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SHORT PAPER OPEN ACCESS

Recognising Facial Identity Across Age: A Comparison of Super-Recognisers, People With Developmental Prosopagnosia and Typical Perceivers

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ABSTRACT

Recognising and matching unfamiliar faces across highly variable photographs of the same face is a challenging task, but few studies have examined the ability to group identities together across photographs depicting different biological ages. This study examined the ability to sort the identity of ambient images that depict two target individuals between infancy and young adulthood. Three participant groups were examined: super-recognisers (SRs), individuals with developmental prosopagnosia (DPs) and controls. SRs significantly outperformed both DPs and controls, making fewer overall errors in clustering the identities. Furthermore, 80% of SRs achieved perfect accuracy, compared with 15% in each of the other two groups. DP performance was highly variable and overall did not differ from controls, with both performing near chance-level. These findings highlight the heterogeneity of impairment in DPs and the SRs' exceptional tolerance for within-person variability, even across significant age-related changes, offering a potential indicator for use in SR screening.

1 | Introduction

Matching pairs of photographs of the same identity is a difficult task for most people (e.g., Alenezi and Bindemann 2013; Fysh and Bindemann 2017, 2018; Megreya et al. 2013; White et al. 2014), especially when images depict a high level of within-person variability (e.g., Jenkins et al. 2011; Sandford and Ritchie 2021). Such variability usually arises from differences in time, day, lighting, pose, camera, facial expression and sometimes even age (see e.g., Bindemann et al. 2013; Burton et al. 2016; Jenkins et al. 2011; Sandford and Ritchie 2021; Sexton et al. 2023). However, experiments with an age gap are typically focussed only on adults. Matching children's faces is even more challenging, often yielding lower accuracy (Kramer et al. 2018). Notably, experienced individuals such as facial comparison practitioners (Michalski et al. 2019) or individuals who are in regular contact with children, such as nursery teachers (Bate et al. 2020), show no

performance advantage. Additionally, sorting tests that require grouping *multiple* images of the same identity further increases the difficulty of the task. Indeed, in a sorting task that used ambient photographs of two unfamiliar adults, no participant achieved perfect accuracy (Jenkins et al. 2011), and the ability to group unfamiliar identities pictured across a developmental trajectory—from infancy to adulthood—is not yet known, despite its relevance in security settings (e.g., missing persons).

Existing theoretical models, and much of the research on within-person image variability, deals with perception and recognition of unfamiliar faces across a range of environmental differences (e.g., luminance, viewpoint, and camera differences) and whilst temporal gaps are considered, these are typically confined to adulthood (see e.g., Burton et al. 2016; Jenkins et al. 2011; Sandford and Ritchie 2021; Sexton et al. 2023). Substantial age gaps in images of adults

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(e.g., 20-year-old vs. 40- and 60-year-olds) have been shown to significantly impair face recognition performance compared with smaller or no gaps, but performance is usually still above chance-level (see e.g., Sexton et al. 2024). Although a 20-year age gap in adulthood often results in fundamental changes to the face, the same 20-year gap during key transformative developmental stages (i.e., between 1 and 20 years) is associated with far greater age-related changes which transform the face across different dimensions. Specifically, ageing during adulthood is more greatly associated with featural changes (González-Alvarez and Sos-Peña 2023; Porcheron et al. 2013; Sforza et al. 2011), such as skin wrinkles and sagging, skin tone and texture, and thinning of lips, though the extent of this can depend on intrinsic individual differences and extrinsic factors (e.g., UV exposure) (Nabila et al. 2021). Although adult ageing also brings about progressive shifts to bone structure and fat repositioning, but these are subtle and occur slowly over a long period of time relative to early developmental changes (for review see Swift et al. 2021). In contrast, early development ageing is predominantly associated with changes to cardioid strain (i.e., geometric remodelling of the facial skeleton by growth) (Pittenger and Shaw 1975; Rhodes 2009) affecting more 'global' cues.

Thus, ageing-related changes over different periods of the lifespan vary not only in the *number* of changes but also in the *type* of changes which may affect face processing in different ways. Consequently, there are limitations with extending conclusions drawn from age-related variability in adulthood to developmental related changes. Effects of temporal variability arising due to significant age-related changes on face perception specifically across the earlier developmental spectrum are less known. A small set of studies have demonstrated the challenge with recognising childhood faces of well-known celebrities, with performance as low as 28% on a Before They Were Famous (BTWF) recognition test (see Bindemann et al. 2014; Russell et al. 2009). Furthermore, in a study comparing face recognition of familiar classmates after 25 years of no contact with a group of unfamiliar controls, performance reduced from 49% to 33% (Bruck et al. 1991). Additionally, recognition performance for other-age faces (young and older) has been found to be 20% less accurate than the same-age versions (George and Hole 1998).

