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Parenting styles in caregivers of children with Autism Spectrum Disorder and effects of service dogs

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Objective: Parents of children with Autism Spectrum Disorder (ASD) have parenting styles that differ from parents of typically developing children. Integration of a service dog (SD) at home has been demonstrated as having multiple effects within families of children with ASD. Our aims were to investigate if (a) specific parenting styles can be identified during parents' interactions with their child with ASD using ethological methods, and (b) integration of a SD have an effect on these styles.

Methods: Behavioural coding was performed on videos recorded at home by 20 parents of 6-12-years old children with ASD before SD integration. Parents were asked to record themselves and their child while making a puzzle. 14 parents performed a second similar recording 3-6 months after SD integration. Data were analysed using Principal Component Analysis, Hierarchical Cluster Analysis and non-parametric tests.

Results: Three parenting styles emerged: Parents Involved in the Task (PIT), Parents Relaxed in the Interaction (PRI), and Parents Disengaged from the Interaction (PDI). PIT were characterised as more controlling and verbally focused on the activity. PRI were less controlling and talk about things other than the activity. The same applied to PDI, except that they were less warm in their interactions. Analysis performed after SD integration revealed that these groups also diverged in the evolution of certain behaviours.

Conclusion: This study is the first to demonstrate that behavioural observations can highlight different parenting styles in caregivers of children with ASD, and that the integration of a SD has effects on these styles, with variation according to parents' style prior to SD integration. Indeed, a decrease in activity control behaviours was observed in parents with an initial profile characterise by higher expression of such behaviours (i.e., PIT), while an increase of those

behaviours was observed in parents initially with an initial profile characterise by a weaker expression of such behaviours (i.e., PRI). Interestingly, the last profile characterized by less engagement in the interaction and activity (i.e., PDI) did not seem to show significant changes.

KEYWORDS

parenting profile, Autism Spectrum Disorder, service dog, parenting behaviour, behavioural coding, ethology

1 Introduction

1.1 Family, a social organisation between different partners

Etymologically, the family refers to a group of individuals living under the same roof (Le Robert, 2022). It is considered as a specific social organisation that includes at least the association of one parent and his/her child (Goldberg, 2010). A parent in this context is someone who cares for and takes care of a child in his/her everyday life, whether or not they are biologically related. This dyad is dynamic by essence and communicates multimodally through interactions, which are themselves at the basis of any social structure (Hinde, 1976). An interaction requires at least two individuals and one type of behaviour. Through the repetition of these social interactions, parent and child build up a social relationship. Each new interaction is then influenced by the previous interactions and the mutual expectations of those to come (Hinde, 1976). Although interactions in this relationship are fundamentally bidirectional, the focus of our study was on parenting behaviours since it can be modified by appropriate interventions (e.g., Brookman-Frazee et al., 2006; Poslawsky et al., 2015). From an evolutionary standpoint, parenting behaviours, as for parental care, are considered as primary aiming at promoting the survival, health, learning and behavioural development of the offspring in order to optimise its fitness.

Parenting behaviours include all behaviours displayed by the parent and directed towards the child (Reed and Osborne, 2014). Some of these behaviours may share common characteristics and may be grouped into “parenting dimensions”. Two main parenting dimensions are commonly reported and identified in the scientific literature. First, Parental warmth (or Parental sensitivity/responsiveness) is defined as “the extent to which parents intentionally foster individuality, self-regulation and self-assertion by being attuned, supportive, and acquiescent to their children’s special needs and demands” (Baumrind, 1991). The second dimension is Parental control (or Parental demandingness) and

refers to “the claims parents make on children to become integrated into the family whole, by their maturity demands, supervision, disciplinary efforts and willingness to confront the child who disobeys” (Baumrind, 1991). Although most authors agree on these two dimensions, some authors suggest the existence of additional dimensions, while other suggest a different subdivision of dimensions (e.g., Prinzie et al., 2009; Boonen et al., 2015). Parenting style corresponds to the parenting attitudes and behaviours that they transmit to their child, creating a specific emotional climate in which the child evolves (Dalimonte-Merckling and Williams, 2020). Based on those two parenting dimensions, Maccoby and Martin (1983) identified four parenting styles (or profiles) that are distinctly distributed along these dimensions of warmth and control (Dalimonte-Merckling and Williams, 2020). Baumrind (1991) defined these four styles as: Authoritarian, Authoritative, Disengaged and Permissive. Authoritarian parents are strict and directive, but are little sensitive to their child’s needs. They impose a strict environment and a clear set of rules, while controlling their child’s activities. A parent with an Authoritative style shows warmth, is sensitive to the child’s needs, also shows control over the child, and uses disciplinary methods to support rather than punish the child. Disengaged parents do not provide structure, supervision or support to their child. Finally, Permissive parents are very sensitive to their child, but have limited control, never impose restrictions on their child and adjust according to them. In general, the assessment of parenting styles is mainly based on questionnaires administered to parents (e.g., Boonen et al., 2014; Lambrechts et al., 2015), such as the Parenting Styles and Dimensions Questionnaire (PSDQ) (Robinson et al., 1995). In contrast, only a few studies have relied on behavioural observations to establish parenting styles (e.g., Bontinck et al., 2018). However, one could argue that parenting dimensions and styles are directly associated with the production of specific parenting behaviours (e.g., Parental warmth can translate into verbal and non-verbal display of affection toward the child [compliments, hugs, kisses, and so on]). This interest in studying parenting styles is even more justified since this latter has been shown as having an impact on various spheres of child development: social, emotional and cognitive (Lambrechts et al., 2015). For example, Casas et al. (2006) demonstrated that children of parents with Permissive and Authoritarian styles displayed

Abbreviations: ASD, Autism Spectrum Disorder; NT, Neurotypical; SD, Service Dog; PIT, Parents Involved in the Task; PRI, Parents Relaxed in the Interaction; PDI, Parents Disengaged from the Interaction; PCA, Principal Component Analysis; HAC, Hierarchical Ascending Classification.

higher levels of relational aggression. Considering the impacts of parenting style on child development prompts a reflection on the potential causes leading a parent to adopt and privilege one style among the others.

Various factors either external (e.g. culture, social support) or internal to the parents (e.g. parenting behaviours received during childhood, belief system about one's own child) may influence their parenting style (Assel et al., 2002; Guttentag et al., 2006; Su and Hynie, 2011). Among them, parental stress (*i.e.*, stress specifically related to child and family problems rather than to daily events) has been shown as playing a role in modulating this style (Reed and Osborne, 2014).

1.2 Having a child with Autism Spectrum Disorder, impact on parenting behaviours

Autism Spectrum Disorder (ASD) is defined as a group of disorders with an onset that typically occurs during the preschool years. This disorder is considered as being multi-factorial in origin. Indeed, while various peri-natal and environmental factors have been identified as risk factors for ASD (e.g., parental age, preterm birth, maternal medication, heavy metal exposure), common and rare genetic variants have strongly been demonstrated as contributing to risk of ASD. Gene-environment interplay as well as epigenetic factors may also be involved. However, a unifying pathophysiology has not yet been identified (Myers et al., 2020; Havdahl et al., 2021; Thapar and Rutter, 2021). ASD is characterized by difficulties with social communication and social interaction, and restricted and repetitive patterns in behaviours, interests, and activities (APA, 2013). These impairments often result in behavioural problems (e.g., tantrums, runaways, behavioural rigidities, stereotypes) that are present throughout the life of the individuals with ASD (Dollion and Grandgeorge, 2022). An heterogeneity is present in the profiles in terms of the manifestation and degree of symptoms severity (Wing, 1988), as well as in the degree of functional impairment individuals with ASD may experience (APA, 2013). Thus, having a child with ASD disrupts the daily life of the family in a singular way, and jointly, influence parenting behaviours.

Parents of children with ASD and parents of neurotypical (NT) children may behave differently toward their child. For example, parents of children with ASD have been reported to initiate more interactions with their child than parents of NT children (Kasari et al., 1993). Furthermore, Doussard-Roosevelt et al. (2003) showed that mothers of children with ASD engaged more physical contact and used less verbal interaction with their child compared to parents of NT children. On a broader level, differences on parenting dimensions are also observed. With regard to Parental control, mothers of children with ASD are reported to less structure tasks than mothers of NT children, since they learned to intervene less quickly to avoid child's frustration and possible escalation of the child's anger (Boonen et al., 2015). Furthermore, higher discipline scores have been found in parents of children with ASD (e.g., Kasari et al., 1988). However, other studies have shown contradictory results, with parents of NT children being stricter (e.g., Maljaars et al., 2014; Lambrechts et al., 2015). It has been suggested that this

divergence may be explained by the fact that several subcategories exist within the Parental control dimension and that not all studies would assess the same subcategories (Lambrechts et al., 2015). In their meta-analysis, Ku et al. (2019) did not find any significant difference between parents of children with ASD and parents of NT children in terms of parental support. However, the number of control behaviours (e.g., parental commands, parental intrusiveness) and negative behaviours (e.g., non-confirming response, mutual negativity) towards the child were higher in parents of children with ASD (Ku et al., 2019). These differences also emerge at the parenting styles level. Indeed, it seems that Authoritarian style is more frequently observed in parents of children with ASD compared to parents of NT children (Reed and Osborne, 2014; Antonopoulou et al., 2020). Also, parents of children with ASD are reported to have lower levels of Authoritative style in comparison with parents of NT children (Rutgers et al., 2007). These parenting styles specificities in parents of children with ASD appear to be related to the level of stress experienced by these parents, as described below.

