transfer to everyday life was limited. Other studies have reported short-term gains from non-facial training programmes (e.g. cognitive map training: Bate, Adams, Bennetts & Line, in press), or intranasal inhalation of the hormone oxytocin (Bate et al., 2014). While both studies present novel insights into the underpinnings of DP, gains rapidly decayed when intervention ceased, and are likely limited to subsets of individuals (e.g. those with particular cognitive presentations).

The limited success of DP remediation studies may reflect long-standing arguments that only compensatory improvements can occur in developmental disorders, as underlying abnormalities are built into neural structures and prohibit experience-dependent plasticity (Thomas, 2003; for a discussion in DP see Bate & Bennetts, 2014). Yet, only two studies

have attempted to train compensatory face recognition strategies in DP: Brunsdon, Colheart, Nickels and Joy (2006) (see also Schmalzl, Palermo, Green, Brunsdon, & Colheart, 2008) attempted to train a child with DP to associate five defining characteristics (including age, gender and distinctive facial features) with familiar faces. Following 14 sessions of training over a one-month period, significant improvements were found in the recognition of trained faces, and were maintained during a three-month follow-up period. While there was little evidence of generalization to other faces, gains to the recognition of trained faces did transfer to everyday life. In other words, the compensatory training introduced by Brunsdon et al. only functioned for the experimental exemplars of the target identities.

In sum, the available evidence suggests that compensatory training may result in larger gains to everyday face recognition performance in DP, yet these gains are restricted to trained faces. While the latter may result from the failure to incorporate transfer within the training programme itself, an alternative approach is to develop a list of more general compensatory strategies that are known to assist DPs in everyday life. The sharing of these techniques will inform others how (a) facial and non-facial person-specific cues may be used to compensate for face recognition difficulties, and (b) situational circumstances can be exploited to assist with person recognition. Importantly, such a resource would offer valuable assistance for individuals who experience any condition characterized by face recognition difficulties (e.g. autism spectrum disorder), without requiring the time and resources demanded by formal training programmes that typically result in mild or very specific gains to only a subset of individuals.

It should be acknowledged that compensatory strategies will not work all of the time, and may be associated with specific risks. As such, there may be particular instances where it is prudent to disclose face recognition difficulties to educators or employers. For

instance, Diaz (2008) stated that informing Steve's teachers about his coping mechanisms, and how they could be managed at school, led to improved educational performance and social adjustment. Further, awareness of an individual's prosopagnosia may be necessary to combat safety risks. Indeed, the parents of DP children in Dalrymple et al.'s (2014) study voiced particular concern about their children's difficulties in distinguishing familiar faces from strangers and becoming separated in a crowd – issues that may be particularly relevant on school excursions. Yet, many case-reports of adult DPs state a reluctance to disclose their condition to others, with particular fears that it may limit their career choices and progression (e.g. Fine, 2012). In addition, some parents may be reluctant to disclose their child's face recognition difficulties because it could put the child at further risk of stranger danger or make them the target of bullying (i.e. because the bully would know that the child cannot identify them) (Dalrymple et al., 2014). Thus, a risk analysis of effective compensatory recognition strategies is urgently needed and may assist thousands of people who are living with prosopagnosia.

The current study aimed to address the issues identified above. In a large-scale qualitative study, we interviewed adults with DP, their significant others (SOs), and the parents of DP children. First, we enquired about the advantages and disadvantages of disclosing face recognition difficulties to others, and when it might be necessary to do so. Second, we asked each individual to identify specific coping strategies that may assist with undisclosed face recognition difficulties in everyday life, together with their associated risks. Importantly, the inclusion of parents and SOs allowed us to gain wider and richer perspectives on these issues.

Method

Participants

Seventy-nine participants took part in this study. Fifty (31 female) had a prior diagnosis of DP and were aged between 27 and 77 years ($M = 53.0$ years, $SD = 13.0$); 26 were the SOs of the DP participants (13 male) aged between 19 and 72 years ($M = 52.6$ years, $SD = 13.0$). The latter individuals were close relatives, partners or adult dependents of the DP participants, and three further participants were the parents ($M = 43.5$ years, $SD = 7.5$) of children with DP (all male aged 5-15 years; $M = 9.0$ years, $SD = 5.5$). Ethical approval for this study was obtained from the institutional ethics committee, and informed consent was collected from all participants.

Adult DPs: All adults with DP were previously known to our laboratory (all are reported in Murray et al., 2018), and their prosopagnosia has been confirmed via objective testing. Adhering to the diagnostic procedures adopted by many other laboratories in their published work (Dalrymple & Palermo, 2015), all individuals were impaired (i.e. performed more than two standard deviations from the published control mean; see SM1) on at least two of the following tests: the Cambridge Face Memory Test (CFMT: Duchaine & Nakayama, 2006), the Cambridge Face Perception Test (CFPT: Duchaine, Germine, & Nakayama, 2007) and a famous faces test that was created within our laboratory and has been used in our previous work (Bennetts, Butcher, Lander, Udale, & Bate, 2015; Burns et al., 2017).

The CFMT is a widely-used test of face memory, in which participants are asked to learn and subsequently identify six novel male faces. In the first stage (18 trials), participants are exposed to each target face three times; subsequently, they are presented with a triad of faces and asked to choose the matching image. In the second stage (30

trials), participants are presented with triads showing the target and distractor faces from novel viewpoints; in the final stage (24 trials) the triads show the faces from novel viewpoints and overlaid with visual noise. Between each stage there is a 20-second review period, during which all target faces are displayed onscreen simultaneously.

While the CFMT is capable of identifying difficulties with face recognition, it is not possible to determine whether those difficulties are perceptual or mnemonic in origin. Consequently, we also assessed participants with DP for purely perceptual difficulties using the CFPT. Each trial of the CFPT displays one target face and six test faces, which vary in their similarity to the target face. Participants are asked to sort the test faces in order of their similarity to the target. There are 16 trials (eight upright, eight inverted), with a time limit of one minute per trial. Scores are calculated by calculating how much each trial deviates from a perfect arrangement – as such, higher scores indicate worse performance. For the purposes of diagnosis, and in accordance with existing protocols (e.g. Dalrymple & Palermo, 2015), only scores from upright trials were considered.

The famous faces task consisted of 60 black and white images of famous people, cropped to remove the body or any external identifying cues (e.g. clothing, background). Participants were asked to name or provide uniquely identifying information about each individual. There was no time limit on the task, and participants responded verbally. If they failed to identify the face, they were provided with the name and asked if they had substantial exposure to the person in the past. Faces that were not familiar to participants were removed from their final score. Scores on this task are therefore presented as the percentage of known faces that participants were able to identify correctly.

In addition to the above tests, we also carried out an extensive background interview and cognitive screening for all DP participants. Individuals were not considered to meet the criteria for DP if they reported a history of neurological, psychiatric or socio-

emotional disorders; or showed deficits of low-level visual processing, or intellectual decline or dysfunction.

