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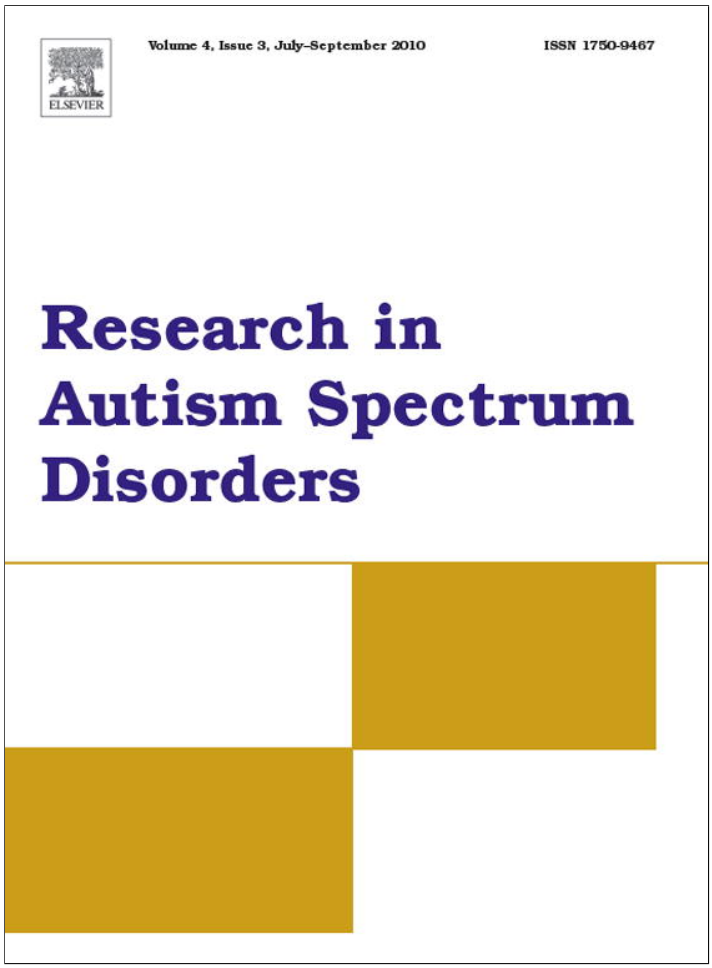

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Review

What studies of family home movies can teach us about autistic infants: A literature review

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ABSTRACT

The current study reviewed all prior studies conducted on family home movies of infants who would be later diagnosed with autism spectrum disorder (ASD). Out of 41 original reports found since 1975, we retained 18 studies (317 films, maximum), sorted according to their methodological design using a quality grid. In the first 2 years of life, signs that differentiated children with ASD from children with developmental delays were as follows: less of a response to their name, less looking at others, lower eye contact quality and quantity, less positive facial expression and intersubjective behaviors (e.g., showing shared attention). Studies focusing on regression confirmed the clinical validity of the phenomena. We conclude that findings from home movies studies along with prospective studies have created the bases for identification of infants and toddlers at risk of developing ASD before the 18–24-month period, despite early diagnosis of autism remains a complex challenge.
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1. Introduction

Autism spectrum disorders (ASD) disturb the development of interpersonal relationships and cooperative behavior. Although genetic factors are now well-established (Cohen et al., 2005), the causal processes that lead to the development of the condition remain unclear and poorly documented, especially during the first years of life. Indeed, diagnosis is rarely made before a child is between 2 and 3 years of age. Improved knowledge of the early developmental course of children who will be eventually diagnosed with ASD appears to be crucial. This knowledge is needed in order to better understand the complex pathogenic phenomena of autism and to improve the early screening and management of autism. Indeed, there is consensus that the earlier treatment begins, the better the child's prognosis is.

For more than 30 years, there has been a growing clinical interest in family home movies of infants who are subsequently diagnosed with ASD. Although numerous limitations have been described, studies of these films have proved to be of scientific merit. They show, in a non-invasive way, the early behaviors of these infants long before the time of clinical diagnosis. We propose here a review of this extensive literature, weighing the scientific quality of the various studies and emphasizing the consistency of the data. In particular, we aimed (a) to review signs in the first 2 years of life that may be useful for the early screening of autism; (b) to chart the phenomenon of regression using a developmental approach; and (c) to address in early-onset cases, beyond the issue of regression, whether competencies are lacking from birth, fail to emerge, or develop normally before stagnating or declining.