Being a parent of a child with ASD involves exposure to various specific factors that may generate stress for these parents. These factors may be either external to the family system, such the lack of access to appropriate services, or experience of social stigma, or internal to it, such as the ongoing condition of the disorder and the presence of child's challenging behaviours and their consequences on the family functioning (Reed and Osborne, 2014; Lambrechts et al., 2015; Clauser et al., 2021). Many studies confirm the presence of greater stress in parents of children with ASD, both through self-reported questionnaires or physiological measures of cortisol (*i.e.*, stress hormone) (Hayes and Watson, 2013; Fecteau et al., 2017; Padden and James, 2017; Fecteau et al., 2023). Interestingly, Boonen et al. (2015) showed that the differences in parenting style observed between parents of children with ASD and parents of NT children disappeared when parents' stress levels were controlled. Considering these particularities of the parent's interaction profile in parents of children with ASD seems even more important when considering the potential repercussions it may have on child development. Indeed, according to the displayed parenting style, some ASD symptoms may be exacerbated, such as problem behaviours (Osborne et al., 2008; Boonen et al., 2014; Lindsey et al., 2020). Although parenting plays a role in the development and prognosis of the child with ASD, it is necessary to reiterate that it does not cause ASD (Reed and Osborne, 2014). However, finding ways to reduce parental stress seems essential, as this could have a positive impact on parenting strategies and, ultimately, on the well-being and behaviour of families with a child with ASD.

1.3 Introducing an animal into the household and its benefits for the family

Nowadays, companion animals occupy a significant place in our homes, where they are considered as part of the family (McConnell et al., 2019). They share the same environment with humans and both benefit from each other's presence (Grandgeorge, 2020). The most common species in our homes and families are cats, fishes and

dogs (report [FACCO/KANTAR-TNS, 2020](#)). The latter may both play a companionship or support role in the home. However, a specific type of dog can be distinguished: the service dog (SD). [Jalongo and Breece \(2018\)](#) define this dog as “an individually trained canine that performs important tasks for a person with a diagnosed disability” (e.g., Down syndrome, ASD, post-traumatic stress disorder) in his/her daily life. Specifically, for children with ASD, the SD is intended to provide technical, psychological and social support to the child.

As observed with NT individuals ([Odendaal and Meintjes, 2003](#); [Wells, 2009](#); [Morrison, 2016](#)), studies have shown that both companion animal and SD can have positive effects on individuals with ASD. Nevertheless, these benefits appear to be multifaceted and include behavioural, emotional and social domains ([Smyth and Slevin, 2010](#); [Grandgeorge et al., 2012](#); [Berry et al., 2013](#); [Carlisle, 2015](#); [Harwood et al., 2019](#)). In particular, SD has a direct effect on children with ASD's stress ([Tseng, 2022](#)). For example, in their study, [Viau et al. \(2010\)](#) notably observed a significant decrease in children with ASD's Cortisol Awakening Response within the first four weeks following integration of a SD within the family, while it then increased afterward when the SD was removed from the family.

Interestingly, other studies have shown that these benefits of companion animals and SD are not limited to the child, but extend to the entire family both in families of NT individuals ([Cox, 1993](#); [McNicholas and Collis, 2000](#)) and families of children with ASD. Indeed, improved family functioning ([Leung et al., 2022](#)) and feelings of security and independence ([Berry et al., 2013](#)) have been reported by parents of children with ASD. Parents also perceive a decrease in their own stress ([Burgoyne et al., 2014](#)). Regarding SD, [Fecteau et al. \(2017\)](#) showed that its inclusion within the family led to a facilitation of parent-child interactions but also to an improvement in stress and cortisol levels in parents of children with ASD. Concerning more specifically these effects on stress and cortisol, through a longitudinal design, with data collection before and after integration of a SD, [Fecteau et al. \(2017\)](#) not only showed that a significant reduction in the parenting stress perceived by the parents of children with ASD was observed 9 months after integration of the SD, but also and above all that compared to a control group (i.e., parents' from families on the waitlist for a SD) parents from families of children with ASD who received a SD showed a significant reduction in wakening and morning cortisol levels within the first 12 weeks following integration of a SD (which suggests an improvement in the regulation of the hypothalamic-pituitary-adrenal axis). Thus, the presence of animals, such as a SD, appears to be beneficial for individuals with ASD but also to have an impact on other family members.

1.4 Aim and hypotheses

Taken together, the current scientific literature raises the following question: Does the integration of a SD within the family of a child with ASD influence parenting styles? We expect that SD integration will have an effect on parent-child interaction and, in particular, will lead to observable changes in parenting strategies. First, we investigated whether specific parenting styles (i.e.,

Authoritative, Authoritarian, Permissive or Disengaged according to those defined by [Baumrind, 1991](#)) could be identified during interactions between parents and their child with ASD, but here, using an original method: direct observation and ethological methods. We then analysed if the integration of a SD in the family influenced these parenting styles.

2 Methods

2.1 Participants

2.1.1 Ethics

This study was performed in line with the principles of the Declaration of Helsinki. This study was approved by the Ethical Committee (French CPP; RCB number: 2020-A02012-37) and the Ethics Committee for Educational and Psychological Research (CEREP) of the University of Montréal (Certificate number: CEREP-20-113-D). All parents provided their written consent, and all children provided an oral assent.

2.1.2 Parents and children

The study was conducted in Quebec (Canada) and in France. Participants were selected from families who were about to receive a SD provided by the Mira Foundation or the Handi'Chiens Association. To be included in the study, children with ASD had to be between the age of 5 and 12 when they receive their SD. They also had to be diagnosed with ASD according to DSM criteria (e.g., DSM 5; [APA, 2013](#)). The SD's referent parent (i.e., the parent who attended the training course conducted by the providing organization (i.e., Mira Foundation or Handi'Chiens Association), and who was the primary handler of the SD) was the parent with whom data collections were conducted during the study. Twenty-three parent-child dyads who met the inclusion criteria were initially enrolled in the study. From this initial pool, 3 parents never participated to data collection. The final sample included 20 parent-child with ASD dyads who participated and sent videos to the research team before attribution of their SD (i.e. T0). Their characteristics are presented in [Table 1](#). After T0, 6 families either dropped out or did not continue with the study. Thus, 14 dyads participated to data collection both before (T0) and after the SD integration (i.e., 3 and/or 6 months after). Based on observations and parental interviews all children with ASD include in this study had verbal ability ranging from partially verbal (i.e., one-word sentences) to fully verbal.

2.1.3 Service dogs

Each dyad was provided a SD. When attributed to the families, SD were 24.0 (\pm 6.3) months old on average. Most of them were females (70.0%). These SD were of different breeds: Labernese (n=8), Golden Retriever (n=6), Labrador (n=5) and German Shepherd (n=1).

2.2 Experimental procedure

The study included two stages of data collection: (a) before the SD was placed in the family (T0) and (b) three to six months after

TABLE 1 Main characteristics of the included children with ASD and parents at both follow-up periods (T0 and T1).

		Children characteristics at T0	Children characteristics at T1
Age (years)	Mean (\pm SD) Range	9.0 (\pm 1.9) 6.1–12.4	9.5 (\pm 2.1) 6.7–12.8
Sex (number of children)	Girls Boys	6 14	4 10
Comorbidity (percentage)	Presence	70.0%	71.4%
		Parents characteristics at T0	Parents characteristics at T1
Age (years)	Mean (\pm SD) Range	40.2 (\pm 5.1) 28.0–48.0	
Sex (number of parent)	Mothers Fathers	19 1	13 1
Home country (number of dyads)	France Canada (Quebec)	11 9	10 4

placement (T1). Contacts information for families meeting the inclusion criteria and interested into participating in the study was sent to the research team by the Mira Foundation and the Handi’Chiens Association. Parents were then contacted by the research team to provide information about the objectives and methodology involved in the study, and to proceed to signature of the consent form if they agreed to participate. At each stage of data collection, parents were asked to record a 10-minutes video (*i.e.*, 600 seconds) of themselves performing a specific activity with their child with ASD: a jigsaw puzzle or, more generally, an activity that required the assembly of pieces (*e.g.*, building an electronic circuit). A tutorial video was sent to the parents to guide them on how to perform those recordings. Recommendations were given but adaptations could be made with validation by the research team, if necessary. Ideally, each parent-child dyad should sit on a table in a quiet room of their choice. It was recommended that no other people should be present and that potential sources of distraction for the child with ASD should be avoided (*e.g.*, lighted screens or TV, objects unnecessary to the activity and music). Additionally, the requested material was one or some puzzles adapted to the child with ASD, an object to track the duration of the activity (*e.g.*, a watch or time timer) and a device to record the interaction (*e.g.*, video camera, mobile phone, tablet) that should be placed facing the participants. To start the activity, the parents had to be seated next to her/his child with the puzzle box opened and to invite her/him to start the puzzle. During the recording, parents and children were free to interact. In particular, parents were free to intervene in their child’s activity and to participate or not in the activity. The child had the possibility to switch to another puzzle or activity, if he/she wished to. The activity ended after 10 minutes. If the child with ASD had not completed the puzzle, he/she was free to continue after the camera was turned off. It was accepted that the videos would last

more or less than 10 minutes. On average, the videos lasted 651.6 ± 238.6 seconds at T0 and 660.6 ± 223.2 seconds at T1.