Child DPs: Parents of children with DP had all contacted the research team about their children's face processing abilities. The children all had normal or corrected-to-normal vision (including low-level vision as measured by sub-tests of the Birmingham Object Recognition Battery; Humphreys & Riddoch, 1993), and no history of neurological damage or illness, general cognitive impairments, or co-occurring developmental disorders. Children and their parents attended a screening session to determine whether the children met the criteria for DP. Children were assessed using age-appropriate tasks, including the Cambridge Face Memory Test-Kids (CFMT-K; Dalrymple, Garrido, & Duchaine, 2014; see SM1) and a simultaneous face-matching task (Bennetts et al., 2017). The CFMT-K adopts a similar format to the traditional CFMT, but the stimuli are children's faces. Younger children (< 8 years old) complete a shortened version (containing only four target faces, 48 trials in total); older children complete a full version (containing 6 target faces, 72 trials in total). Scores are computed as percentages, to facilitate comparisons across different versions of the test. The face-matching task involves the simultaneous presentation of a target face and three test faces. As in the CFMT-K, the matching test uses child faces as stimuli, and there is no time limit for responses. Unlike the CFMT, all children complete the same version of the test, containing 30 trials. In both tasks, children are asked to choose which of the three test faces matches the identity of a target face; responses are made by keypress.

Children were considered to meet the criteria for DP if they performed more than two SDs below the mean for their age group in both tests. For children over the age of six years, age-specific norms were extracted from Bennetts et al. (2017); 4- and 5-year old children's scores were compared to a group of 10 typically developing age-matched

controls who completed the same tasks in our lab. Teenage participants (>12 years of age) were assessed using the adult CFMT and CFPT, and scores were compared to published data for typically-developing adolescents of the same age (Bennetts, Mole, & Bate, 2017) (see SM1 for individual scores).

Materials and Procedure

Questionnaires

All participants initially completed a questionnaire that enquired about the disclosure of DP and potential coping strategies (see SM2). The questionnaire was distributed to participants either online or via a document that was sent by email. Four participants were sent the questionnaire in the post at their request. Three versions of this open-ended questionnaire were developed in order to obtain rich information: one version was aimed at adults with DP, one was developed for the unaffected SOs of adults with DP, and the final version was for the parents of children with DP. The versions of the questionnaire were very similar, and the component questions were altered only in wording (i.e. not in content) to ensure that they were appropriate for the three different classes of participant (see SM2).

Interviews

Following completion of the questionnaire, participants were invited to take part in a follow-up semi-structured interview in which they could expand upon their responses. The interview consisted of three open-ended questions related to the aims of the study. These questions were designed to extract a more detailed account of how participants coped with the condition on a daily basis. For example, participants were asked about the effectiveness of their recognition techniques, and whether sharing their experiences with others aided coping. Twenty-three DPs (14 female) opted to take part in the interview, where they were

asked further open-ended questions. Seven SOs (six female) were asked the same questions in relation to their friend or relative with DP, and two parents (one male) responded to similar questions about their DP child. As for the questionnaire, the phrasing of the questions was changed to suit each group, but the content of the questions did not vary substantially between the groups (see SM2).

Interviews were carried out by a researcher who had been introduced to the participants prior to the interview stage – either via email or in person during earlier research sessions. The interview process, including the recording of interviews and treatment of the data, was thoroughly explained to the participants prior to the interview itself. Consequently, we expected participants to be comfortable with the interviewer and the interview procedure.

All interviews were audio recorded using a ReTell 156 Telephone Handset Call Recording Connector and an Olympus VN-731 PC (2GB) recorder. These interviews were transcribed by a third party and then checked for accuracy by the first author. Due to the nature of the interviews, their length substantially varied from person to person. For DPs, the interviews ranged from 10.0 minutes to 59.3 minutes ($M = 18.1$ minutes), those of SOs ranged from 10.1 minutes to 50.1 minutes ($M = 19.6$ minutes), and the interviews of parents ranged from 11.3 minutes to 50.2 minutes ($M = 36.2$ minutes).

Data Analysis

Two analytical techniques were applied to the data, based on the data type provided. Content analysis was used to analyse the data related to the disclosure of DP. Thematic analysis was used for questions related to coping strategies.

Content analysis: Elo and Kyngas' (2007) approach to content analysis was adopted to explore issues related to the disclosure of the condition, in order to provide a systematic

and objective means of describing and quantifying the data. Quantification allows for the data to be characterized in a way that is potentially reliable and valid; making replicable and valid inferences from the data to their context, with the purpose of providing knowledge, new insights, a representation of facts and a practical guide to action (Krippendorff, 1980). This method aims to attain a condensed and broad description of the phenomenon, with the outcome of analysis being the development of categories that describe the phenomenon. These categories are then used to build a model or conceptual system (Elo & Kyngas, 2007), and content validation for the analytical process is achieved via the use of co-researchers who are responsible for supporting category production and coding issues.

Data related to the disclosure of DP were analyzed using inductive rather than deductive content analysis. Given the lack of existing data regarding the disclosure of DP, the use of inductive content analysis was deemed more appropriate as it builds up an understanding of an underexplored construct. The data were initially organized using open coding. This was achieved by writing notes and headings within the questionnaires and transcribed interviews, in order to describe all aspects of the content. Categories were then generated, which were grouped under higher order headings in order to reduce the number of categories. Finally, subcategories were formulated that were then grouped into generic categories depending on their similarity, and these were further grouped into main categories. This was carried out using the process of abstraction (Elo & Kyngas, 2007).

Thematic analysis: Data related to the use of recognition techniques and the risks associated with these techniques were analyzed using inductive thematic analysis. This approach was taken to identify key themes and principles regarding coping strategies in order to establish the coping strategies that are used, the aspects that are successful, and difficulties associated with those used. Thematic analysis allowed us to summarize the

large data set that we collected, creating a well-structured set of themes that highlight similarities and differences among participant responses (King, 2004). The data were organized to show patterns in semantic content and summarized to interpretation, where the significance of the patterns, their broader meaning and implications were theorized (Braun & Clarke, 2006). Themes which were identified were strongly data driven, as opposed to being driven by the researcher's theoretical interest in the area (Braun & Clarke, 2006). Themes were also identified within the explicit meanings of the data, and no underlying ideas or assumptions were examined.

Results and Discussion

Disclosure of DP

Following inductive content analysis on all DP, SO and parental questionnaire and interview responses on this issue, the main categories for each group were identified as *disclosure of DP* and *the importance of raising awareness*. These categories are further elaborated in Table 1.