2. Methods

Utilizing the PubMed and PsycINFO databases, we screened the literature published from January 1975 to January 2008 with the following criteria: (''autistic'' or ''autism'' or ''pervasive developmental disorder'' or ''infantile psychosis'' or ''childhood psychosis'') and (''home'' or ''family'') and (''movies'' or ''films'' or ''videos'' or ''videotapes''). Out of the 93 articles found, we excluded 46 articles because they did not address home movies made during infancy before any diagnosis of Pervasive Developmental Disorders (PDD). Of those excluded, 22 dealt with experimental studies after the diagnosis was made, eight focused on videos as a tool for care, five focused on other disorders, five focused on early signs obtained by other methods, and six were irrelevant. We also screened the reference lists of the 47 relevant articles and found seven additional references. Out of the 54 articles retained, we excluded dissertation abstracts ($N = 5$), papers on data already reported elsewhere ($N = 3$: Bernabei, 1998; Massie, 1975, 1977), studies with roughly the same sample ($N = 2$: Adrien, Perrot, et al., 1991; Adrien et al., 1992) keeping the larger one (Adrien et al., 1993), papers on preliminary results ($N = 1$: Rosenfeld, Korolitski, Coyer, & Montes de Oca, 1990), and reviews ($N = 2$: Malvy et al., 1999; Palomo, Belinchon, & Ozonoff, 2006). Thus, we listed 41 relevant studies for review.

Given the great number and variety of methodological designs, we constructed a quality grid to prioritize the studies with a quality coefficient that was estimated according to nine criteria: (a) *sample size* ($N < 10$ vs. 10–15 vs. >15), (b) *diagnostic criteria* (no criteria vs. diagnostic criteria of PDD vs. restricted diagnostic criteria and/or specific assessments scale: Childhood Autism Rating Scale (CARS), Autism Diagnostic Interview-Revised (ADI-R)), (c) *age range* (>1 year vs. 6–12 months vs. <6 months), (d) *IQ assessment* (no IQ vs. IQ assessed but lower than control), (e) *control group* (no control vs. normally developing control vs. delayed control), (f) *blindness* (no vs. yes), (g) use of *video coding tools* (no vs. yes), (h) *quotation reliability* (single quotation vs. double vs. double with interrater reliability or kappa), and (i) use of *data analysis* (no vs. yes). Each study received a score from 0 to 2 for each criterion. Dichotomous variables (no vs. yes) received a score 0 or 2. We then computed the ''quality score'' (from 0 to 18 points) for each study (see scores in Table 1).

To review the early characteristics of children with autism, we decided to keep only the more pertinent studies that received a quality score equal to or higher than 13 (out of 18 points). Then, when possible, we gathered the data and grouped them by age and by each pertinent field for autism. Next to the significant results, we also mentioned the non-significant results from all studies coding the same behavior frequencies. Because, according to Allison et al. (2008) skills are reduced rather than completely absent in infants with ASD, we kept only the significant results, and ignored the non-significant ones for two studies coding the presence/absence of specific behaviors instead of frequency (Maestro et al., 2001; some items in Clifford, Young, & Williamson, 2007). Given the limited number of longitudinal studies, all were kept for the developmental questions regardless of the quality score.

Table 1
Main methodological characteristics of home movie studies on infants who later exhibit ASD (1975–2008).