2.3 Data collection

Data collection began in December 2020 and ended in November 2022. Each parent sent their video recordings via a secure transfer platform (*i.e.*, Chapril or Drop.Infini) at both stages of data collection. The videos were then analysed using The Observer XT 11.5 or 16.0 software for behavioural coding. A behavioural repertoire was created specifically to code parent-child interaction behaviours (Table 2). Classical ethological methods in behaviour analysis were used (Altmann, 1974). Using *scan sampling*, with a 5 seconds interval (*i.e.*, 131.4 ± 45.8 scans on average per individual), the following behaviours were coded on parents: parent-child with ASD distance, gaze direction, facial expression and participation in the activity. All parents’ vocalisations (except those directed towards another person present), as well as gestures intended for interaction were collected using *focal sampling* (occurrences). A detailed version of this behavioural repertoire can be found in [Supplementary Material \(S1\)](#).

All videos were coded by the same observer. A second observer double-coded all behavioural items for 14.7% of the videos. Inter-observer reliability was calculated using The Observer XT 16.0 software. Inter-raters reliability was considered excellent (mean Kappa index across all behaviours of 0.86, with a range from 0.82 to 0.94 across observations).

2.4 Statistical analyses

2.4.1 Behavioural extraction

Due to variations in parent and child visibility on the recordings, behaviours collected in *scan sampling* and gestures (*focal sampling*) were proportioned over the total duration of participants’ visibility on the videos and of dyad presence in the same room (*i.e.*, when the child is present in the room with his/her parent). Vocalisations were repropotioned over the total duration of dyad presence in the room. Finally, due to inter-dyad variability in the duration of recordings, the extracted scores were all repropotioned over a total duration of 10 minutes.

2.4.2 Statistical analyses

Statistical analyses were conducted using the RStudio software (version R-4.1.0.) with a significance threshold of $p=0.05$. Due to the limited sample size (20 individuals at T0 and 14 individuals at T1), non-parametric statistics were used.

First, for the results at T0, descriptive statistics followed by Friedman tests were performed to compare the different modalities within each behavioural category (*e.g.*, gaze direction) and Wilcoxon *post-hoc* tests were applied, in order to characterise how parents interacted with their child with ASD. Wilcoxon tests were also used when a behavioural category included only two modalities (*e.g.*, negative comments). Next, in order to determine if different parenting styles could be identified and how they differed

TABLE 2 Behavioural repertoire of the parent (A) and definitions of behavioural modalities of the vocal repertoire (B).

A		
Behavioural categories	Definitions	Behavioural modalities
Scan sampling		
Parent-child distance	Distance between the nearest visible body parts of the child and the parent	Directly in contact; Close ($d \leq \frac{1}{2}$ child's arm); Intermediate ($d \leq 1$ child's arm); Distant ($d > 1$ child's arm).
Gaze direction	Estimated gaze direction based on head and eye orientation	Gaze directed towards: the interaction partner; an object in the activity; the environment (<i>i.e.</i> , any other direction).
Facial expression	Full facial expressions displayed and clearly identifiable	Positive (<i>i.e.</i> , joy); Negative (<i>i.e.</i> , sadness and anger); No marked valence.
Participation in activity	Individual's engagement in the activity	Engaged simultaneously with the partner (<i>i.e.</i> , parent and child look at and handle an object related to the puzzle activity); Engaged alone (<i>i.e.</i> , only the parent looks at and handles an object related to the puzzle activity); Engaged in another activity (<i>i.e.</i> , the parent looks at and handles any other object not related to the puzzle activity); Not engaged in any activity (<i>i.e.</i> , the parent does not look at and/or handle any object in general).
Focal sampling		
Parent's vocalisation	Any vocalisation emitted by the parent and directed directly or indirectly to the child	Initiator of the conversation: the parent initiates a new vocal exchange after a minimum of 3 seconds of silence after the last vocalisation expressed (either by the parent or the child) (Meirsschaut et al., 2011).
		Type of vocalisation: characterisation of the vocalisation emitted (<i>e.g.</i> , activity-related) (see Table 2. (b)).
Parent's gesture	All gestures made by the parent for communicative purposes with the child	Subcategories: Gesture to approve/disapprove a child's action/vocalisation, to express affection, to illustrate one's own words or to support the child in carrying out the action (<i>e.g.</i> , refocusing attention, correcting an action).

B			
Link with activity	Behavioural categories	Definitions	Behavioural modalities
Activity-related	Comment on parent's action	Vocalisation made by the parent about his/her own action/production in the activity	Request: interrogative vocalisation related to parent's own action/production.
			Affirmation: declarative vocalisation related to parent's own action/production.
	Positive comment	Vocalisation to value the child's action or production in the activity	Compliment: vocalisation to congratulate and value the child's action/saying.
			Validation: vocalisation to confirm the child's action/saying.

(Continued)

Continued

B			
Link with activity	Behavioural categories	Definitions	Behavioural modalities
	Negative comment	Vocalisation to rectify the child's action or production in the activity	Encouragement: vocalisation to support and reassure the child in his/her action.
			Invalidation: vocalisation to disapprove the child's action/sayings. Correction: vocalisation to correct the child's action/ saying by providing the solution to the child.
	Framing vocalisation	General vocalisation related to the child's activity and/or action	Regulation: vocalisation to change child's activity progress and redirect the child's attention (no use of action verbs).
			Description: vocalisation to describe the child's action/ production or the activity or an object of the activity (statements and questions).
			Request for opinion: vocalisation to question the child about what he/she thinks of his/her action/production.
	Action request	Vocalisation emitted to make the child perform a desired action	Imposition: declarative vocalisation expressed with the intention to make the child perform an action immediately (use of action verbs).
			Induction: interrogative (or conditional) vocalisation expressed with the intention to make the child perform a given action immediately (use of action verbs).
			Proposal: vocalisation expressed to suggest an action to the child that he/she may accept to perform or not (possible choice), or referring to the child's willingness to perform it (use of action verbs).
	Non-verbal vocalisation	Emitted sound and onomatopoeia	Positive: non-verbal expression of joy and valuation around the child or parent's action/production.
			Negative: non-verbal expression of sadness/anger and of devaluation about the child or parent's action/production.
			No marked valence: any other non-verbal vocalisation related to the activity.

(Continued)

Continued

B			
Link with activity	Behavioural categories	Definitions	Behavioural modalities
Non-activity-related	Child-related vocalisation	Child-related vocalisation in general	Positive prosocial vocalisation: vocalisation to express a fact and value/ compliment the child.
			Affect-related vocalisation: vocalisation to rephrase the child's emotions/feelings, to apologise to the child, to ask about the child's emotional state, etc.
			Negative remark: vocalisation to express a fact and devalue the child.
	Parent-related vocalisation	Parent-related vocalisation in general (self-perception, emotional state, etc.)	
	Another topic	Vocalisation concerning a theme different from the activity and not corresponding to the above definitions.	
	Non-verbal vocalisation	Sound and onomatopoeia emitted	Positive: non-verbal expression of joy and valuation towards the child/ parent/other subject.
			Negative: non-verbal expression of sadness/anger and devaluation around the child/parent/other subject.
			No marked valence: any other non-verbal vocalisation unrelated to the activity.

at T0, a Principal Component Analysis (PCA) using a Varimax rotation was performed on data subset of behavioural variable at T0 in order to explore and extract parenting dimensions. A Hierarchical Ascending Classification (HAC) was then used to identify groups that differed according to the parenting dimensions extracted from the PCA. Kruskal-Wallis and Dunn (*post-hoc*) tests were used to compare groups on individuals' scores on the PCA dimensions, as well as on each behavioural variable.

Behaviours displayed before and after SD integration (*i.e.*, T0 versus T1) were compared using Wilcoxon tests. Additional Wilcoxon tests were used to compare behaviours at T0 and T1 within each group of parents in order investigate for behavioural changes between both stage of data collection. Kruskal-Wallis and Dunn (*post-hoc*) tests were used to examine whether groups of parents identified as differing in parenting styles at T0 still differed in their behaviours at T1 and how their interaction behaviours evolved (*i.e.*, behavioural measurement at T1 minus T0).

3 Results

For clarity, only significant results and trends were reported below.