Currently, the most comprehensive theoretical model for explaining recognition across age is the relatively recent Episodic Prototypes Model (EPM; Schneider and Carbon 2021). EPM posits that single face prototypes representing an individual during specific life episodes are stored, and any new encounters with a face matched closely with that era are then compared with this episodic prototype. Specifically, the face images from that period of life where the face was undergoing a period of similarity (e.g., childhood years) cluster together to form a single prototype to represent that era, and a new prototype is created and stored when the face becomes dissimilar enough during a different life episode (e.g., teenage years). This model typically assumes that learning occurs through multiple exposures of faces over several independent instances, thus although highly relevant to sorting, its applicability to multiple exposures within a *single* instance is unclear. Further, individual differences in this process have not yet been explored.

Given that there are well-documented individual differences in facial identity recognition and matching ability, it is highly plausible that such differences will extend to one's ability to withstand temporal within-person image variability—at least to some degree. Face perception ability ranges from individuals who experience day-to-day challenges with recognising faces ('developmental prosopagnosia', DPs; Bate and Tree 2017) to those who excel at this task ('super-recognisers', SRs; Bate et al. 2021). Pertinently, SRs have been found to be more resistant to within-person variability and not only perform better than controls on a sorting task comprising unfamiliar faces, but their performance with sorting unfamiliar faces was found to be on par with controls who *were* familiar with the same set of faces (Yovel et al. 2024). This superior advantage also extends to the *recognition* of childhood photos of known celebrities on the BTWF task (Russell et al. 2009) and *matching* of unfamiliar identities across adolescence (high school photographs) with their 25-year-old version in the Yearbook Test (YBT) (Mayer and Ramon 2023). Further, whilst only few studies have compared performance on the *matching* of pairs of children's faces across ability groups, SRs have been shown to outperform both controls (Belanova et al. 2018) and people who are in high contact with children (e.g., nursery and primary school teachers) (Bate et al. 2020). No research has been conducted to examine child-to-child matching performance in DPs, and none investigating child-to-adult matching of unfamiliar faces in both DPs and SRs.

Thus, little is known about the full range of ability in matching of children's faces to adult faces, and how this process maps onto known abilities in face recognition. Although we might expect that DPs would perform poorly on this task, it is worth noting that there is mixed evidence for the generalisation of impairments of facial identity perception across other aspects of face processing in DPs (see e.g., Bennetts et al. 2024; Fysh et al. 2020; Mello and Duchaine 2025; Murray et al. 2022). Thus, DPs sometimes record failures in specific processes or sub-processes which do not consistently generalise to other face identity tasks (for review, see Mello and Duchaine 2025). For instance, some DPs show a failure in face recognition memory but do not show impairment in face identity perception and encoding on, for example, matching tasks (see Bate et al. 2019; Dalrymple et al. 2014; Fox et al. 2008; Murray et al. 2022). Furthermore, there is also heterogeneity in performance on non-identity face processing tasks amongst DPs. For example, some studies found that a small subset of their DP sample also record a deficit in gender perception (e.g., Chatterjee and Nakayama 2012; Marsh et al. 2019) and emotion recognition (e.g., Biotti and Cook 2016; Duchaine et al. 2006). Therefore, given the variability in performance across different face processing task amongst DPs, and the lack of research examining face identity perception of childhood faces, it is unclear whether DPs will perform worse than controls on this task.

Taken together, these studies indicate that recognising identities across age is uniquely challenging and there may be individual differences in the natural ability to track identity across age which have not yet been explored. The lack of research is surprising considering the ability to identify, match and recognise faces across the lifespan has real-world relevance in contexts such as long-term missing person's investigations, child abduction and exploitation cases and border

control. Importantly, understanding the full range of ability on this task may enable strategic deployment of high performing individuals on these tasks in applicable security settings and the exclusion of individuals who perform poorly. Ramon (2021) proposed a diagnostic framework for the assessment of different skills across sub-processes of face cognition using a multi-level assessment with a battery of tests to predict performance on real-world security tasks (Mayer and Ramon 2023). This framework already includes cross-age face matching in the older age ranges (adolescent to adult in the YBT; Ramon 2021), and extending it to include cross-age face matching in the younger age ranges (infancy to adulthood) could make a valuable contribution, with direct applications to tasks such as identifying missing persons.