< *Insert Table 1* >

Disclosure of DP: Twelve of the 50 adult DP participants reported that they have disclosed their condition within their workplace, and a further 19 have disclosed their condition on a social basis (see Table 2). Two of the three parents had informed their child's school. Some DPs, SOs and parents reported a positive impact of disclosure – not only raising awareness of the condition, but also allowing people to understand the reasons behind recognition failure and associated “negative” behaviours (see Table 1). This indicates that people may be accepting of the condition, and can assist DPs by introducing themselves at each new encounter. For instance, one parent explained that full disclosure

prompted teaching staff to be more mindful when allocating group work. The school also introduced nametags to aid recognition and took a general interest in DP and how it affects children. They reported that other children were more thoughtful towards their DP child. Thus, in some instances, disclosure can assist with coping.

< *Insert Table 2* >

However, many DPs, SOs and parents stated that they would only disclose their condition to people that they frequently encounter. Others confirmed that they would not inform any other person, particularly in the workplace. This was largely due to uncertainty surrounding the reception of this information, and its potential consequences for their career. On a personal basis, some DPs felt that disclosure of their condition may make them vulnerable, citing concerns for their safety. Table 2 indicates that some individuals would not disclose their condition in any capacity, or would only inform people due to necessity. However, most SOs and parents disagreed with this caution, with only one SO and one parent feeling that there was a negative impact of disclosing the condition to others. This parent reported that they did not inform other parents of their child's DP, for fear of being judged.

Confidence in disclosing DP was garnered from a formal diagnosis of the condition. Many DPs, SOs and parents were hugely relieved when they received a formal assessment, as it helped to alleviate feelings of low self-worth. Diagnosis also increased understanding of DP amongst SOs and parents, and prevented children with DP from being misdiagnosed with other related conditions. It also provided DPs with an explanation for their recognition failures that they can now present to others.

Raising awareness: DPs, SOs and parents felt that it was important to raise awareness of the condition amongst the general public and relevant healthcare professionals. Table 1 indicates that participants from all groups felt that there was an

overall general lack of awareness and understanding of DP. DPs and SOs reported that increased understanding of the condition would reduce negative and stigmatized comments towards those affected, and also prevent them from being labelled as rude or atypical. Some SOs believed that heightened awareness may encourage others to assist those with DP in terms of identity recognition, by introducing themselves during each encounter. Parents felt that it was crucial to raise awareness amongst educational staff, in terms of being able to address their child's difficulties at school. Furthermore, increased awareness may prevent confusion and potential misdiagnoses: two parents found that educational staff would try to attribute their child's difficulties to conditions such as autism, even after they disclosed their child's DP to the school.

Notably, both DPs and SOs also commented on the consequences of their own lack of awareness of the condition. Many DPs felt that if they had been aware of their condition earlier, it would have been much more beneficial in terms of coping. A number of SOs also noted that they experienced positive effects, such as relief, when they were made aware of their DP SO's condition: their own lack of awareness had meant that they were not able to fully understand the reasons for their recognition difficulties. This suggests that raising awareness of DP is not only important for changing how members of the public interact with DPs, but could also help DPs and SOs themselves.

Overall, findings indicated a critical need to increase awareness and understanding of DP amongst both the general public and relevant professionals, particularly educational staff, in order to aid with everyday life with the condition.

Coping Strategies

Following thematic analysis, two main themes emerged across the DP, SO and parental questionnaire and interview responses: *daily recognition strategies* and *inconsistent success*

of strategy use. These responses were specifically related to questions regarding the development and effectiveness of the recognition strategies adopted by DP adults and children on a daily basis, and are summarized in Table 3. They are further elaborated in Table 4. These tables describe the different types of recognition strategies that are adopted, and the factors that may result in their failure.

< *Insert Tables 3 and 4* >

Daily recognition strategies: DPs adopt a range of recognition techniques in order to cope with their difficulties (see Table 3). These tend to be utilized within all situations where daily recognition of others is required. Many are labour-intensive and mentally exhaustive, due to the use of multiple strategies within different settings.

Some adults preempt their recognition failures within social settings, perhaps by asking a partner or friend to aid with identification - a task that many are happy to carry out. Alternative techniques are to develop associations between the identity of an individual and aspects of their character, accessories, or location; to search for memorable non-facial cues; or to try to identify individuals through conversation. However, all these techniques are labour-intensive and mentally exhausting. Table 3 suggests that many SOs are not fully aware of the use of these strategies, perhaps because they do not require assistance or because they are often skillfully implemented.

Both DP adults and children particularly favour the use of extra-facial cues to recognition, such as voice, hairstyle and gait. However, children also rely upon the use of smart phones and computers - enabling them to easily communicate and identify their friends when meeting them in person. While Diaz (2008) reported that Elizabeth and Steve rely heavily on the use of a computer to interact and socialize, the use of social media has significantly developed since the time of their interview, and may now be of even greater assistance to DP individuals. Many adults in the current study also described alternative

recognition aids, such as writing and memorizing extensive notes about a person, and attempting to associate these with a photograph of that person prior to a meeting. Others use seating plans or nametags to assist with identity recognition at work.

Some individuals simply avoid social and occupational situations that may result in embarrassing recognition failures, or attempt to use humour or excuses to disguise or distract from their difficulties.

Inconsistent success of strategy use: Although DPs have developed a number of recognition strategies that they rely upon on a daily basis, many feel that the effectiveness of these techniques can be somewhat inconsistent. This is due to many factors that can interrupt the success of certain strategies, such as unexpected changes in appearance, an unfamiliar context, or infrequent contact with a particular individual (see Table 3). For instance, regular contact is needed to maintain familiarity with a person, and to build a biography around that individual to assist with recognition techniques. Being unable to recall a person's face also prevents the development and use of associative recognition strategies, such as linking a distinctive feature to a personality trait.

Further, if individuals do not remain consistent in their appearance or the context in which they are expected to be encountered, the use of recognition strategies can become even more effortful and exhaustive. Many adults find it particularly difficult to recognize women because they are more likely to change their hairstyle or accessories, and DP children struggle to distinguish between their peers when wearing school uniform. As many primary school teachers are female, compensatory strategies may be particularly error prone in young children. In addition, as compensatory strategies can take years to refine and confidently implement, DP children may require additional assistance with their difficulties.

As such, disclosure of DP may be necessary in educational settings. One parent reported that their child's school had made helpful adaptations to assist with identity recognition: staff identify themselves to the child, wear nametags, and use classroom maps to assist with the identification of peers. Training is also provided to all staff likely to come into contact with the DP child, giving them the confidence to enquire about a person's identity without embarrassment.

Summary

The majority of adult DPs are reluctant to disclose their condition in the workplace. The most commonly used compensatory strategies are the use of effortful preparation techniques and extra-facial cues to recognition – techniques that can be labour-intensive to implement. These techniques are only effective if regular contact is made with individuals, encounters occur within the expected context, and others maintain a consistent appearance. Recognition failure is therefore sometimes inevitable, and some DPs do not use compensatory strategies at all. Despite this, most DPs continue to use their recognition strategies in everyday life.

General Discussion

This study aimed to (a) identify the advantages and disadvantages of DP disclosure, and (b) identify effective coping strategies that can be used to circumvent face recognition failures. While a minority of the DP participants choose to disclose their prosopagnosia in occupational settings, ~60% have informed others within a social setting, mostly with a positive reception. This appears to be aided by the fact all of our participants had received a

diagnosis of the condition, giving them confidence in their disclosure and information to share with acquaintances.