3.1 Characteristics of initial parenting styles before SD integration

3.1.1 General description of parenting behaviours
3.1.1.1 General considerations

Neither the parents nor the children displayed any inappropriate or aggressive behaviours during the observations. Behavioural modalities differed significantly between each other within categories of the behavioural repertoire (Friedman tests, $9.7 < F < 40.7$, $p < 0.01$) (Table 3). Parents spent significantly more time close to their child (*i.e.*, less than half an arm, 83.3%) than at any other distance ($0 < W < 18$, $p < 0.01$). Parents' gaze direction was predominantly oriented toward the activity- (87.9% of the time) toward the environment and the child (Wilcoxon tests; $W = 0$, $p < 0.001$). Their facial expressions were mostly without marked valence (89.1%), rather than positive or negative ($0 < W < 190$, $p < 0.001$), and more often positive (5.8%) than negative ($W = 0$, $p < 0.001$). Parents were more often engaged in the activity simultaneously with their child with ASD (41.2%) or not engaged in any activity (40.9%) than engaged in another activity or engaged alone in the activity ($0 < W < 190$, $p < 0.01$). They vocalized more than they did gestures toward their child with ASD ($X = 105.3 \pm 58.4$ vocalisations and $X = 31.8 \pm 28.7$ gestures; $W = 0$, $p < 0.001$) and were

TABLE 3 Summary table of behaviours displayed by parents during the interaction with their child with ASD.

Behavioural category			Behaviour	M	SD	F (*or W)	p
Scan sampling							
Parent-child distance (%)			Directly in contact	6.3	8.4	39.6	p<0.001
			Close	83.3	22.6		
			Intermediate	3.4	7.1		
			Distant	2.0	4.9		
Gaze direction (%)			Partner in interaction	3.9	5.2	28.5	p<0.001
			Object in the activity	87.9	21.6		
			Environment	3.3	3.1		
Facial expression (%)			Positive	5.8	6.6	38.7	p<0.001
			Negative	0.1	0.4		
			No marked valence	89.1	21.9		
Participation in activity (%)			Engaged simultaneously with partner	41.2	26.5	40.7	p<0.001
			Engaged alone	11.7	9.3		
			Engaged in another activity	1.2	1.4		
			Not engaged in any activity	40.9	26.7		
Focal sampling							
Vocalisation	Activity-related	Comment on parent's action	Request	2.1	3,9	158.0*	0,002
			Affirmation	9.4	7,7		
		Positive comment	Compliment	3.6	4,1	28.6	p<0,001
			Validation	9.8	8,7		
			Encouragement	0.4	1,0		
		Negative comment	Invalidation	4.7	7,5	0.0*	0,002
			Correction	0.4	0,6		
		Framing vocalisation	Regulation	15.1	18,1	29.5	p<0,001
			Description	23.6	16,3		
			Request for opinion	0.6	0,9		
		Action request	Imposition	9.1	11,2	11.4	0,003
			Induction	3.6	3,4		
			Proposal	1.2	1,6		
		Non-verbal vocalisation	Positive	3.5	4,2	25.9	p<0,001
			Negative	0.2	0,6		
			No marked valence	6.9	5,2		
	Non activity-related	Child-related vocalisation	Positive prosocial vocalisation	0.7	1,7	37,9	p<0.001
			Affect-related vocalisation	1.0	1,5		
			Negative remark	0.1	0,5		
		Parent-related vocalisation		0.2	0.4		
		Another topic		7,1	10.5		

(Continued)

TABLE 3 Continued

Behavioural category			Behaviour	M	SD	F (*or W)	p
Focal sampling							
		Non-verbal vocalisation	Positive	0.6	1,0	9.7	0,008
			Negative	0.0	0.0		
			No marked valence	1.4	2,3		
	Vocal initiation		Initiator	13,7	9	189,0*	p<0.001
			Non-initiator	91,6	56.4		
Gesture	Reply gesture		Approval	2,2	2.6	15,2	p<0.001
			Disapproval	1,3	2.0		
			No opinion	0,0	0.0		
	Reaction gesture		Positive	0,7	1.4	24,5	p<0.001
			Negative	0,3	0.7		
			No marked valence	4,9	4.3		
	Supportive gesture		Refocusing	14,4	12.7	36,7	p<0.001
			Demonstration	3,5	5.6		
			Solution pointing	2,7	4.7		
			Adjustment	1,9	5.8		

Friedman and Wilcoxon tests, significance level: $p < 0.05$. M=mean number of occurrences and frequency (in scans), SD=standard deviation, F=results of Friedman test, W=results of Wilcoxon test; * indicates when a Wilcoxon test was applied.

more often non-initiators than initiators of the vocal exchanges ($W=189$, $p < 0.001$).

3.1.1.2 Activity-related verbal vocalisations

Overall, few encouragements, corrections and requests for child's opinion were verbally displayed by parents in comparison with other vocalisations (less than 3 times in total on average). In particular, with regard to positive comments, parents were significantly more likely to validate the action and less likely to encourage the child about what they were doing ($0 < W < 103$, $p < 0.01$). Only 25% of the parents showed the latter type of vocalisations towards their child. Negative comments were rarely expressed, and when they were made, they tended to be invalidations rather than corrections ($W=0$, $p < 0.01$). Among framing vocalisations, descriptions were significantly more frequent than other vocalisations ($158 < W < 190$, $p < 0.05$). Regulations were also more frequent than requests for opinion ($W=1$, $p < 0.001$). Action requests to the child were more often impositions, then inductions and finally proposals ($98 < W < 148$, $p < 0.05$). Regarding comments on their own action, parents talked about what they were doing mostly as affirmations and very little as requests ($W=158$, $p < 0.01$).

3.1.1.3 Non-activity related verbal vocalisations

They were rarely observed, except for those related to another topic which were more expressed ($4 < W < 120$, $p < 0.05$). Those related to the parent were expressed for only 20% of the individuals.

3.1.1.4 Non-verbal vocalisations

They were more related to the activity than non-related ($X=10.6 \pm 7.4$ vs $X=2.0 \pm 3.0$; $W=0$, $p < 0.001$). Those related to activity without a marked valence were the most expressed ($0 < W < 104$, $p < 0.05$), while positive ones were more emitted than negative ones ($W=6$, $p < 0.01$). Those not related to the activity were only very weakly expressed ($0 < N < 1.4$ in total on average). Specifically, the negatives ones were never observed.

3.1.1.5 Gestures

No parent displayed reply gestures referring no opinion, in contrast to reply gestures referring approval and disapproval ($W=0$, $p < 0.05$). Reaction gestures with no marked valence were the most common compared to positive and negative reaction gestures ($1 < W < 163$, $p < 0.01$). Refocusing gestures were the most expressed among supportive gestures ($0 < W < 8$, $p < 0.01$).

3.1.1.6 Valence of the behaviours

Less than 25% of parents displayed behaviours with a negative valence (*i.e.*, negative facial expressions, negative non-verbal vocalisations related or not to the activity, negative remarks or negative reaction gestures). In contrast, 80% of the parents showed positive facial expressions and non-verbal vocalisations related to the activity.

3.1.2 Parenting styles

To reduce variation between parents and to improve the dispersion of the variables, some behavioural variables were not

included in the analysis or were grouped. For behaviours recorded using *scan sampling*, only positive and negative facial expressions were kept for analyses. For behaviours recorded using *focal sampling*, non-verbal vocalisations without marked valence expressed both related and not related to the activity, verbal initiations and non-initiations, reply gestures and reactions without marked valence were not included in the PCA. Vocalisations of corrections and invalidations were grouped under the label “Negative comments”. The above adjustments were performed in order to focus on behaviours with marked rather than unmarked valence (e.g., facial expressions, non-verbal activity-related and non-activity-related vocalisations with unmarked valence were removed). Additional behaviours were also excluded since they were directly depending on the instructions that were provided for the recordings (e.g., parent-child distance, participation in activity), or because they were very rarely expressed or were not indicative of parenting strategies (e.g., gazes).

The first three dimensions of the PCA explained 49.7% of the total variance. The first dimension explained 23.5% of the variance and was positively supported by validations, regulations, inductions, requests for the child’s opinion and negative non-verbal vocalisations related to the activity (Table 4). Regarding gestures, it was also positively supported by negative reaction gestures and all supportive gestures, except for refocusing ones. Since these behaviours were mainly aimed at modifying the child’s action or redirecting his/her attention toward the activity, this dimension was labelled “Activity control”. Thus, the higher the parent scored on this dimension, the more they displayed interventions aiming at controlling/directing his/her child’s action. The second dimension explained 16.1% of the variance and was positively supported by descriptions and impositions, as well as refocusing gestures, while it was negatively supported by non-activity related vocalisations about any other topic and positive non-verbal vocalizations. Because those behaviours were predominantly activity-related versus non-activity-related vocalisations, this dimension was named “Verbal focus on activity”. Thus, the higher the parents scored on this dimension, the more they talked about the activity, and the less they scored on it, the more they talked about topics non-related to the activity. Finally, the third dimension explained 10.2% of the variance and was positively loaded with positive facial expressions and positive non-verbal vocalisations related to the activity. Because these behaviours were positively valenced and oriented toward the child, this dimension was called “Parental warmth”. Thus, the higher the parents scored on this dimension, the warmer they were with their child.

Following the PCA, a Hierarchical Cluster Analysis (HCA) was performed to determine whether different parenting styles could be identified. Four clusters emerged from the HCA (i.e., A, B, C, D). However, style D only included one parent, who therefore presented a particular style, notably by displaying certain behaviours observed in other parents, but in much greater proportions. It was notably the

case for supportive gestures, except for refocusing ($N=26.4$ adjustments, 19.2 demonstrations and 16.8 solution pointing), and for regulations ($N=71.6$) and validations gestures ($N=33.4$). Although this one-parent group emerged from the HCA, it was not included for inter-group comparisons.