Thus, the aim is to examine differences in the ability to group identities across age. Therefore, in this study, we compare SRs, DPs and controls on a single-trial sorting task involving two identities photographed between infancy and young adulthood. We predicted that the task would be highly challenging for typical observers, and more so for DPs, whilst SRs would show superior performance compared with both the other groups.

2 | Method

2.1 | Participants

A total of 153 participants took part in this study. Sixty (50 female) individuals had previously been deemed to meet the dominant diagnostic criteria for DP (Impaired performance on at least two of three screening tasks—CFMT, CFPT and Famous Faces Test; Bate and Tree 2017; Bate et al. 2019) ($M_{\text{age}} = 46$, $SD = 11.87$, range = 21–62), and 46 (33 female) had previously been screened and deemed to meet the inclusion criteria for SR (Superior performance on at least two of three screening tasks—CFMT+, MMT and PMT; Bate et al. 2018, 2021) ($M_{\text{age}} = 42$, $SD = 9.54$, range = 25–63)—recruited from our lab's pre-existing participant pool.¹ Forty-seven control participants (24 female), approximately matched to the DP and SR groups, were recruited through Prolific ($M_{\text{age}} = 37$, $SD = 7.73$, range = 24–54). The criteria for the control group included United Kingdom as location, over 18 and must have normal or corrected-to-normal vision. Mean age and range were similar across participant groups, but to rule out any patterns arising from age differences between and within groups, participant age was added as a covariate in the analysis. All participants received small monetary compensation for their participation. Ethical approval was obtained from the Institution's Ethics Board (Ref: 47626), and all participants provided written consent to take part.

2.2 | Materials and Procedure

Following the precedent of other sorting studies (see Jenkins et al. 2011; Johnson et al. 2020), we opted to use a single-trial task. Thus, 12 face photographs depicting two female identities were selected from our existing face database (Murray et al. 2022). This comprised six images for each identity

spanning in age between 1 and 19 years (Ages for ID 1: 1, 7, 11, 15, 18 and 19 and ID 2: 1, 4, 11, 13, 15 and 18). We used a tapering approach to select the identities for this task. First, we used the subset for which participants had given prior additional consent for their photographs to be published publicly; this was considered important given the intention to potentially use these as a brief diagnostic screening tool. Second, within that subset, we identified the sets of photographs which comprised the best quality frontal-profile images (e.g., image resolution, no sunglasses, hats, facial hair) which spanned toddlerhood to young adult, for which we had recorded known information on chronological age for all the images. Third, from the remaining photographs, we matched identities across age and ethnicity. Within those, we excluded identities with salient distinguishing facial features (such as moles or birthmarks). Finally, we paired two identities which had six photos spanning similar known ages and with broadly similar defining features, specifically both identities have similar skin tone, hair texture and eye colour. Once selected, the photographs were cropped closely around the face (chin to top of head) such that no background could be seen. The size of the images was adjusted so that the width was consistent (230 pixels) and the height was allowed to vary to maintain ratio and not introduce any distortion. To keep the images as natural as possible, no other manipulations were made to the photographs, and the photographs were presented in full colour (see Figure 1).

The grouping task was set up in Qualtrics survey platform and participation was restricted to PC only and could not be completed on a tablet or phone. Participants were presented with the deck of 12 unfamiliar faces in a random order alongside two empty boxes, with the following instructions: *In this task you are required to sort a stack of 12 facial images into two identities (people). On the next screen, the faces will be presented in a random order in the centre of the display with two empty boxes. Your task is to group photographs representing the same identity together, so that pictures of the same individual are placed in the same group. You can move these back and forth until you are satisfied with your groupings.*

We chose to inform participants that there are only two identities; this was done deliberately for a few reasons. First, to narrow the scope of the task by limiting the types of errors that can be made, which would simplify the measurement score and interpretation by removing the variability in the number of clusters that could be created. Second, previous sorting tasks using adult-only faces have proven exceptionally challenging (see Jenkins et al. 2011; Johnson et al. 2020). Typically, participants form several clusters (averaging between seven and nine) representing perceived distinct identities for only two identities in previous single-trial sorting tasks (see Jenkins et al. 2011; Johnson et al. 2020). Therefore, we expected that the cumulative difficulty resulting from using highly variant images from toddlerhood to young adulthood of unfamiliar identities would have likely yielded floor effects and masked any nuanced differences that may emerge between groups. Participants were therefore informed that there were only two identities but were *not* told that the 12 faces were equally divided across the two identities. Participants sorted these faces into two groups until they were satisfied with their decision; the task was therefore self-paced with no imposed time limit.