Nevertheless, one of the main themes to emerge from the discussions of disclosure centered around the fact that public and professional awareness of DP is still low, which impacts DPs and those around them in a number of ways. First, the lack of awareness of the condition can delay identification of individuals with DP. Several participants noted that early diagnosis of their condition would have been beneficial for their ability to cope with the condition. Lack of awareness on a professional level can also lead to DP being attributed to different causes, such as autism spectrum disorder. This is particularly pertinent to children with DP, who may struggle to effectively communicate their experiences to their parents or teachers.

Second, lack of awareness of DP can have negative impacts for those around DPs, who may feel slighted or upset when DPs fail to recognize them; as well as the SOs of DPs, many of whom reported that they were not able to fully comprehend their DP-SO's experiences. This difficulty understanding the experience of a loved one with DP echoes parental reports from Dalrymple et al. (2014), and, on a practical level, may make it more difficult for SOs to assist DPs in social situations. Finally, a number of DPs noted that a lack of awareness of DP has led to negative or stigmatized reactions among the general public – for example, people attributing their difficulty with faces to rudeness or laziness. Many participants pointed to this when providing their reasons for non-disclosure in the workplace. Indeed, the fear of career repercussions that was originally identified by Yardley et al. (2008) is still very real, and most adults with the condition prefer to attempt to inwardly manage their condition while at work.

This finding in itself highlights the need to identify effective coping strategies that can be shared with others. Indeed, the limited success of prosopagnosia remediation

programmes supports theoretical suggestions of limited plasticity in developmental disorders, and particularly in adulthood (Thomas, 2003), which suggests that the development of effective compensatory strategies may be the most effective way to improve everyday functioning in DP. Here, we attempted to identify the most effective coping strategies that are used by individuals with DP, other than complete disclosure of the condition. The most effective compensatory strategies were found to be the discrete assistance of a SO, the use of extra-facial information, and preparation for expected encounters via an extensive range of recognition aids. Each of these techniques has its drawbacks: some strategies may only be useful in a limited range of situations (e.g. SOs tend to be absent in one's workplace), while particular risk factors limit the success of others. For example, unexpected changes in appearance or context can disrupt tactics that revolve around specific cues or recognition aids, whereas situational factors that require within-person consistencies in appearance (e.g. the wearing of school uniform) and a lack of contact can undermine the effectiveness of many strategies that rely on extra-facial cues.

Nevertheless, it is clear that most DPs continue to use compensatory strategies, at least to some degree of success. Some of the compensatory strategies that were uncovered in this study are elaborate, and no doubt evolved over many years of practice. A further clear theme that emerged from the study is that most strategies are effortful, and many DPs mentioned the mental exhaustion that results from their implementation. This finding, and many of the other identified risk factors, suggests that young children may find it difficult to implement these techniques without support. Instead, when taken together with the need to protect the health and safety of young children with DP, it would be prudent to disclose their prosopagnosia to schools and caregivers. Indeed, the benefits of such disclosure are supported by parents within this study and in previous work (e.g. Dalrymple et al., 2014; Diaz, 2008). Not only will such disclosure within educational settings improve public and

professional awareness of DP, but many of the strategies that have been identified in this study can be openly implemented within a school to assist the development, independence and safety of DP children.

Importantly, this study provides a list of recommended compensatory techniques that can be shared with any individual who experiences face recognition difficulties. This list has been summarized in Table 3, together with recommendations for their successful implementation. To date, there have been few attempts to collate information on compensatory techniques used by DPs. As such, we believe these recommendations offer an important resource for people who are diagnosed with face recognition difficulties and their SOs – one which will assist with the development of effective recognition strategies, or simply allow individuals to be more aware of the circumstances in which certain strategies are more likely to fail (and consequently may require an alternate approach). Furthermore, these recommendations may offer an opportunity for the SOs of DPs – especially parents and those who may find it difficult to understand the condition – to discuss their SO-DP's experiences. This resource is also intended to be of use to professionals who encounter individuals with face recognition problems – as such, these recommendations form the first attempt to offer clinical management for DP.

References

- Barton, J. J. (2003). Disorders of face perception and recognition. *Neurologic Clinics*, *21*, 521-48.
- Bate, S., Adams, A., Bennetts, R., & Line, H. (in press). Developmental prosopagnosia with concurrent topographical difficulties: A case report and virtual reality training programme. *Neuropsychological Rehabilitation*, 1-23.
- Bate, S., & Bennetts, R. J. (2014). The rehabilitation of face recognition impairments: a critical review and future directions. *Frontiers in Human Neuroscience*, *8*, 491.
- Bate, S., Bennetts, R., Mole, J. A., Ainge, J. A., Gregory, N. J., Bobak, A. K., ...Bussunt, A. (2014). Rehabilitation of face-processing skills in an adolescent with prosopagnosia: Evaluation of an online perceptual training programme. *Neuropsychological Rehabilitation: An International Journal*, *25*(5), 733-762.
- Bate, S., Cook, S.J., Duchaine, B., Tree, J.J., Burns, E.J., & Hodgson, T.L. (2014). Intranasal inhalation of oxytocin improves face processing in developmental prosopagnosia. *Cortex*, *50*, 55-63.
- Bate, S., & Tree, J. J. (2017). The definition and diagnosis of developmental prosopagnosia. *The Quarterly Journal of Experimental Psychology*, *70* (2), 193-200.
- Bennetts., R. J., Butcher, N., Lander, K., Udale, R. & Bate, S. (2015). Movement cues aid face recognition in developmental prosopagnosia. *Neuropsychology*, *29*, 855–860.
- Bennetts, R. J., Mole, J., & Bate, S. (2017). Super-recognition in development: a case study of an adolescent with extraordinary face recognition skills. *Cognitive neuropsychology*, *34*(6), 357-376.

- Bennetts, R. J., Murray, E., Boyce, T., & Bate, S. (2017). Prevalence of face recognition deficits in middle childhood. *The Quarterly Journal of Experimental Psychology*, *70* (2), 234-258.
- Bornstein, B. (1963). Prosopagnosia. In L. Halpern (Eds.), *Problems of dynamic neurology Jerusalem: Hadassah Medical School* (pp. 283-318). Jerusalem: Jerusalem Post Press.
- Bowles, D. C., McKone, E., Dawel, A., Duchaine, B., Palermo, R., Schmalzl, L., ... Yovel, G. (2009). Diagnosing prosopagnosia: Effects of ageing, sex, and participant-stimulus ethnic match on the Cambridge Face Memory Test and Cambridge Face Perception Test. *Cognitive Neuropsychology*, *26* (5), 423-455.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*, 77-101.
- Brunsdon, R., Coltheart, M., Nickels, L., & Joy, P. (2006). Developmental prosopagnosia: A case analysis and treatment study. *Cognitive Neuropsychology*, *23*(6), 822-840.
- Burns, E.J., Bennetts, R.J., Bate, S., Wright, V.C., Weidemann, C.T., & Tree, J.J. (2017). Intact word processing in developmental prosopagnosia. *Scientific Reports*, *7*, 1683.
- Dalrymple, K. A., Fletcher, K., Corrow, S., das Nair, R., Barton, J. J. S., Yonas, S., ...Duchaine, B. (2014). “A room full of strangers every day”: The psychosocial impact of developmental prosopagnosia on children and their families. *Journal of Psychosomatic Research*, *77*, 144–150.
- Dalrymple, K. A., Garrido, L., & Duchaine, B. (2014). Dissociation between face perception and face memory in adults, but not children, with developmental prosopagnosia. *Developmental Cognitive Neuroscience*, *10*, 10-20.