The three other groups differed significantly from each other on each of the three PCA dimensions (Kruskal-Wallis tests; $9.8 < X^2 < 14.4$, $p < 0.01$) (Figure 1). Group A differed from the other two groups and was characterised by higher Activity control and Verbal focus on activity (Control- A: 3.3 ± 2.8 in mean score on the dimension, B: -3.8 ± 0.8 , C: -4.2 ± 0.7 ; Focus- A: 5.1 ± 1.7 , B: -1.6 ± 2.4 , C: -5.3 ± 2.2 ; Dunn tests; $2.3 < Z < 3.7$, $p < 0.05$). Group B differed from the other two groups and had lower scores on the Parental warmth dimension (A: 0.9 ± 2.8 , B: -2.8 ± 1.3 , C: 1.8 ± 2.3 ; $-2.9 < Z < 2.5$, $p < 0.05$). Due to those significant difference on the first two dimensions, group A ($N=7$) was labelled “Parents Involved in the Task [PIT]”. Since it was characterised by low Activity control and Verbal focus on activity and low Parental warmth, Group B ($N=6$) was labelled “Parents Disengaged from the Interaction [PDI]”. Group C ($N=6$) was labelled “Parents Relaxed in the Interaction [PRI]” due to its lower Activity control and Verbal focus on activity, paired with a higher Parental warmth than the previous group. Descriptively, the parent in group D had the highest score in Activity control, a high score in Verbal focus on activity and a medium score in Parental warmth (respectively $X=24.40$, $X=6.37$ and $X=0.15$).

The styles (i.e., groups) identified through the PCA differed significantly at T0 on specific behaviours considered in the analysis as described below (Kruskal-Wallis tests) (Table 5). PIT displayed more description ($X=38.4 \pm 13.9$; Dunn’s tests, $2.4 < Z < 2.6$, $p < 0.05$), regulation ($X=26.4 \pm 8.8$; $2.8 < Z < 3.0$, $p < 0.01$) and imposition vocalisations ($X=20.0 \pm 10.1$; $2.9 < Z < 3.2$, $p < 0.01$) than parents from the two other groups. This is also the case for supporting gestures ($X=1.4 \pm 0.6$ adjustments, $X=5.2 \pm 3.8$ solution pointing, $X=29.8 \pm 5.4$ refocusing; $2.9 < Z < 3.5$, $p < 0.01$), except for demonstration ones. For this latter, PIT expressed it ($X=6.1 \pm 5.7$; $Z=2.9$, $p < 0.01$) more than PDI did and only a similar trend was observed compared with PRI ($Z=2.0$, $p < 0.08$). Also, compared to PDI, PIT emitted more affirmations about their action ($X=14.8 \pm 9.8$; $Z=2.5$, $p < 0.05$) and displayed more negative comments ($X=10.7 \pm 10.3$; $Z=2.9$, $p < 0.01$). There was also a tendency for PIT to make more negative comments than PRI ($Z=2.1$, $p < 0.08$). Finally, PIT also displayed more inductions vocalization ($X=5.5 \pm 1.8$; $Z=2.9$, $p < 0.01$) than PRI. Concerning PRI, they displayed more positive facial expressions ($X=14.0 \pm 10.6$; $Z=-2.5$, $p < 0.05$) than PDI. There was also a tendency for them to smile more than PIT ($Z=-2.0$, $p < 0.08$). PRI displayed more parent-related vocalisations ($X=0.7 \pm 0.6$; $-2.8 < Z < -2.7$, $p < 0.01$) and vocalisations about another topic ($X=16.9 \pm 14.8$; $-2.6 < Z < -2.3$, $p < 0.05$) than the two other groups. The two trends observed seem to indicate that PIT validated their child more than PDI ($Z=2.3$, $p < 0.05$, respectively $X=12.8 \pm 8.6$ and $X=4.8 \pm 4.4$) and that PRI displayed more positive non-activity related non-verbal vocalisations than PIT ($Z=-2.2$, $p < 0.05$, respectively $X=1.5 \pm 1.4$ and $X=0.1 \pm 0.2$).

TABLE 4 Scores of the different behavioural variables on the three dimensions of the PCA.

Behavioural category	Behaviour	1 st Dimension	2 nd Dimension	3 rd Dimension
Scan sampling				
	Positive facial expression	-0.309	-0.242	0.679
	Negative facial expression	-0.179	–	-0.339
Focal sampling				
Activity-related vocalisation	Request about Parent's action	–	0.108	-0.28
	Affirmation about Parent's action	0.222	0.412	0.578
	Compliment	–	0.214	-0.156
	Validation	0.714	0.279	–
	Encouragement	–	–	0.121
	Negative comment	0.545	0.505	0.241
	Regulation	0.857	0.433	–
	Description	–	0.778	0.192
	Request for opinion	0.631	-0.24	–
	Imposition	0.481	0.675	0.249
	Induction	0.644	0.568	-0.291
	Proposal	-0.122	–	-0.28
	Positive non-verbal vocalisation	-0.295	–	0.746
	Negative non-verbal vocalisation	0.844	-0.216	0.117
Non-activity related vocalisation	Positive prosocial vocalisation	-0.172	0.357	-0.311
	Affect-related vocalisation	-0.138	-0.275	0.112
	Negative remark	–	0.132	0.474
	Parent-related vocalisation	-0.145	-0.55	0.407
	Another topic	–	-0.65	0.149
	Positive non-verbal vocalisation	-0.133	-0.656	0.159
	Negative non-verbal vocalisation	NA	NA	NA
Gesture	Positive reaction gesture	0.173	–	0.425
	Negative reaction gesture	0.745	0.102	0.277
	Refocusing	0.297	0.774	0.292
	Demonstration	0.847	0.328	–
	Solution pointing	0.787	0.311	–
	Adjustment	0.935	–	–
Cumulative variances (%)		23.5	39.6	49.7
Dimension name		Activity control	Verbal focus on activity	Parental warmth

The variables carrying the information are those above 0.6 and in bold. NA: Behaviour not displayed during the observation, -: Behaviour with a weight lower than 0.1, P: Parent, C: Child.

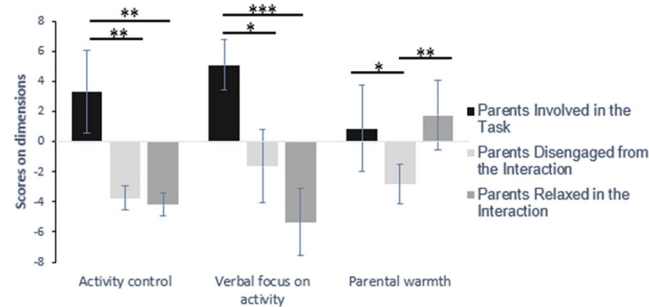


FIGURE 1

Distribution of parenting styles from the PCA, according to the three dimensions. Average scores per group of parenting style, on the three parenting dimensions (\pm SD). Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2 Effects of integrating a SD

Due to the difference in sample size between T0 ($N=20$) and T1 ($N=14$), and based on the hypothesis that the groups identified at T0 may continue to differ at T1 but on other behaviours than just those selected for the PCA, the results presented below are based on analyses performed on all collected behaviours. From the initial sample who participated at T0, 3 parents from the PIT group, 5 parents the PDI group and 5 parents from PRI group participated at T1.

3.2.1 Comparison of results before (T0) and after (T1) SD integration, regardless of parenting styles

Compared to T0, parents produced fewer activity-related non-verbal vocalisations without marked valence at T1 (at T0, 6.2 ± 4.0 vs. at T1, 4.6 ± 4.1 ; $W=84$, $p < 0.05$). They also initiated less vocal interaction at T1 (at T0, 14.4 ± 9.3 vs. at T1, 10.9 ± 8.8 ; $W=95$, $p < 0.01$). Two trends were also observed for an increase in vocalisations about another topic (at T0, 6.5 ± 8.3 vs. at T1, 11.9 ± 7.3 ; $W=22$, $p < 0.08$) and in refocusing gestures (at T0, 10.8 ± 9.6 vs. at T1, 15.8 ± 15.7 ; $W=23$, $p < 0.08$).

3.2.2 Comparison of results on behavioural observations at T0 and T1 within parenting styles

No significant difference was observed comparing each group individually on the number of behaviours expressed at T0 and T1 (Wilcoxon tests, $p > 0.05$). Only for PDI, a trend seemed to show that they invalidated less after the integration of the SD ($X=10.7 \pm 15.3$ at T0, $X=4.6 \pm 2.6$ at T1, $W=0$, $p < 0.08$).

3.2.3 Comparison between parenting styles identified at T0 on behaviours observed at T1

Here was explored if groups of parents differing in parenting behaviours at T0 (*i.e.*, PIT, PDI and PRI) still differed from one another at T1. In general, the parenting style groups identified at T0 differed significantly in the following behaviours at T1. In terms of *vocalisations*, groups differed on those of corrections, compliments and related to the child's affect, as well as not being initiators of the exchanges (Kruskal-Wallis tests, $6.6 < X^2 < 7.7$, $p < 0.05$). Four trends indicated that they also seemed to differ on invalidations,

validations, positive prosocial vocalisations and on being the initiator of the exchanges ($5.1 < X^2 < 5.9$, $p < 0.08$). Regarding *gestures*, the groups differed significantly on refocusing ones ($X^2=7.0$, $p < 0.05$). Finally, in terms of *done break poother behaviours*, groups differed in parental solitary engagement ("engaged alone") in the activity ($X^2=6.9$, $p < 0.05$).