Studies	Team	Object studied	Age range[a] (months)	Sample size: index/controls[b]	Inclusion criteria	Control for IQ[c]	Blind	QS
Osterling et al. (2002)	Washington	Aut. signs, dev. skills	12	20/14 DD/20	PDD (D3R)	64/53 (DD)	Y	18
Clifford and Dissanayake (2007)	Adelaide	JA, gaze, affect	0–6–12–18–24	22/15 (DD+TD)	AD (D4)	65/83 (TD+DD)	Y	18
Clifford et al. (2007)	Adelaide	Developmental skills	12/24	15/15DD/15	AD (D4)	69/77 (DD)	Y	17
Maestro, Muratori, Cavallaro, et al. (2005)	Pisa	Social attention	0–6–12	15/13	AD (D4)	7 < 70; 7 > 70	Y	17
Maestro et al. (2002)	Pisa	Social attention	0–6	15/15	PDD (D4)	6 < 70; 7 > 70	Y	17
Baranek et al. (2005)	Chapel Hill	Object playing	9–12	11/10 DD/11	AD (D4)	56/65 (DD)	Y	17
Baranek (1999)	Chapel Hill	Aut. signs, dev. skills	9–12	11/10 DD/11	AD (D4)	56/65 (DD)	Y	17
Goldberg et al. (2008)[d]	Irvine	Regression reported	6; 12; 18; 24	56/14	ASD	66	Y	16
Colgan et al. (2006)	Chapel Hill	Gestures	9–12	21/14	AD (D3+4)	14 < 70, 7 > 70	Y	16
Receveur et al. (2005)[d]	Tours	Aut. signs, dev. skills	10–12; 16–18; 24–26; >48	18	AD (D4)	10 < 50/8 > 50	Y	16
Werner and Dawson (2005)	Washington	Aut. signs, dev. skills	12/24	15LOA/21EOA/20	PDD (D4)	55	Y	15
Osterling and Dawson (1994)	Washington	Aut. signs, dev. skills	12	11/11	PDD (D3R)	4 < 75, 6 > 75	Y	15
Werner (2000)	Washington	Aut. signs, dev. skills	8–10	15/15	PDD (D3R)	8 < 70, 4 > 85	N	14
Ozonoff et al. (2007)	Sacramento	Motor development	0–24	26EOA/28LOA/25DD/24	AD	61/55/64 (DD)	N	14
Zakian et al. (2000)	Tours	Autistic signs	0–8–17–24	14/10	AD (D4)	6 < 50; 8 > 50	Y	14
Adrien et al. (1993)	Tours	Autistic signs	0–12–24	12/12	AD (D3R)	7, 7–105	Y	14
Mars et al. (1998)	Philadelphia	Aut. signs, dev. skills	12–30	25/25	AD/PDD (D4)	55	Y	14
Maestro, Muratori, Cesari, et al. (2005)[d]	Pisa	Autistic signs	0–6–12	40	PDD (D4)	22 < 70, 18 > 70	N	14
Maestro et al. (2006)	Pisa	Social attention	0–6–12–18	15EOA/15LOA/15	AD (D4)	–	Y	13
Maestro et al. (2001)	Pisa	Developmental skills	0–6–12–18–24	15/15	AD (D4)	–	Y	13
Losche (1990)	Berlin	Cognition	4–12–21–30–42	8/8	AD (D3)	MR	Y	13
Bernabei et al. (1998)[d]	Roma	Developmental skills	0–6–12–18–24	10	PDD (D4)	9MR + 1HF	Y	13
Bernard et al. (2006)[d]	Tours	Gestures	12–18–24–30–36	8/8	AD	56	N	11
Bernard et al. (2002)[d]	Tours	Gestures	12–18–24–30–36	7	AD (D4)	37–131	N	10
Maestro et al. (1999)[d]	Pisa	Autistic signs	0–6–12–18–24–36	26/normal scores	PDD (D4)	–	N	10
Rosenthal et al. (1980)[d]	San Francisco	Cognition	0–36	14/14	PDD	–	N	9
Bernabei and Camaioni (2001)[d]	Roma	Developmental skills	0–36	1	AD (D4)	MR	N	NA
Eriksson and De Château (1992)[d]	Stockholm	Aut. signs, dev. skills	0–14	1	AD (D3R)	60	N	NA

JA = joint attention; aut. signs = autistic signs; dev. skills = developmental skills; DD = developmental delay; TD = typical development; EOA = early onset autism; LOA = late-onset autism; AD = autism disorder; ASD = autism spectrum disorder; PDDNOS = pervasive developmental disorder not otherwise specified; D3 = DSMIII; D3R = DSMIIIR; D4 = DSMIV; HF = high-functioning; MR = mental retardation; Qual. score = quality score; N.A. = not appropriate.

[a] Indicating intermediate age, meaning that authors realized sub-analysis for each intermediate age range.

[b] Unless specific indication (DD), control were normally developing children.

[c] Mean IQ, or repartition of the autistic sample according to IQ, or IQ range/when indicated, mean IQ in DD sample.

[d] Studies excluded from the review of early signs of autism and used in other analyses.

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Table 2
Early signs of PDD in home movie studies ($N = 18$): significant differences for infants with ASD compared with typically developing children.