- Dalrymple, K., & Palermo, R. (2016). Guidelines for studying developmental prosopagnosia in adults and children. Wiley Interdisciplinary Reviews. *Cognitive Science*, 7 (1), 73-87.
- Davies-Thompson, J., Fletcher, K., Hills, C., Pancaroglu, R., Corrow, S. L., & Barton, J. J. (2017). Perceptual learning of faces: A rehabilitative study of acquired prosopagnosia. *Journal of Cognitive Neuroscience*, 29 (3), 573-591.
- DeGutis, J. M., Bentin, S., Robertson, L. C., & D'Esposito, M. (2007). Functional plasticity in ventral temporal cortex following cognitive rehabilitation of a congenital prosopagnosic. *Journal of Cognitive Neuroscience*, 19(11), 1790-1802.
- DeGutis, J., Cohan, S., & Nakayama, K. (2014). Holistic face training enhances face processing in developmental prosopagnosia. *Brain*, 137, 1781-1798.
- Diaz, A. L. (2008). Do I know you? A case study of prosopagnosia (face blindness). *National Association of School Nurses*, 24(5), 281-289.
- Duchaine, B. (2008). Editorial comment on prevalence of hereditary prosopagnosia (HPA) in Hong Kong Chinese population. *American Journal of Medical Genetics Part A*, 146A, 2860–2862.
- Duchaine, B. C. (2000). Developmental prosopagnosia with normal configural processing. *NeuroReport*, 11, 79-83.
- Duchaine, B., Germine, L., & Nakayama, K. (2007). Family resemblance: ten family members with prosopagnosia and within-class object agnosia. *Cognitive Neuropsychology*, 24 (4), 19-30.
- Duchaine, B., & Nakayama, K. (2005). Dissociations of face and object recognition in developmental prosopagnosia. *Journal of Cognitive Neuroscience*, 17, 249–61.
- Duchaine, B., & Nakayama, K. (2006). The Cambridge Face Memory Test: Results

for neurologically intact individuals and an investigation of its validity using inverted face stimuli and prosopagnosic subjects. *Neuropsychologia*, 44, 576-585.

Elo, S., & Kyngas, H. (2007). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107-115.

Fine, D. R. (2012). A life with prosopagnosia. *Cognitive Neuropsychology*, 29, 354-359.

Humphreys, G., & Riddoch, M.J. (1993). *Birmingham Object Recognition Battery*. Hove, UK: Lawrence Erlbaum Associates.

King N. (2004). Using templates in the thematic analysis of text. In Cassell C., Symon G. (Eds.), *Essential guide to qualitative methods in organizational research* (pp. 257–270). London, UK: Sage.

Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*. Sage Publications, Newbury Park.

Murray, E., Hills., P.J., Bennetts, R., & Bate, S. (2018). Identifying hallmark symptoms of developmental prosopagnosia for non-experts. *Scientific Reports*, 8, 1690.

Schmalzl, L., Palermo, R., Green, M., Brunsdon, R., & Coltheart, M. (2008). Training of familiar face recognition and visual scan paths for faces in a child with congenital prosopagnosia. *Cognitive Neuropsychology*, 25(5), 704-729.

Thomas, M.S.C. (2003). Limits on plasticity. *Journal of Cognition and Development*, 4(1), 99-125.

Yardley, L., McDermott, L., Pisarski, S., Duchaine, B., & Nakayama, K. (2008). Psychosocial consequences of developmental prosopagnosia: A problem of recognition. *Journal of Psychosomatic Research*, 65, 445–451.

Tables

Table 1: An elaboration of DP, SO and parental responses for the “disclosure” and “raising awareness” categories

Category	Group	Description	Quotes
Disclosure	DPs	<p>Many (N = 26) DPs found that disclosure helped to raise awareness and aided coping, but stated that they would only inform others if there was a specific reason. Some (N = 7) were cautious about whom they informed of their condition; a large proportion (N = 25) would not disclose their condition at all due to the uncertainty of how this would be received.</p>	<p>“Sharing experiences doesn’t make the recognition easier but what it does is remove any concerns I’ve got that I might be giving the wrong impression” [DPM70].</p> <p>“It can be very helpful informing others, because I feel comfortable running into the office and whispering to a colleague, who’s that standing at the desk? Should I recognise her?” [DPF49].</p>
	SOs	<p>Many (N = 18) felt positive about DP disclosure: it would reduce embarrassment, raise awareness and</p>	<p>“Yes informing others helps because people aren’t offended when you don’t recognize them” [SOF19].</p>

		<p>promote understanding about recognition failure. Many (N = 14) had seen that upfront disclosure of the condition results in acceptance from others. Only one SO predicted a negative impact of disclosure. Some (N = 9) reported that their DP-SO did not ever disclose their DP; a small number (N = 4) were unaware whether their DP-SO informed others.</p>	<p>“I do not know if they inform others” [SOM63].</p>
	Parents	<p>One of the three parents reported a positive impact in disclosure. They were happy for open disclosure to raise awareness. The remaining parents only informed others out of necessity. One reported that they did not inform other parents of their child’s DP, through fear of being judged.</p>	<p>“The school have been very good about it. They’ve printed out the nametags of the other children in the early days” [PM5].</p>

Raising awareness	DPs	<p>Many (N = 24) felt that raising awareness is important to improve public understanding – a lack of understanding often results in negative and stigmatized reactions. Many (N = 17) felt that earlier diagnosis would have helped with coping.</p>	<p>“More recently I have informed people, but some people seem to think I’m just a bit weird or making excuses for not making an effort” [DPF39].</p> <p>“I’d have a freer life and perhaps developed my coping strategies much earlier if I received information earlier” [DPF69].</p>
	SOs	<p>Some (N = 14) felt it is important to raise public awareness to increase understanding. Some (N = 16) believed a general lack of awareness underlies feelings of offence following recognition failures. Some (N = 7) felt relieved when they were informed of their DP-SO’s condition, allowing understanding of recognition failures, and reassurance that DP was a recognized condition.</p>	<p>“Yes. I think people have sometimes assumed she has been rude / ignorant. Explaining would help them to understand” [SOF44].</p> <p>“It’s a bit of a relief, to be honest. But there was something, some label, I don’t know, some sort—that explanation that wasn’t just because he’s a bit cooky...So, it did relieve a bit of frustration, I suppose. That was a positive realization rather than...a negative thing” [SOF51].</p>