3.2.3.1 Vocalisations

In particular, PIT corrected ($Dunn's$ tests, $2.4 < Z < 2.6$, $p < 0.05$, PIT: 2.8 ± 1.8 vs. PDI: 0.2 ± 0.5 and PRI: 0.3 ± 0.5) and complimented their child ($2.4 < Z < 2.6$, $p < 0.05$, PIT: 2.8 ± 1.8 vs. PDI: 0.2 ± 0.5 and PRI: 0.3 ± 0.5) significantly more than the two other groups. Furthermore, PRI differed from PDI in emitting more vocalisations related to the child's affect ($Z=-2.3$, $p < 0.05$, PDI: 0.4 ± 0.6 and PRI: 2.3 ± 1.9), with a similar trend compared to the PIT group ($Z=-2.1$, $p < 0.08$, PIT: 0.3 ± 0.6). PDI differed from PIT in that the latter were more non-initiators of the exchanges ($Z=2.6$, $p < 0.05$, PIT: 109.6 ± 11.7 and PDI: 50.1 ± 32.5), and similarly compared to PRI according to the observed trend ($Z=-2.0$, $p < 0.08$, PRI: 97.5 ± 23.1). For all four trends, PIT seemed to validate ($Z=2.2$, $p < 0.05$, PIT: 7.9 ± 2.4 and PDI: 2.7 ± 2.2) and invalidate more their child ($Z=2.2$, $p=0.05$, PIT: 4.6 ± 2.6 and PDI: 0.7 ± 1.2) as well as to make more positive prosocial vocalisations ($Z=2.2$, $p < 0.05$, PIT: 0.6 ± 0.5 and PDI: 0.0 ± 0.0) than PDI. Also, PDI appeared to be more initiators of the exchanges compared to PRI ($Z=2.2$, $p < 0.05$, PDI: 14.6 ± 7.0 and PRI: 5.6 ± 3.1). *Gestures*. PIT made significantly more refocusing gestures than PDI ($Z=2.6$, $p < 0.05$, PIT: 40.5 ± 17.2 and PDI: 6.9 ± 6.0), and similarly compared to PRI according to the observed trend ($Z=2.0$, $p < 0.08$, PRI: 10.4 ± 5.2). *Other behaviours*. PDI were significantly less engaged alone in the activity than PRI ($Z=-2.4$, $p < 0.05$, PDI: 6.6 ± 5.7 and PRI: 21.1 ± 5.0), as well as compared to PIT according to the observed trend ($Z=2.1$, $p < 0.08$, PIT: 30.0 ± 22.8).

3.2.4 Comparison of parenting styles identified at T0 on differences between T0 and T1

Groups of parents were compared in the evolution of their behaviours (*i.e.*, the number of times the behaviour was expressed at T1 minus at T0) in order to determine if parents' behaviours changed differently according to parents' initial parenting style

TABLE 5 Summary table of behaviours displayed by each group of parents for the behaviours selected for the PCA.

Behavioural category	Behaviours	Kruskall-Wallis tests		Means and standard deviation per group					
		χ ²	p	PIT		PDI		PRI	
				M	SD	M	SD	M	SD
Scan sampling									
Positive facial expression		6.9	0.031	4.9	3.7	3.7	5.3	14.0	10.6
Negative facial expression		1.2	0.538	0.0	0.0	0.4	0.9	0.1	0.3
Focal sampling									
Activity related vocalisation									
	Request about the P's action	0.0	0.983	1.4	1.5	3.6	7.0	1.3	1.2
	Affirmation about the P's action	6.3	0.042	14.8	9.8	3.9	2.6	8.1	5.1
	Compliment	1.7	0.437	4.0	3.5	3.2	4.7	3.3	5.1
	Validation	5.7	0.059	12.8	8.6	4.8	4.4	7.2	4.5
	Encouragement	2.9	0.235	0.3	0.4	0.0	0.0	0.9	1.7
	Negative comment	8.9	0.012	10.7	10.3	0.8	1.0	1.5	1.0
	Regulation	11.5	0.003	26.4	8.8	3.6	3.5	4.0	3.7
	Description	8.8	0.012	38.4	14.0	17.7	16.3	14.4	4.8
	Request for opinion	0.2	0.920	0.6	0.9	0.4	0.6	0.6	1.0
	Imposition	12.8	0.002	20.0	10.1	1.7	1.7	1.3	1.2
	Induction	8.6	0.014	5.5	1.8	3.1	3.4	0.6	0.6
	Proposal	0.2	0.904	1.1	1.8	1.6	2.1	1.0	1.0
	Positive non-verbal vocalisation	4.7	0.096	3.2	2.3	1.5	1.3	6.5	6.4
	Negative non-verbal vocalisation	2.4	0.305	0.1	0.2	0.0	0.0	0.2	0.4
Non-activity related vocalisation	Positive prosocial vocalisation	2.0	0.363	0.9	1.1	1.2	2.8	0.2	0.4
	Affect-related vocalisation	0.6	0.748	0.6	0.7	0.7	0.9	2.0	2.4
	Negative remark	1.0	0.614	0.3	0.7	0.0	0.0	0.1	0.3
	Parent-related vocalisation	10.2	0.006	0.0	0.0	0.0	0.0	0.7	0.6
	Another topic	8.2	0.017	2.5	2.7	2.3	3.6	16.9	14.8
	Positive non-verbal vocalisation	5.1	0.078	0.1	0.2	0.4	0.7	1.5	1.4
	Negative non-verbal vocalisation	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0
Gesture	Positive reaction	3.4	0.184	0.9	1.5	0.0	0.0	1.0	1.8
	Negative reaction	0.4	0.837	0.3	0.7	0.1	0.3	0.2	0.4
	Refocusing	12.6	0.002	29.8	5.4	5.3	4.1	4.7	3.2
	Demonstration	8.8	0.012	6.1	5.7	0.4	0.6	0.9	0.8
	Solution pointing	15.0	0.001	5.2	3.8	0.2	0.4	0.0	0.0
	Adjustment	13.7	0.001	1.4	0.6	0.2	0.5	0.0	0.0

Significance level: $p < 0.05$ (in bold), Trend $p < 0.08$ (in italics). Results on Kruskal-Wallis tests: χ^2 =Chi-Square value, p =p-value; M=mean number of occurrences or scans, SD=standard deviation.

group before SD attribution. In general, significant differences were observed between the groups in their behavioural evolutions for corrections and regulations vocalisations, as well as disapprovals gestures (Kruskall-Wallis tests, $6.3 < X^2 < 7.5$, $p < 0.05$). Two trends revealed differences in invalidations and reaction gestures without marked valence ($5.2 < X^2 < 5.3$, $p < 0.08$).

In particular, PIT differed significantly from PRI in several aspects. They increased their number of correction vocalisations compared to T0, unlike PRI who slightly decreased them (Dunn Tests, $Z = 2.5$, $p < 0.05$, PIT: 1.9 ± 1.2 vs PRI: -0.2 ± 0.8). They also decreased their number of regulation vocalisations while PRI increased them ($Z = -2.6$, $p < 0.05$, PIT: -14.6 ± 2.8 vs PRI: 3.1 ± 4.8). A similar trend was also observed compared to PDI, who, as PRI, seem to increase their regulation vocalisations ($Z = -2.0$, $p < 0.08$, vs PDI: 2.5 ± 6.1). For reaction gestures without marked valence, the observed trend seems to show that PIT decreased these gestures, while PRI increased them ($Z = -2.2$, $p < 0.05$, PIT: -3.7 ± 2.4 vs PRI: 6.5 ± 9.0). Regarding PRI, they slightly increased their number of disapproval gestures in contrast to the other two groups who slightly decreased them ($-2.4 < Z < -2.3$, $p < 0.05$, PIT: -1.0 ± 0.9 and PDI: -0.6 ± 1.3 , vs PRI: 0.9 ± 0.9). A trend was also observed for a difference between the evolution of PRI, who increased their number of invalidations vocalisations, compared to PDI who slightly decreased them ($Z = -2.3$, $p < 0.08$, PDI: -0.2 ± 1.0 vs PRI: 1.8 ± 0.9). Thus, it notably appears that while parents from the PIT manifest an increase in behaviours aiming at controlling their child with ASD's activity (i.e., regulation vocalizations, reaction and disapproval gestures) after integration of the SD, parents from the PRI manifest a decrease in the expression of such behaviours. Furthermore, while PIT and PRI appears to both evolve in inverse directions, parents from the PDI do not seem to manifest any significant change, at least within the first 6 month after SD integration.

4 Discussion

The main aims of this study were (1) to explore if different parenting styles could be identified through direct observation and behavioural coding of parents interacting with their child with ASD while performing a specific task; and (2) to investigate if the integration of a SD within the family had an effect on those parenting styles. Three different parenting styles were identified among parents that participated in this study (i.e., Parents Involved in the Task (PIT), Parents Relaxed in the Interaction (PRI) and Parents Disengaged from the Interaction (PDI). In addition, SD integration appeared as having an incidence on parenting behaviours and parenting styles, and these modifications seemed to vary according to parent's initial parenting style.