	First year	Second year	Study
Clifford and Dissanayake (2007)	Lower eye contact frequency and quality, less response to name, lower affect quality	Same findings as in the first year, and lower JA frequency (in initiation ++ and response too) and quality, lower requesting frequency (in initiation) and quality	1
Clifford et al. (2007)		Less response to name, peer interest, positive affect, eye contact quality and frequency, declarative showing, nestling, conventional games, functional play, anticipatory postures, more gaze aversion.	2
Maestro, Muratori, Cavallaro, et al. (2005)	Less social attention in the first but not in the second semester.		3
Maestro et al. (2002)	0–6 months: less looking at, orienting toward, smiling at, vocalizing to . . . people; less seeking contact, anticipating the other's aim, attuning behaviors, exploration of object.		4
Baranek et al. (2005)	No significant difference across levels of play, or duration of object play.		5
Baranek (1999)	Unusual posturing, less response to name		6
Osterling et al. (2002)	Less orienting to name, looking at people, gesturing, looking at objects held by others, more repetitive actions.		7
Colgan et al. (2006)	Less *variety* in social gestures; no less *total* or *initiated* gestures (pointing was excluded).		8
Werner and Dawson (2005)	Less complex babble or words: EOA < TD < LOA. Less protodeclarative pointing (EOA).	Less words and sentences, declarative pointing, orienting, and gaze.	9
Osterling and Dawson (1994)	Less orienting to name, showing object, pointing (none), looking at face.		10
Werner et al. (2000)	8–10 months: less orienting to name after excluding the 3 LOA		11
Losche (1990)	Less "goal-directed actions"	Less goal-directed actions; sensorimotor development delayed from 13 to 21 months onward and then reduced.	12
Maestro et al. (2006)	EOA: less social attention at 0–6 months; LOA: more social and non-social attention at 6–12 months.	EOA and LOA: less social attention, and more non-social attention at 12–18 months.	13
Maestro et al. (2001)	0–6 months: less pointing comprehension, anticipation of other's aim. 6–12 months: less declarative pointing, communicative gestures.	Less communicative gestures, 18–24 months: less shared attention and meaning vocalization.	14
Zakian et al. (2000)	0–8 months: no significant item	9–17 *months*: ignores people, poor interaction, no smile, no expressive mimic, too calm, no expression of emotion. 18–24 *months*: same items and prefers aloneness, no vocal communication, no imitation, inappropriate use of objects, no differentiation of persons, unstable attention.	15
Mars et al. (1998)		Less following verbal directions, looking at faces, showing objects, alternating gaze, looking at people, pointing with gaze, expressing words, imitating vocalizations.	16
Adrien et al. (1993)	Poor interaction, no social smile, lack of appropriate facial expressions, hypotonia, unstable attention.	8 new items: ignores people, prefers solitude, no eye contact, lack of appropriate gestures and or expressive postures, excessively calm, unusual postures, hypoactivity, no expression of emotion.	17
Ozonoff et al. (2007)	Later motor maturity for DD and EOA, compared with TD		18

JA = joint attention; EOA/LOA = children with early-onset/late-onset autism; DD = children with developmental delay; TD = typically developing children.

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3. Results

3.1. General comments

Out of the 41 studies gathered, about 70% ($N = 29$) came from five main research groups. The *San Francisco team* in 1975 was the pioneer in publishing studies ($N = 3$) of family home movies of infants who would later develop autism, focusing both on *mother–child interactions* and *early symptoms*. The *Tours team* conducted many studies ($N = 15$), first using a scale constructed to recognize the *early symptoms* of autism, and later, new tools to screen various *early skills* (e.g., gestures, imitation and joint attention). The *Washington team* ($N = 4$) tried to improve upon the methodology by standardizing age and context and comparing with a developmentally delayed sample. The *North Carolina team* conducted studies ($N = 3$) on roughly the same sample, coding first *social, affective and sensori-motor behaviors,* then *object playing* using computer-based coding, and finally *social interaction gestures*. Last, the *Pisa team* ($N = 6$) assessed the onset of symptoms (e.g., early attention to people vs. attention to objects; age of regression) through home movies on large samples with different control conditions, such as early signs from parental interviews and early signs from matched controls with typical development.

Most studies searched for statistically significant differences in autistic vs. control comparisons, whereas others described early signs, skills, or longitudinal development of autistic infants without statistical analysis (Adrien, Faure, et al., 1991; Adrien, Gattegno, Streri, Reynaud, & Barthélémy, 2005; Bernabei & Camaioni, 2001; Bernard, Guidetti, Adrien, & Barthélémy, 2002; Eriksson & De Château, 1992; Gattegno, Ionescu, Malvy, & Adrien, 1999; Massie, 1978a; Sauvage et al., 1988; Teitelbaum, Teitelbaum, Nye, Fryman, & Maurer, 1998; Trevarthen & Daniel, 2005). Finally, some studies aimed to compare different ages (Bernabei, Camaioni, & Levi, 1998; Maestro, Muratori, Cesari, et al., 2005) or different pathological groups (Dubois-Carmagnat et al., 1997; Goldberg, Thorsen, Osann, & Spence, 2008; Receveur et al., 2005). Comparisons with developmentally delayed (DD) children have enabled identification of the specific signs of ASD.