	Parents	All parents felt very strongly about awareness raising in schools: staff members and children do not understand DP. When they disclosed their child's DP, two parents found that staff would try to attribute their child's difficulties to conditions such as autism.	<p>“Other pupils just don't get it at all despite [DP child's] attempts to explain. It just makes him seem more different” [PM15].</p> <p>“And various members of staff, actually secondary school...have great difficulty getting their head around it” [PM15].</p>
--	---------	--	--

Table 2: A summary of DP, SO and parental responses about disclosing DP and raising awareness of the condition. Data refer to the number of affirmative mentions for each viewpoint across participants (i.e. one individual may mention their viewpoint on more than one occasion), rather than the number of individual participants who agreed with each perspective (see Table 1 for this information).

Disclosure and awareness	Total number of times mentioned		
	DPs	SOs	Parents
	(N = 50)	(N = 26)	(N = 3)
Upfront disclosure of condition	38	10	2
Non-disclosure of condition	25	9	1
Disclosure of condition due to necessity	26	7	2
Cautious disclosure of condition	7	0	0
Benefits of disclosing condition	30	18	8
Negative impact of disclosing condition	0	1	1
Sharing experiences aids coping	11	0	0
General lack of awareness and understanding of DP	24	5	6

Table 3: Summary of recommended recognition strategies and their associated risks.

Strategy	Total number of mentions			Potential risks
	DPs (N = 50)	SOs (N = 26)	Parents (N = 3)	
<p><i>Reliance on SOs to cue the identity of others:</i></p> <p>Ask SOs for identity prompts</p> <p>Ask others to tailor conversations during social events</p>	12	11	0	Requires preparation and effort; need to be discrete; SOs have to be present; may not be possible to direct conversation.
<p><i>Visual association:</i></p> <p>Develop memorable links between a person's qualities and character using objects, locations, etc.</p>	5	2	0	Requires regular contact and some degree of familiarity with each person. Some DPs struggle with visual imagery.
<p><i>Use distinguishing facial cues to identity:</i></p> <p>Memorise distinguishing facial features, e.g. unusual eyebrows, blemishes, distinctive features, skin tone.</p> <p>Exaggerate physical attributes of the face (caricaturing)</p>	22	0	1	Requires regular contact to maintain associations. Can be mentally exhaustive and effortful. Requires extensive study of people's

<p>Use mouth movements during speech</p> <p>Use idiosyncratic motion within the entire face</p>				<p>faces which can be deemed socially inappropriate.</p>
<p><i>Identify others through conversation:</i></p> <p>Ask people to introduce themselves</p> <p>Repeat a person's name during conversation</p> <p>Introduce oneself first and hope they do the same</p> <p>Use the topic of conversation as a cue to identity</p> <p>Use general small talk to cue identity</p> <p>Gauge a person's reaction to the conversation</p> <p>Use the voice as an identity cue</p> <p>Be more of a listener than a talker to buy time</p>	13	5	2	<p>Can be mentally exhaustive, and conversations may not reveal identity. Using introductions can be perceived as odd, formal or old-fashioned, or simply inappropriate in some contexts. May be viewed as unwilling to engage in some/all aspects of conversation.</p>
<p><i>Extra-facial cues to identity</i></p> <p>E.g. voice, gait, mannerisms, hairstyle, smell, jewellery, clothes, body shape/posture, character, height, tattoos, ethnicity, gender, spectacles, handwriting, school bags.</p>	10	1	2	<p>Can be unreliable when suddenly changed or met out of context, some information may not always be present. Multiple strategies may need to be combined – mentally exhaustive.</p>

				Environments that require uniform may prohibit some strategies.
<i>Recognition aids</i>	10	1	2	Can be unreliable in different contexts. Effortful. Name tags are often inappropriate, and when they are used can be difficult to read. Person may have changed some aspects of appearance from original photograph.
<p>Memorise detailed notes on behaviour, appearance, etc.</p> <p>Study photographs</p> <p>Use social media for repeated exposure</p> <p>Write names down during meetings</p> <p>Use name tags</p> <p>Obtain identifying information before an encounter</p>				
<i>Avoidance:</i>	9	1	0	May be inappropriate or untenable at work, could bring about adverse psychosocial consequences. Excuses may still be interpreted as “rudeness” or shift focus to other “detrimental” traits (e.g. absent-mindedness).
<p>Avoid uncomfortable situations</p> <p>Use pretence or humour to hide difficulties</p> <p>Avoid using names or being the one to make introductions</p> <p>Avoid being the first person to arrive at a prearranged spot</p>				
<i>No strategy use</i>	7	7	0	

Table 4: An elaboration of DP, SO and parental responses about coping strategies

Theme/subtheme	Group	Description	Quotes
Daily recognition strategies			
Preparation	DPs	<p>Some heavily rely on their SOs for prompts and reminders.</p> <p>Some mentally associate memorable objects or locations with particular individuals, or group them into particular categories.</p>	<p>“I also rely on my partner to help – she will say hello to people we know and include their name in the opening sentence/make reference to something she knows I will recognise” [DPF43].</p> <p>“Usually it helps if I have a “label”... e.g. “Mr X the school governor with the motor bike”, or if I can link them with a memorable place or event” [DPM62].</p>
	SOs	Many are relied upon to aid recognition within social situations and daily encounters. SOs use names when greeting people, or discretely inform their DP of others' identity.	“So, I think, we had this party last year and he was reasonably okay but he did say to me, “Oh, if there's someone coming who you may know and I might

		They also provide suggestions for recognition aids. Some reported that their DP associates particular experiences or facts with certain individuals.	have forgotten, can you just jog my memory when they come in?" [SOF62]. "When she knows a fact about them that are interesting to her she kind of used it to stamp the person into her brain" [SOF43].
	Parents	A reliance on others helps children with recognition. During social encounters, one DP child relies on those present to identify all other individuals.	"Tends to be quiet initially so others identify the people there" [PM15].
Effort	DPs	Many put large amounts of continuous and laboured effort into their recognition strategies, e.g. memorising distinguishing facial features or actively searching for non-facial cues to recognition (e.g. specific behaviours or location-based cues).	"Once I know someone well enough to remember they have a certain feature that makes them unique, I use that as a little cheat to ensure they are who I think they are" [DPF27]. "If I don't know who they are, I would just make...a lot of general small talk about stuff that doesn't matter until it comes to you who they are or they

		Some try to identify others through the topic of conversation, or make a conscious effort to remember and repeat an individual's name during conversation.	might give you some clue. They might make some comments about something, some common experience you've had and then you can place them" [DPF46].
	SOs	Much effort is put into close observation, searching for non-facial cues to recognition. One SO reported the use of seating plans at work, and others described DPs prolonging conversations to gather sufficient information for identification	"Just talks to them long enough for the light to dawn on who he is talking to. It does come but is via the conversation not the face" [SOF64].
	Parents	Children put large amounts of effort into their recognition strategies. Some try to memorize distinguishing facial cues; others use school bags or seat locations as aids. Another waits to be greeted during a conversation, then tries to discretely establish identity.	"Memorises everybody's rucksacks at school so can identify people from that" [PM15]. "He will simply smile sweetly and say "hello"...he wouldn't use their name. But he would act as if he did recognize them" [PM5].