FIGURE 1 | Illustration of the images of the two intermixed identities.

3 | Results

For accuracy score, we used a similar approach to Tüttenberg and Wiese (2019) and calculated sorting error by determining the number of images of one identity incorrectly sorted into a pile containing at least four (i.e., the majority) of images of an identity set. However, given the smaller stimulus set to that used in Tüttenberg and Wiese (2019), we set a limit of three errors, since beyond this point there was usually no majority pile and correct matches were more likely to be random. Thus, participants were allocated a score of 0 if they made no errors, a score of 1 if they made a single error (i.e., added one extra photo into an otherwise correct pile—AAAAA & BBBBBA), a score of 2 if they made two errors (i.e., added two extra photos in otherwise two correct piles—AAAA & BBBBBA or swapped two identities across piles—AAAAAB BBBBBA) and a score of 3+ if three or more errors were made. Table 1 summarises the spread of errors across participant groups.

A chi-square test revealed a significant association between participant group and number of sorting errors, $\chi^2(6)=68.26$, $p<0.001$, with a medium effect size and Cramer's $V=0.47$. Post hoc tests indicated that SRs and DPs ($\chi^2(3)=48.11$, $p<0.001$), SRs and Controls ($\chi^2(3)=45.63$, $p<0.001$), differed significantly in their distribution of number of errors. Whereas DPs and controls did not differ ($\chi^2(3)=3.22$, $p=0.359$).

For additional detail, Table 2 presents the frequency of misclassifications across age clusters. Specifically, this summary

TABLE 1 | Summary of number of sorting errors including number of participants and proportion of participants (percentage in parentheses) by participant group.

Number of sorting errors	Controls	DPs	SRs	Total
0	7 (14.9%)	9 (15%)	37 (80.4%)	53 (34.6%)
1	1 (2.1%)	2 (3.3%)	2 (4.3%)	5 (3.3%)
2	7 (14.9%)	17 (28.3%)	4 (8.7%)	28 (18.3%)
3+	32 (68.1%)	32 (53.3%)	3 (6.5%)	67 (43.8%)
Total <i>N</i>	47	60	37	153

only includes instances involving one or two classification errors and excludes cases with three or more errors. Each age cluster contained between one and two photographs per identity (see Section 2 for the full distribution across identities). Because the number of photographs representing each cluster (one to two photographs per cluster per identity) varied across identities, statistical comparison of error frequencies between clusters would be inappropriate. Nevertheless, the distribution of errors is reported for descriptive purposes. Inspection of the distribution suggests that misclassifications were concentrated in the upper and lower extremes (1 year and 18/19 years); however, these apparent differences should be interpreted cautiously.

TABLE 2 | Summary of frequency of misclassifications for the different age clusters by participant group.

	1 year	4–7 years	11–13 years	15 years	18–19 years	Total
Controls	6	2	2	1	4	15
DPs	8	7	4	5	12	36
SRs	4	3	0	1	2	10
Total	18	12	6	7	18	61

4 | General Discussion

In line with SRs' exceptional facial identity recognition abilities (Bate et al. 2021), this group outperformed controls and DPs at discerning between two identities across the ages. These findings suggest that SRs' exceptionally high tolerance for large within-person image variability of unfamiliar faces extends also to significant structural facial changes that occur over the developmental period between infancy and adulthood. In contrast, DPs and controls performed similarly; whilst many performed at chance-level or slightly higher, there was considerable individual variation in each group, and only a few sorted the faces with fewer than three errors.

Findings here provide a first indication that SRs may be more adept than the typical population at integrating age-related featural changes with identity. The process underlying this advantage is unknown. A computer modelling study found that individuals retain idiosyncratic features across the adult lifespan (20s to 70s) which would support age-independent recognition despite within-person variability and temporal changes (Mileva et al. 2020). In the present study, participants could 'build' an identity in a stepwise or cumulative manner by observing what perceptual information at one age overlaps with the information at the next closest age, and so on. This task is different to say recognising a single childhood face from a known adult representation one is familiar with (e.g., BTWF; Russell et al. 2009), because participants can view multiple age episodes in between the oldest and youngest. Additionally, it is worth noting that the task here differs in a few ways from the classic sorting tasks, in that we used unfamiliar faces and the paradigm constrained number of groups to two instead of having a fully unconstrained sorting task. It has been argued that SRs may be more efficient at processing identity-relevant information, which may relate in this case to more age-stable physical features (such as moles, dimples and facial width in the upper face; Caplova et al. 2017; Nute and Moss 2000), and more proficient at ignoring identity-irrelevant changes in facial features across photographs (see Yovel et al. 2024). The findings here may indicate that SRs are exceptionally sensitive to the subtle age-stable or idiosyncratic facial information to withstand substantial age-related changes that occur from childhood to adulthood.