Study quality varied based on the various methodological variables taken into account by our quality grid; 22 studies obtained a score of 13 or more. With regard to early autistic signs, we also excluded four studies without comparisons to typical children (Bernabei et al., 1998; Goldberg et al., 2008; Maestro, Muratori, Cesari, et al., 2005; Receveur et al., 2005), resulting in 18 studies with an aggregate of a maximum of 317 films (perhaps less, since authors might have used the same films twice without mentioning it).

Regarding developmental issues, we found nine articles dealing with late-onset autism (Bernabei & Camaioni (2001); Eriksson & De Château (1992); Goldberg et al., 2008; Maestro, Casella, Milone, Muratori, & Palacio-Espasa, 1999; Maestro, Muratori, Cesari, et al., 2005; Maestro et al., 2006; Osterling, Dawson, & Munson, 2002; Werner & Dawson, 2005; Werner, Dawson, Osterling, & Dinno, 2000) and 11 longitudinal studies (Adrien et al., 1993; Bernabei et al., 1998; Bernard et al., 2002; Bernard, Adrien, Roux, & Barthélemy, 2005; Bernard, Adrien, Roux, & Barthélémy, 2006; Clifford & Dissanayake, 2007; Maestro et al., 1999, 2001; Malvy, Adrien, Roux, Lataste, & Sauvage, 1994; Receveur et al., 2005; Werner & Dawson, 2005). The methodology of all selected studies is summarized in Table 1.

3.2. Early signs of ASD during the first 2 years of life

We summarize the data of the 18 selected studies in Table 2 according to the first and second years of age. In this section and in the next sections, we report in parentheses the number we have given to each study in Table 2. Because for different reasons (see discussion of limitations) home movie studies did not always obtain the same results, we have also signaled conflicting results in parentheses. For the initial 6 months, significant signs were consistently observed only by the Pisa team: less social attention (Table 2: studies 3, 4, 13), anticipation of the other's aim, pointing comprehension and attuning behaviors (Table 2: studies 4, 14), and explorative activity (Table 2: study 4).

In the first year as a whole, signs were present in all major autistic domains: socialization, communication, intersubjectivity, and affect. ASD infants lacked social interest (especially in the first semester), interacted poorly (Table 2: studies 4, 15, 17), and looked at others less in six out of nine studies (Table 2: studies 1, 3, 4, 7, 10, 13; but not in studies 6, 9, 11), but inconsistently displayed qualitative gaze anomalies (Table 2: study 1; but not study 15). They displayed, however, higher non-social attention (Table 2: studies 3, 13). Affective behaviors were also reduced, with less appropriate facial expressions (Table 2: studies 15, 17), but an inconsistent reduction in social smiles (Table 2: studies 4, 15, 17; but not in studies 1, 9, 11) and inconsistent lower quality of affect in one out of two studies (Table 2: study 1; but not study 6). Greater levels of distress were not observed, however (Table 2: studies 6, 9, 10). Response to name was reduced in several studies (Table 2: studies 6, 7, 10, 11; but not study 9), as were communicative gestures (Table 2: studies 7, 14; but not studies 8, 10). Vocalization per se was not significantly reduced (Table 2: studies 7, 9, 10, 11); however, vocalizations *to people* (Table 2: studies 3, 4) were reduced. There was also a reduction in interactive behaviors, such as declarative pointing (Table 2: studies 9, 10, 14), showing (Table 2: study 10) and, in one out of two studies, looking at objects held by others (Table 2: study 7; but not study 9).

Regarding motor activity, results differed across studies, but when compared with DD infants, results were mostly non-specific. As ASD children often have cognitive delays, when an item discriminates ASD children from typical developing ones, we are unable to conclude that this item is specific to autism per se unless it discriminates ASD children from DD ones as well. There may be hypotonia (Table 2: study 17), hypoactivity (Table 2: studies 4, 12; but not studies 15, 17) and delayed motor maturity in both ASD and DD children, with only DD showing movement abnormalities (Table 2: study 18). Repetitive

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behavior frequency was either non-significant (Table 2: studies 6, 9, 11) or non-specific compared with DD (Table 2: study 7). Likewise, unusual posturing was not significant (Table 2: studies 15, 17) or non-specific compared to DD (Table 2: study 6). Lastly, neither self-stimulation (Table 2: study 10) nor stereotypies (Table 2: studies 6, 15, 17) were significantly increased in the first year.