Recognition aids	DPs	<p>Most DPs use extra-facial cues to recognition, particularly voice, hairstyle and gait. Many rely on context, as the location of where an individual was originally encountered can be important in terms of future recognition. Some use physical recognition aids such as photographs or social media to promote repeated exposure.</p> <p>Many felt that physical recognition aids would be beneficial at work, e.g. photographic aids positioned around various locations or the use of nametags.</p>	<p>“The hair. The hair is a big one” [DPF52].</p> <p>“I often get people confused regarding who it was I spoke to, or who was at an event. Instead, I most often remember where they were in relation to where I was when I spoke to them” [DPF27].</p> <p>“I have found Facebook to be very useful as repeated exposure to people's photographs reinforces my memory of them” [DPM58].</p> <p>“Name tags are brilliant, with large letters on them, and placed so that it is not too obvious that you don't know who they are whilst rapidly reading their name tag” [DPM68].</p>
	SOs	<p>Extra-facial cues are mostly used to aid recognition of others, particularly voice, hairstyle and gait. One reported</p>	<p>“As a teacher, he would have photo grids of pupils with their names and I think the groupings/places they may usually have been seated in and made</p>

		the use of photos to gain familiarity, and felt that similar aids should be introduced into the workplace.	himself familiar with their faces and names” [SOF51].
	Parents	Extra-facial cues are most commonly used for recognition, particularly voice, hairstyle and gait, and sometimes clothes and body shape. Older children also use context, and a mobile phone or computer to improve recognition. The introduction of photographic aids or nametags within a school would be useful. Further suggested aids include allowing children to wear their own clothing, keeping seating consistent, and taking a register at the beginning of each lesson to enable associations.	“Let people wear their own clothes, sit in the same place, wear name tags” [PM6]. “Children are assigned a place. The register is taken at the beginning of every lesson so that everybody, you know, who’s sitting next to you and you look and wait until they say, “Yes, Miss.” And you know who they are. And then you can go around your table and very quickly you learn the route” [PM15].
Indirect strategy use	DPs	Some use avoidance strategies to hide or excuse their DP. Rather than developing coping strategies, they attempt to avoid the reality of their difficulties.	“I think you can sort of hide behind being a bit absent-minded or a bit day-dreaming or something like that and I probably do that as well” [DPM51].

		A small number are open about their DP, e.g. by apologizing in advance for their recognition failures, or using humour to make insignificance of any errors.	“I always apologise in advance, i.e. let people know when I first meet them that I am unlikely to recognise them again” [DPF51].
	SOs	Some SOs reported the use of avoidance strategies by DPs, either to hide the condition or make excuses for it, e.g. the avoidance of using names during conversation. Some stated that their DP was honest about their condition to others, and may actively apologize in advance for recognition failures.	“My partner never takes the initiative in introducing people, even if she thinks she knows who they are, in case she's wrong. For the same reason she also avoids using people's names when talking to them” (SOF43).
Inconsistent success of strategy use			
Factors impacting strategy use	DPs	Recognition strategies can only be maintained via regular contact with others, and become slightly easier with each encounter. Many find daily use of strategies to be effortful, as sudden changes in appearance impact the success of using certain recognition techniques. Some	“It can be too much using strategies all the time, I think you sort of save it for close friends and family” [DPM51]. “You just accept you're going to get it wrong with other people and just accept that you'll have to get

		find that recognition failure is often inevitable, and ultimately accept this rather than attempting to implement strategies.	yourself out of it at some point and have to apologize or just get it wrong” [DPM51].
	SOs	<p>Repeated contact helps DPs gain confidence in their recognition strategies, but this takes time and practice.</p> <p>Changes in physical appearance can reduce success, particularly for females who can change their hair and make-up on a daily basis. Context is also important for recognition success.</p>	<p>“He’s recently started a new job and he said it was quite a problem to start with because most of the women there have the same straightened hair” [SOF51].</p> <p>“And especially when you see people out of context. If you might meet one friend, say, at church and then some weeks later, meet them in...(the) supermarket, or on the street, or in a completely different set of circumstances, then she’d be very much at a loss” [SOM72].</p>

	Parents	Female children are particularly difficult to recognize in a school setting, as many have the same hair colour, hairstyle, and wear similar/no makeup.	“He finds girls particularly difficult. There are too many blue eyed blondes as far as he’s concerned in terms of trying to tell them apart. They all have a similar hairstyle” [PM15].
Problems with strategy use	DPs	A number of problems contribute towards the effectiveness of strategy use, e.g. difficulties in recalling where a person was first encountered, or being unable to imagine a person’s face. Reliance on extra-facial features is only effective if features remain consistent, e.g. hairstyle. If particular features are not observable, e.g. if an individual is seated and the key information is gait, strategies may fail. A number of recognition aids are unreliable, non-beneficial or not appropriate to the workplace, e.g. name identifiers.	“Even if it’s five minutes after seeing someone, I can't reconstruct their face in my mind” [DPF70]. “Studying faces, remembering clothes, smell and voice feels like hard work, and is only really effective if consistent” [DPM51]. “Name badges are almost no help at all because the badges are usually below eye level, and so if you need to read the badge it's quite obvious that you're breaking eye contact to look down at their badge” [DPF49].

	SOs	Name identifiers can be unreliable: they cannot be consistently used within all situations.	“Name tags would help but not in everyday social environment, i.e. socialising” [SOM56].
	Parents	Memorizing school bags only works for a short period of time, as children frequently change their bags and do not bring them to social events.	“September is always a really difficult month as far as school’s concerned because a lot of people change their bags” [PM15].

SM1: Diagnostic Scores for DP Adults and Children

Table 1: Screening scores for the adult DPs. Diagnostic criteria were impairment on at least two of three tests using published-cut-offs (see Murray et al., 2018): the CFMT (cut-off score of 58.33%), CFPT (cut-off score of 57.64%) and famous faces test (cut-off score of 60%)¹. Some participants only completed the CFMT and CFPT, hence inclusion criteria for these individuals required poor performance on both these tests.