Both DPs and controls performed similarly, with the majority (more than 50%) making three or more errors. However, some participants did manage two or fewer errors. This may reflect floor effects with some utilisation of basic strategies across both groups, such as some success with matching hair colour or grouping the closer age groups. It is surprising that a small number of DPs (9 of 32) achieved perfect accuracy on this task.

The reason for this is not clear; however, research has found that face perceptual encoding is preserved in some DPs even if recognition memory is impaired (see Bate et al. 2019; Dalrymple et al. 2014; Fox et al. 2008; Mello and Duchaine 2025; Murray et al. 2022). It has also been argued that recognition memory relies more strongly on perceptual encoding skills, but the reverse is less likely (see White 2025), thus failure may occur at recognition point in DPs for multiple reasons whilst perceptual encoding remains intact. It is also plausible that some DPs developed highly effective compensatory strategies to 'work out' identity, such as identifying extraneous cues (see Portch et al. 2023), that were successful on this task.

We used a single trial for this experiment, which is not unusual and has been found to yield meaningful results in previous studies (see Jenkins et al. 2011; Johnson et al. 2020). The use of a single trial was driven partly by practical constraints, including the limited size of suitable pairs of faces in our database. This was sufficient to pilot a brief screening tool and prioritise efficiency and ecological validity. Nonetheless, additional trials could help to determine whether these abilities will generalise to other faces and to develop a stronger theoretical understanding of the emerging differences between groups. The pair of identities used in this sorting task was suitably sensitive to distinguish between SRs and DPs/controls, thus may serve as a useful brief pre-diagnostic screening to filter qualifying participants for a full assessment. However, it is not known to what extent modifications to the task, for example by selecting more similar or distinct identities, changing the number of groups or photographs and increasing the number of identities will change the outcome, but this first experiment certainly opens a worthwhile avenue for further research. Future research should seek to replicate these findings with a larger and broader set of identities. Additionally, further tests need to be conducted to comprehensively examine whether the superior face skills of SRs in applied settings, based on current tests, would transfer to cross-age face matching. This has significant implications in missing persons and child exploitation investigations.

In conclusion, research examining the potential overlap between age and identity processing is scarce (see Attard-Johnson et al. 2024, 2025) and this was the first study to examine individual differences (SRs, DPs and controls) in the ability to sort unfamiliar identities from photographs depicting images of people from early childhood through to adulthood. Individual differences observed in other face tasks may extend to identity recognition of faces which undergo significant changes through early childhood; this was particularly pertinent for the SR group, whilst differences between DPs and controls were not recorded. Whilst it is plausible that the task was not sensitive enough to

detect perceptual differences between DPs and controls, it is also possible that DPs are not impaired below the typical level of performance on this perceptual task. However, this task appears to be highly effective at detecting SRs. Given the theoretical and applied importance of SR research, this brief 2-min sorting task could serve as an efficient and widely accessible screening tool for identifying potential SRs within large populations. Specifically, by casting a wide net and filtering potential SRs with minimal time commitment, high scoring individuals could then be specifically invited to undertake the full standardised assessments for SRs. Thus, this targeted approach could make SR recruitment more economical and potentially capture individuals who were unaware of their superior face recognition abilities.

Author Contributions

Janice Attard: conceptualization, methodology, investigation, visualization, writing – original draft, writing – review and editing, formal analysis, funding acquisition. **Olivia Dark:** data curation. **Ebony Murray:** writing – review and editing, methodology. **Sarah Bate:** conceptualization, methodology, investigation, writing – original draft, writing – review and editing, funding acquisition.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in Open Science Framework at https://osf.io/2zg4b/overview?view_only=958949801dad4bf8a004b103cb27f1ae.

Endnotes

¹ Details on diagnostic criteria and participant scores, sorting scores and correlations between tests can be accessed in Tables S1–S4 and correctly sorted images can be accessed at https://osf.io/2zg4b/overview?view_only=958949801dad4bf8a004b103cb27f1ae. A version of the grouping task can be completed at https://run.pavlov.org/JATTA_RDJOHNSON/facesorttask22.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Performance on face recognition and perception tasks for the SR participants. **Table S2:** Performance face recognition and perception tasks for the DP participants. **Table S3:** Correlations between tests for the SR participants. **Table S4:** Correlations between tests for the DP participants.