It is important to note that during the first year of life, numerous traits identifiable with ASD, such as rigid and repetitive object playing, unusual posturing, less gesturing, less looking at objects held by others, less looking at the camera, and perhaps visual fixation and lower affective expression (Table 2: studies 6, 7) were in fact not discriminated in the delayed infant/typical infant comparison. However, some items did discriminate autistic from DD children in the first year, specifically less frequent orientation to name, looking less at others and lower quality of affect (Table 2: studies 1, 6, 7).

In the second year, poor social interaction persisted, with less looking at people (Table 2: studies 1, 2, 9, 16, 17; but not study 15), decreased quality of eye contact (Table 2: studies 1, 2; but not study 15), and even gaze aversion (Table 2: study 2). New signs were also inconsistently reported, such as isolation (Table 2: studies 15, 17; but not study 16), less nestling (Table 2: study 2; but not study 16) and less imitation (Table 2: study 15; but not study 16). Lower mimicry and expression of emotions (Table 2: studies 15, 17) and positive affect quality (Table 2: studies 1, 2; but not study 16) persisted, with inconsistent reductions in social smiling (Table 2: studies 15, 17; but not studies 1, 2, 9, 16). Communicative gestures, expressive postures (Table 2: studies 14, 17; but not study 16), and response to name (Table 2: studies 1, 2, 9; but not study 16) were lower, as were the number of words and sentences. Autistic infants displayed more stereotyped vocalizations (Table 2: studies 9, 14, 15, 16) and followed verbal directions less (Table 2: study 16). Pointing (Table 2: studies 2, 9, 16), declarative showing, requesting, shared attention, and anticipatory postures (Table 2: studies 1, 2, 14, 16) were reduced, especially in initiation and quality (Table 2: study 1). Activity and cognition were also impaired, as evidenced by the observation of unstable attention (Table 2: studies 15, 17), hypoactivity, hypotonia, unusual postures (Table 2: studies 12, 17, 18; but not study 15), inappropriate use of objects (Table 2: study 15), and lower Piagetian sensorimotor stages (Table 2: study 12), as well as reduced amounts of functional play, symbolic play, and actions following a social script (Table 2: studies 2, 12).

Compared with DD, the signs specific to ASD seemed more numerous in the second year (eight significant items are reported for the second year vs. three in the first year): lower eye contact quality, gaze aversion, lower social peer interest, less positive affect, less nestling, less protodeclarative showing, less anticipatory postures and less conventional games (Clifford et al., 2007; Clifford and Dissanayake, 2007). Eye contact quality and affect quality were found to be the best predictors of a later diagnosis of autism (Clifford et al., 2007). However, regarding protodeclarative pointing, the delayed group fell between typical and autistic groups (Clifford et al., 2007), exhibiting a (slight) delay in joint attention behaviors that was less impaired than in the autistic sample (Clifford and Dissanayake, 2007). Thus, in the second year, pre-autistic signs (lack of social behavior and joint attention) became more obvious, allowing a distinction to be made between autistic and delayed children, whose cognitive delays also increased (Losche, 1990; Rosenthal, Massie, & Wulff, 1980).

3.3. Is autistic regression or late-onset autism (LOA) a valid concept?

Two single-case studies of autistic "regression" reported by parents supported the existence of this phenomenon. The first child waved good-bye, played peek-a-boo, babbled often, played normally and used protodeclarative pointing before the occurrence of an acute regression around 12 months. He then showed signs of withdrawal as well as both silent and repetitive behavior and play (Eriksson & De Château, 1992). The second child smiled, gazed, pointed, waved and played patty-cake, but from 22 months onward, the child began to show repetitive and stereotyped behavior, isolation, language stagnation, and decline of mental age (Bernabei & Camaioni, 2001). Until 12 months of age, he always turned when called; between 12 and 19 months of age, he then engaged in this behavior inconsistently, and after 22 months, the child no longer responded (Bernabei & Camaioni, 2001).