4.1 Distinction of parenting styles before the integration of the service dog

In the present study, not all parents interacted in the same way with their children with ASD. Analyses of those behavioural

variations in parents' interaction with their child with ASD highlighted three parenting dimensions: Activity control, Parental warmth and Verbal focus on activity. The dimensions of "Activity control" and "Parental warmth" seem similar to the dimensions of warmth and control defined by Baumrind (1991). For example, a parent with a high score on the "Activity control" dimension displays behaviours that help to establish and maintain a structure in the activity (e.g., validations and regulations) and control what the child is doing. On the other hand, a warm parent, in this study, is a parent who is smiling and laughing, contributing to the creation of a positive emotional climate. The "Verbal focus on activity" dimension has not been observed or described in previous studies. It could consist in a sub-dimension of the classically referred 'Activity control', and might have emerged due to the type of activity parents were involved in for this study, i.e., completing a jigsaw puzzle. This assumption particularly resonates with Lambrechts et al. (2015), who suggested that different subcategories of Parental control could be distinguished. The interaction and communication difficulties inherent to ASD can affect the interaction between parents and their child with ASD. Thus, we cannot exclude that parents' use of certain strategies while interacting with their child, in particular 'activity control' and 'verbal focus on activity', may have been influenced by the degree of overall interaction difficulty with their child. It would be of interest for future studies to explore this issue of the links between the child's degree of difficulty and parenting strategies using mixed methods approach (e.g., use of behavioural coding, standardized scale, and parental interview).

Although a "Parental warmth" dimension could be identified, it only accounted for 10.1% of the global variance. A greater contribution of Parental warmth could have been expected, as previous authors identified this dimension as one of the two fundamental dimensions in determining parenting styles (Baumrind, 1991; Dalimonte-Merckling and Williams, 2020). Among hypothesis that might account for this low contribution of parental warmth, one that can be ruled out, would be that that parents of children with ASD display less behaviours indicative of Parental warmth (e.g., reassuring gestures or complimentary vocalisations). Indeed, the meta-analysis by Ku et al. (2019) demonstrated that parents of children with ASD and parents of NT children do not differ in Parental warmth or supportive behaviours. In addition, other authors such as Maljaars et al. (2014) report more positive parenting behaviours in parents of children with ASD. A hypothesis that may explain this result is that unlike standardised scales and questionnaires usually used, that relies on parental or third person perception of parenting behaviours (e.g., Boonen et al., 2014; Lambrechts et al., 2015), the specific characteristics of ethological methods might make it more difficult to objectify this Parental warmth through behaviour. Finally, another hypothesis would be that the very situation behaviours were collected in may have had an influence. Indeed, performing a very specific task dyads (i.e., completing a jigsaw puzzle), with a limitation in time and space, while being videorecorded are all elements that may have had an influence on parent-child interaction and may have possibly limited the expression warm behaviours (e.g., hugs, laughs and kisses) while

prompting the expression of controlling behaviours (i.e., focus on the task and its completion).

Based on these three dimensions, three distinct parenting styles were identified: Parents Disengaged from the Interaction [PDI], Parents Relaxed in the Interaction [PRI] and Parents Involved in the Task [PIT]. These three profiles appear to correspond to the parenting styles described by Maccoby and Martin, 1983 (Dalimonte-Merckling and Williams, 2020). First, Parents Disengaged from the Interaction [PDI] would correspond to “Disengaged parents”. Both in the literature and in this study, they are characterized by less control and warmth than the other groups. Behaviourally, parents with this profile notably displayed fewer supporting gestures in a complex task (i.e., completion of a puzzle), and less regulation vocalisations or requests for action in the form of impositions and inductions. Second, Parents Relaxed in the Interaction [PRI] seems to correspond to the ‘Permissive parents’ profile. Parents with PRI profile are characterized by lower expression of controlling behaviours but greater display of warmth (i.e., laughs and smiles) compared to PDI. Also, the fact that they talk about something other than the activity supports the idea that these parents are not trying to control the child’s actions, but are rather trying redirect the discussion to another topic. Third, Parents Involved in the Task [PIT] seem to rather correspond to in-between profile between the “Authoritarian parents” and “Authoritative parents” styles. They are characterised by a variety of regulatory behaviours, supportive gestures and requests towards their child with ASD and therefore by strong Activity control, just as Authoritarian and Authoritative parents are in terms of Parental control. However, in this study, only one group (i.e., PIT) was found to have significantly greater Activity control than the other groups, because of the potential difficulty in highlighting parental warmth, which usually enables Authoritative and Authoritarian styles to be distinguished (Dalimonte-Merckling and Williams, 2020). Thus, refining the behavioural repertoire used in this study or combining the ethological approach with other methods (i.e., questionnaires, standardized scales) could improve the assessment of Parental warmth, and thus lead to a better differentiation of these two parenting styles. Additionally, one parent seemed to display a profile differing from the three identified parenting styles. This parent notably displayed a large number of behaviours related to Activity control and Verbal focus on activity; which might be considered as a more “Authoritarian style”. Increasing the number of participants, could thus help to the emergence of a possible fourth group, including parents with a profile similar to this single parent, i.e., Authoritarian group. Although this identification of three parenting profiles in the present study seems consistent with the classic literature referring a typology of parenting profiles distinguished according to four categories, and thus seems to encourage a compartmentalized vision of parenting styles, it is important to point out that parenting profiles are not categorical in essence, since we are rather dealing with inter-individual variations along a continuum in the use of parental warmth and parental control strategies.

As discussed previously, different parameters may contribute to variations in parenting style (e.g., parent’s socio-economic status, family culture, child’s ASD symptomatology) (Liu and Guo, 2010;

Bontinck et al., 2018; Hoff and Laursen, 2019). More specifically, the parent’s psychological state and parental stress level have been pointed out as affecting parenting strategies and parenting styles in parents of NT children (Abidin, 1992; Anthony et al., 2005; Deater-Deckard and Scarr, 1996; Wu et al., 2019). Indeed, parental depression and stress has been demonstrated to have negative effects on parenting attitudes and/or parenting behaviours in parents of NT children (e.g., Lovejoy et al., 2000; Crnic et al., 2005; Wilson and Durbin, 2010). Thus, exploring if such parameters have a direct incidence on parenting behaviours displayed using behavioural coding could be of interest for future researches in the investigation of the specificities of parenting style in parents of children with ASD. Considering these parameters could even be of greater interest as previous studies demonstrated that higher levels of stress and higher incidence of psychological health issues are present in parents of children with ASD (Phetrasuwan and Shandor Miles, 2009; Smith et al., 2012; Hayes and Watson, 2013; Porter and Loveland, 2019) and have already demonstrated detrimental effects on self-perceived parenting behaviours (e.g., Osborne and Reed, 2010).

4.2 Changes in parenting behaviours and styles following the service dog integration

First, 3 to 6 months after the SD integration into the family, changes were observed on some parenting behaviours. This presence of changes in parents within a relatively short period after SD integration seems consistent with some previous studies, such as the study by Fecteau et al. (2017) which reported a decrease in wakening and morning cortisol 12 weeks after integration of a SD and reduction in perceived parental stress 9 months after integration. However, no significant difference was observed when comparing the behaviours displayed by each of the groups between before and after SD integration, which may indicate that profiles did not drastically changes. The small sample size of the groups may have contributed to this inability to reach statistical difference in these comparisons (i.e., 3 or 5 individuals per group at T1). Nevertheless, the three profiles still differed from each another after the SD integration, but on behaviours that are different from T0 (i.e., before SD integration). In the first six months, integration of a SD seems in particular to have an effect on two types of parenting styles: PIT and PRI. When we compare the three groups at T1, some continue to differ on the same interaction behaviours as they did at T0, such as PIT, who expressed more certain types of controlling behaviours (e.g., more corrections) compared to one or both of the other groups. However, after SD integration, PIT differed by giving more compliments to their child than the other two groups. Thus, at T1, then now differed by a greater expression of one positive behaviour, where, in contrast, PRI were no longer differentiated from other groups by positive facial expressions. At the same time, it was observed that the three groups differed in how their interaction behaviours evolved; for example, PRI increased in control behaviours (e.g., regulations and disapprovals gestures) while PIT reduced the expression of regulation vocalization. In contrast with PIT and PRI groups, our analysis did not reveal

significant changes in PDI group. It would thus seem that SD integration did not lead to significant changes in their behaviour within the first six months. There is currently no study providing an explanation for the lack of changes in some parents' parenting behaviour. A hypothesis would be that, for these parents, noticeable effects might emerge later than within the first 6 months and/or that differences might be observed using tasks other than completing a jigsaw puzzle. More generally, these results show that parents' interaction behaviours toward their child with ASD do not evolve in the same way after SD integration according to their initial interaction profile. Parents with a profile initially characterized by higher focus and control of their child's activity (i.e. PIT) decreased the expression of behaviours aiming at orienting and channelling their child's activity after SD integration, while the opposite was observed for parents with a profile initially characterized by lower focus and control of the activity and more warmth toward their child (PRI). Additionally, parents with an initial profile characterized by less interaction and engagement in the activity with their child do not seem to manifest significant changes, at least within the first 6 months after SD integration.