	Gender	Age	CFMT score (%)	CFPT score (%)	Famous Faces (%)
DPM63	M	63	40.28*	62.50	23.64*
DPF49	F	49	48.61*	54.17*	18.75*
DPF77	F	77	54.17*	51.39*	35.56*
DPF56	F	56	58.33*	66.67	37.74*
DPF68	F	68	52.78*	58.33	56.00*
DPM65	F	65	51.39*	59.72	50.00*
DPM53	M	53	45.83*	62.50	31.03*
DPM48	M	48	52.78*	50.00*	61.67
DPM68	M	68	38.89*	63.89	43.40*
DPF49	F	49	44.44*	44.44*	32.14*
DPF29	F	29	55.56*	63.89	47.37*
DPF70	F	70	52.78*	59.72	34.62*
DPF32	F	32	45.83*	66.67	38.89*

¹ Note that four individuals showed borderline impairments. Because these individuals report severe everyday difficulties with face recognition, and diagnostic issues when working with arbitrary statistical cut-offs, these individuals were included in the study to increase sample size.

DPF69	F	69	54.17*	55.56*	52.54*
DPF37	F	37	58.33*	45.83*	33.90*
DPM70	F	70	51.39*	41.67*	44.00*
DPF53	M	53	58.33*	33.33*	54.50*
DPF52	F	52	47.22*	45.83*	71.90
DPF57	F	57	41.67*	55.56*	-
DPM51	M	51	56.94*	44.44*	75.40
DPF29	F	29	41.67*	48.61*	58.00*
DPF37	F	37	48.61*	44.44*	-
DPF46	F	46	54.17*	44.44*	67.30
DPM40	M	40	50.00*	44.44*	77.60
DPM48	M	48	54.17*	37.50*	-
DPF54	F	54	48.61*	38.89*	-
DPF44	F	44	54.17*	44.44*	39.00*
DPF39	F	39	48.61*	45.83*	-
DPF25	F	25	44.44*	54.17*	-
DPM40	M	40	58.33*	51.39*	-
DPF64	F	64	48.61*	43.06*	94.00
DPF56	F	56	52.78*	58.33	61.11
DPF62	F	62	54.17*	37.50*	-
DPM53	M	53	56.94*	68.06	52.80*
DPF43	F	43	56.94*	59.72	-
DPF54	F	54	41.67*	59.72	72.80
DPM52	M	52	54.17*	33.33*	70.00
DPF52	F	52	48.61*	34.72*	-

DPF48	F	48	52.78*	75.00	60.00*
DPF69	F	69	66.67	50.00*	51.00*
DPF60	F	60	36.11*	41.67*	-
DPM68	M	68	52.78*	37.50*	-
DPM76	M	76	40.28*	59.72	49.00*
DPM72	M	72	51.39*	48.61*	-
DPM62	M	62	44.44*	44.44*	-
DPM58	M	58	52.78*	44.44*	-
DPF52	F	52	43.06*	43.06*	-
DPF27	F	27	51.39*	70.14	-
DPF53	F	53	48.61*	38.89*	-
DPF51	M	51	54.17*	41.67*	-

* Signifies impairment

Table 2. Screening results for younger DP children on the CFMT-K and face matching task, and for a teenager on the CFMT and CFPT. Diagnostic criteria were impairment (performance that is more than 1.7 SDs from the control mean) on at least one of the relevant two tests: the CFMT-K (controls: N = 32: 17 male, 15 females, age range = 5.5-6.5 years, mean age = 6 years; cutoff score 28.21%) and a face matching task (control: N = 83: 39 male, 44 females, age range = 5.5-6.5 years, mean age = 5.94, cutoff score 28.55%); or the CFMT (adolescent controls: N = 11, age range 13.2-16.0 years, mean age = 15.1 years, cutoff 55.66%), and the CFPT (adolescent controls: N = 13, age range 13.2-16.0 years, mean age = 15.0 years, cutoff 65.76%). PM5, who scored slightly above the cut-off point (but close to chance levels of performance for the face memory task), was considered to be a borderline DP.

	Gender	Interview age	Screening age	Face Memory (%)	Face Matching (%)
PM6	M	6	4	27.08*	33.33
PM5	M	5	4	39.58	86.66
PM15 ^a	M	15	14	52.78*	50.00*

* Signifies impairment

^aParticipant PM15 was screened as a teenager and therefore completed the adult screening tests (the CFMT and CFPT), and was compared to adolescent control data (from Bennetts, Mole, & Bate, 2017) to determine his DP.

SM2: Questionnaire and Interview Items

Questionnaire items for DP participants

1. Do you tend to inform others about your face recognition difficulties?
 - a. Does this help in any way to cope with it on a daily basis?
 - b. Are there some groups of people you wouldn't inform about your difficulties?
2. Have you developed any methods or techniques to help you recognise people?
3. If something could be done to help aid your recognition of people, what would your suggestions be?

Questionnaire items for SO participants

1. If something could be done to help aid your significant other's recognition of people, what would your suggestions be?
2. Does your significant other tend to inform others of their face recognition difficulties?
 - a. Do you think informing others is helpful? If so, how does it help?
3. Has your significant other developed any methods or techniques to help them recognise people?

Questionnaire items for parents

1. Do you tend to inform others of your child's face recognition difficulties?
 - a. Do you think informing others is helpful? If so, how does it help?
2. Has your child developed any methods or techniques to help him/her recognise people?
3. If something could be done to help aid your child's recognition of people, what would your suggestions be?

Interview questions for DPs

1. Does it help to share your experiences with other people, from a coping point of view?
 - a. If so how do you communicate this information?
 - b. Are there any effects of sharing this information?
2. Have you developed any methods or techniques to help you recognise people?
 - a. How effective are they?
 - b. Do you use the same methods or techniques for all situations?
3. Do you find your face recognition difficulties cause you to do certain things or act in certain ways when you're around people?

Interview questions for SOs

1. Has your significant other developed any methods or techniques to help them recognise people?
 - a. How effective are they?
 - b. Does your significant other use the same methods or techniques for all situations?
2. Do you think your significant other's face recognition difficulties cause him/her to do certain things or act in certain ways when he/she is around people?
 - a. Do you think having face recognition difficulties has an impact on your significant other's social interactions? If so, are there any social interactions/groups of people who are most affected?
3. Do you think that your significant other's face recognition difficulties cause him/her to approach situations or activities in a particular way?
 - a. Do you think having face recognition difficulties prevents your significant other from carrying out certain everyday tasks? If so, which tasks?

Interview questions for parents

1. Has your child developed any methods or techniques to help him/her recognise people?
 - a. How effective are they?
 - b. Does your child use the same methods or techniques for all situations?
2. Do you think your child's face recognition difficulties cause him/her to do certain things or act in certain ways when he/she is around people?
 - a. Do you think having face recognition difficulties has an impact on your child's social interactions? If so, are there any social interactions/groups of people who are most affected?
3. Do you think that your child's face recognition difficulties cause him/her to approach situations or activities in a particular way?
 - a. Do you think having face recognition difficulties prevents your child from carrying out certain everyday tasks?
 - b. Are there any situations or tasks that you try to keep your child away from due to their prosopagnosia? If so, why?