Goldberg et al. (2008) focused on the concordance between information derived from parental report and from the direct observation of home movies and reported better concordance for language loss than for other losses (e.g., pointing, showing, joint attention, social gaze, orienting to name, functional and symbolic play), which parents often failed to report. Furthermore, two studies focusing on the time of onset that included 40 and 26 cases, respectively (Maestro et al., 1999; Maestro, Muratori, Cesari, et al., 2005), showed that most cases began in the first semester, whereas other cases began within the second semester and a few cases after the first year (late-onset autism; LOA). However, even after a regression, islands of interaction and communication persisted for several months (Bernabei & Camaioni, 2001), and then disappeared completely. Only three studies directly compared infants with early-onset autism (EOA) and LOA, according to regression reported by parents on the ADI-R (Osterling et al., 2002; Werner & Dawson, 2005) or assessed in home movies (Maestro et al., 2006). At 1 year of age, infants with LOA did not differ from typical children; they gazed (Maestro et al., 2006; Osterling et al., 2002), smiled (Maestro et al., 2006), vocalized to people (Maestro et al., 2006; Werner & Dawson, 2005), pointed (Werner & Dawson, 2005), oriented to their name (Osterling et al., 2002) and paid attention to objects held by others (Osterling et al., 2002) as typical children did. This differed significantly from infants with EOA. However, there may be some slight signs of LOA in the second semester, such as higher scores on non-social competencies (Maestro et al., 2006).

In contrast, at 2 years of age, there were no differences between EOA and LOA in declarative pointing, social gaze, orienting to name, or language development (Werner & Dawson, 2005). Finally, in the light of this review, LOA appears to be a valid concept. A child from the LOA group may coarsely be defined as resembling a typical child at 1 year and then shifting to resemble an EOA child at 2 years.

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3.4. Developmental course in early-onset autism

Although longitudinal studies show that every child's development is unique, we will describe a mean course. As seen above, in EOA, the core autistic symptomatology, lack of social and communicative activity, is present from the first year, and even from the first semester, but at a lower rate. This could explain why professionals do not detect it earlier. Thus, all children seem to have mutual attention and emotional reactions from the first months of life, and some of them show social interest, social turn-taking, and peek-a-boo (Bernabei et al., 1998). Therefore, social skills may be present at the beginning of life, though infants, who later go on to be diagnosed with ASD, rarely make use of them. Children then seem to progress in social (Bernabei et al., 1998) and communicative areas (Bernard et al., 2002) from the first to the second or third semester, before losing previously mastered behaviors, especially ones that are socio-interactive and associated with attachment (Bernabei et al., 1998; Bernard et al., 2002). In the second year, poorer social interest and reactivity change into aversion and avoidance, with a decrease in social activity (Adrien et al., 1993; Bernabei et al., 1998; Malvy et al., 1994; Receveur et al., 2005; Werner & Dawson, 2005) and communicative gestures (Adrien et al., 1993; Bernabei et al., 1998; Bernard et al., 2002; Malvy et al., 1994), making the pathology easier to detect. EOA and LOA showed, between 12 and 24 months, an absolute decrease of the same magnitude in social gaze (Werner & Dawson, 2005). Likewise, intersubjective skills (pointing, shared attention, anticipation, initiation of requests), though reduced early on in a child's development, may increase within the second year (Bernabei et al., 1998; Bernard et al., 2002; Clifford and Dissanayake, 2007; Maestro et al., 2001) before decreasing at the end of the second year (Bernabei et al., 1998; Bernard et al., 2002; Maestro et al., 2001). Also, vocalization to people decreased in the first semester (Maestro et al., 2002; Maestro, Muratori, Cavallaro, et al., 2005), increased within the second semester (Maestro, Muratori, Cavallaro, et al., 2005) and then stagnated within the second year (Werner & Dawson, 2005). This stagnation occurs at a time when, in typical children, there is a tremendous increase in expressive language. Nevertheless, some ASD children did produce words in the second year (Bernabei et al., 1998; Bernabei & Camaioni, 2001). With regards to verbal comprehension, although children with autism are usually less attentive to language and less responsive to name by the end of the second semester (Werner et al., 2000), some children do exhibit verbal comprehension in the first year and maybe more in the 2nd year (Bernabei et al., 1998).