Overall, two non-exclusive and non-exhaustive hypotheses may provide an explanation for these changes. First, as demonstrated by a large number of studies, introducing a SD into the family of a child with ASD can reduce physiological and perceived parental stress (e.g., [Burgoyne et al., 2014](#); [Fecteau et al., 2017](#); [Lindsay and Thiagarajah, 2021](#)). Here, integration of a SD potentially reduced participating parents' stress levels and consequently changed their parenting behaviour. This hypothesis notably based on results observed by [Boonen et al. \(2015\)](#) who, found that parenting behaviours of parents of children with ASD and NT children did no longer differ anymore when parenting stress is statistically controlled. On the other hand, the previous literature has demonstrated that integrating a SD may have numerous benefits for the child with ASD: reduction in stress and anxiety (e.g., [Viau et al., 2010](#)), increase in self-confidence (e.g., [Smyth and Slevin, 2010](#)), increase in social and communication skills ([Carlisle, 2015](#)) and reduction in problematic behaviours ([Berry et al., 2013](#); [Burgoyne et al., 2014](#)). It is likely that these psychosocial and emotional improvements may have contributed to changes in parenting behaviours. Thus, an alternative hypothesis would be that the effects of SD integration on the child with ASD will modify his or her behaviour, and consequently the parent will adapt and modify his or her own interaction behaviour. Additionally, we may not exclude that both direct effects on parents and indirect effect on them (i.e., effects on the child leading to benefits on the parent) may both be related and influence each other. More generally, these findings are consistent with those of [Leung et al. \(2022\)](#), who reported that the presence of an animal in the family improved the family functioning on a broader scale. The family dynamic evolves and improves; for example, parents who might have felt socially stigmatised or even socially isolated will be able to organise new family excursions and outdoor activities because of the reduction in social difficulties of their child with ASD ([Dollion and Grandgeorge, 2022](#)).

It would be of interest for future studies to explore the influence of child-related parameters on parents' behaviours and parenting

styles. For example, according to their age children do not have the same knowledge and skills, which affect their level of autonomy and needs, and therefore influence parent-child interaction and parenting strategies. Other parameters such as child's gender and ASD severity could also be of interest. Additionally, exploring the child's behavioural profile and its relationship with parent's parenting style could also be of great interest. Indeed, interactions are bidirectional by essence ([Hinde, 1976](#)), and parents could act differently depending on their child's behaviour. For example, [Boonen et al. \(2015\)](#) have shown that some parents anticipate their child's behaviour, and more specifically potential moments of frustration, and in return adapt their own actions. In the end, many factors can come into play and affect parenting behaviour and, by extension, parenting style. Thus, it would be interesting to explore whether certain behaviours or parameters, such as those associated with the child, are associated with these styles or are predictive of a specific development.

4.3 Limits of the study

While our sample size corresponds to those often found in previous studies, increasing the number of participants would allow to overcome various limitations of this study. Indeed, the small size potentially reduced our ability to identify the four distinct categories of parenting styles classically defined in the literature. Nonetheless, it is important to mention that this low inclusion rate was notably due to the low number of SDs attributed per year. Moreover, a high attrition rate is often present in studies involving longitudinal monitoring ([Marcellus, 2004](#); [Young et al., 2006](#)). Given the great heterogeneity in symptomatology inherent to ASD (e.g., variation in use of verbal language, eye contact) and the potential effects on parent-child interaction, increasing the sample size would make it possible to increase the representativeness of the profiles of the children included. Similarly, increasing the number of observations before and after the integration of the SD, as well as extending the observation period after the integration of the SD over a larger period of time could also be of interest. Not only would this increase the amount of behavioural data collected, but it could also enable to explore for changes that may take longer to emerge and/or to explore the stability of those changes over a longer period of time. In addition, extending recordings to other activities and daily situations, especially closer to naturalistic situations (e.g., parent-child reunion after school, book reading) could be relevant as well, in order to provide more general view of parenting styles. Furthermore, it would be of interest for future studies to consider investigating the effects of the integration of a SD on the parent-child interaction dynamic, not only over a longer time frame, but also according to a more dynamic and integrative perspective, meaning by considering additional aspect that may as well be relevant, such as: child-parent attachment, child with ASD' behavioural specificities and difficulties, as well as the child's developmental outcomes. The interest in exploring these elements is not only justified because of the links between children with ASD's symptomatology and parents' stress and quality of life ([Benson and Karlof, 2009](#); [Giovagnoli et al., 2015](#); [Pastor-](#)

Cerezuela et al., 2016), but also because of the relationships between attachment and parental behaviour with children with ASD's development (Hutchison et al., 2016; Teague et al., 2017; Crowell et al., 2019; Clauser et al., 2021). Additionally, in addition to the small sample size, the wide age range of children with ASD included in the dyads considered in this study have to be mentioned as a limitation, since the expression of autistic traits has been shown to reduce over time (Pender et al., 2020). In line with this last argument and considering the strong inter-individual heterogeneity in symptomatology, difficulties and strengths observed in individuals with ASD, adding a standardized scale for measurement of children with ASD's symptomatology and level of difficulties would have been of interest (e.g., Social Responsiveness Scale, Vineland-II, Autism Behavior Inventory). Similarly, the addition of a standardized self-report scale (e.g., Parenting Styles and Dimensions Questionnaire) would also have been of interest in order to explore if variations and changes in parenting behaviours coincides with variation in parents' own perception of their parenting behaviours.

Moreover, the presence of an external observer could have led to a potential audience effect (*i.e.*, changes in behavioural and/or emotional state due to the presence of another person) (Scalon Jones et al., 1991; Somerville et al., 2013). The fact that recordings were done by the parents themselves in their own home limited this bias. However, although the absence of a direct observer diminished the observer effect, parents filmed themselves knowing that an observer will study these videos. Increasing the number or diversifying the recording situations may therefore also be beneficial to further reduce this impact; especially when considering that the observer effect may both influence parent's and child's behaviours. In addition, other limitations may have played a role in our study, such as the complexity of the activity. It is possible that the completion of a jigsaw puzzle not only influence the expression of certain parenting behaviours, but also the child's behaviours, which in turn may influence parenting behaviours. For example, a parent may be more likely to invalidate a child's action if he or she has difficulty completing this type of activity. Subsequently, it would be interesting to observe parent-child interactions during a less complex and freer activity such as drawing, for example, where the child may be more autonomous and is free in his/her production. Finally, the sample for this study consisted of French and French-speaking Canadian parents. We may not exclude that culture differences may have had an impact on the strategies they used; although studies on parents of neurotypical children do not seem to support this hypothesis (*e.g.*, Liu and Guo, 2010; Sahithya et al., 2019).

5 Conclusion

In conclusion, a heterogeneity is present in how parents interact with their child with ASD, allowing the identification of three different styles: Parents Involved in the Task (PIT), Relaxed in the Interaction (PRI) and Disengaged from the Interaction (PDI). In

terms of interaction behaviours, these styles notably differed in the extent to which they controlled the activity, focused verbally on the activity or, conversely, talked about another topic, and displayed more or less Parental warmth. In addition, while these styles continued to diverge after the integration of a SD into the family, they did on behaviours different from those on which they initially differed. Furthermore, their interaction strategies evolved in different ways, and in particular, the effects seemed to be greater for the parents Involved in the Task and the Relaxed in the Interaction ones. Thus, not all parents of children with ASD have the same initial style and, depending on this style, the presence of the SD will not have the same effects on parenting behaviours within the first six months. This study highlights the importance of pursuing research on SD effects on families with a child with ASD. In addition, the parenting style of parents of children with ASD receiving a SD could be a new element to consider by SD handover organisations during the attribution process. For example, considering a parent's profile in addition to the child's profile could be of interest in order to identifying which service dog would have the best profile to integrate the family. This could allow organisations providing SD to target for a dog with a behavioural and personality profile in line not only with the profile and needs of the child with ASD, but also with the parent's profile, and/or to avoid pairing less compatible profiles (*e.g.*, pairing a dog with an independent personality profile with a very warm parent). According to the procedures and ways of working specific to each organisation, this pairing process could, for example, involve giving parents the opportunity to spend some time with the SD and interact with it, in order to experiment and confirm their affinity/compatibility with it, prior to the SD choice and attribution. It could also rely on more refined and rigorous methodologies involving behavioural testing of the SD to assess his or her personality and completion by the parents of standardised scales measuring parenting strategies (*e.g.*, the parenting styles and dimensions questionnaire (PSDQ); Robinson et al., 1995).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Comité de protection des personnes (RCB number: 2020-A02012-37) [FRANCE]; Comité d'éthique de la recherche en éducation et en psychologie (CEREP) Université de Montréal (Certificate number: CEREP-20-113-D) [CANADA]. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MP: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. MG: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. NF: Conceptualization, Methodology, Project administration, Resources, Supervision, Writing – review & editing. FA: Conceptualization, Methodology, Project administration, Resources, Supervision, Writing – review & editing. NC: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. AL: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. CD: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. NF–H: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. AT: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. FK: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. SH: Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – review & editing. PP: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Validation, Writing – review & editing. ND: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fetho.2024.1382533/full#supplementary-material>

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