As for autistic onset, several courses of cognitive development are observed (Rosenthal et al., 1980): cognitive delay appears to be both an early and dynamic phenomenon, with developmental alteration over time (Losche, 1990; Rosenthal et al., 1980) and perhaps even an *absolute* cognitive decline (Bernabei & Camaioni, 2001; Losche, 1990). This cognitive alteration goes along with autistic symptomatology: children who ignored people more in the third semester became more delayed later on (Receveur et al., 2005). Though reduced since the first months of life, many social, communicative and intersubjective skills are present and even *growing* during the first 2 years, before beginning to stagnate or even decrease in the second and/or third year.

4. Discussion

4.1. Comparing findings from home movie studies with those from prospective studies

Some limitations of home movie studies have been emphasized, such as the uncertainty concerning their representativeness, the lack of standardization, and the risk of selection by parents. Fortunately, recent prospective studies using high-risk samples (e.g., those with autistic siblings) confirm most home movie's results, validating their merit. Indeed, prospective studies showed an early lack of social engagement around the first birthday (Landa, Holman, & Garrett-Mayer, 2007; Zwaigenbaum et al., 2005) and even between 6 and 12 months (Bryzon et al., 2007). In prospective studies, communication skills were also impaired as early as 12–14 months, with a reduced response to name (Nadig et al., 2007; Zwaigenbaum et al., 2005), reduced phrases and/or vocabulary comprehension (Landa & Garrett-Mayer, 2006; Mitchell et al., 2006; Zwaigenbaum et al., 2005), reduced language production (Landa & Garrett-Mayer, 2006; Zwaigenbaum et al., 2005) and reduced gesture production (Mitchell et al., 2006; Zwaigenbaum et al., 2005), all predicting an outcome of autism spectrum disorder (ASD) at 2 or 3 years. Reduced intersubjective skills already described in clinical settings at 18 months (Baron-Cohen et al., 1996; Wetherby, Watt, & Morgan, 2007) have been found even at 14 months (Sullivan et al., 2007). Early affective impairments and irritability have also been found between 6 and 12 months (Bryzon et al., 2007), and more distressed reactions have been found at 12 months (Zwaigenbaum et al., 2005). Lastly, hypoactivity at 6 months (Zwaigenbaum et al., 2005) and more stereotyped behaviors as early as 12 months (Loh et al., 2007) were also found, but the latter study found sizeable overlap between the group of siblings who would become ASD, the group of siblings who would not, and the control group. Regarding specificity, a study comparing ASD, DD and TD communication in the 18–24-month period found impairments in the ASD group for social, intersubjective and communicative fields, with gaze shifts, gaze/point follow, acts for joint attention and the rate of communicating specifically impaired, when compared with the DD group (Wetherby et al., 2007).

Concerning the developmental course, prospective studies again converge with home movie studies, showing a great variability in the individual course of development (Bryzon et al., 2007). In particular, one prospective study has supported the validity of regression (Landa et al., 2007). Also, they suggest a dynamic alteration during development, with ASD infants showing a decrease in social engagement, concomitant with irritability and intolerance to intrusions (Bryzon et al., 2007), as well as a decrease in disengagement of visual attention skills (Zwaigenbaum et al., 2005) between 6 and 12 months. In the

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second year, they showed a slower increase of development in all scores of the Mullen Scales of Early Learning with, at times, an absolute decrease in one or more scores (Landa & Garrett-Mayer, 2006), a frequent notable decrease in developmental quotient on either the Bailey or Mullen scales (Bryzon et al., 2007), and stagnation in response to joint attention (Sullivan et al., 2007). Thus, we can state that home movie studies provide reliable and naturalistic data about ASD infancy, which have useful and valuable clinical and theoretical implications.

4.2. What are the early warning signs for ASD that can be used in an early screening?

A large consensus exists in the literature for the idea that early treatment may positively influence the course of autism. Pursuing a thorough analysis of home movie findings could help to operationalize new tools for early screening, as has been done by the North Carolina group (Baranek et al., 2005; Reznick et al., 2007) with the First Year Inventory. With regards to developmental maturation, it appears that signs of risk during the first year are poorer social interest (e.g., poor interaction and not looking at others, especially in the face), poorer communication (e.g., vocal and gestures expression and reception, especially response to name), poorer intersubjective skills, and poorer affective expression. Lastly, detection of at-risk infants becomes easier in the second year, because early social signs are intensifying; expressive and receptive language fails to develop (and is often the first sign reported by parents), while the lack of intersubjective skills and affective expression persists. We have summarized this developmental view in Fig. 1.

Because there are numerous early warning signs, should there be a preference for which one to use? Some authors used a discriminant analysis technique to estimate the discriminant power of potential markers (Baranek, 1999; Clifford et al., 2007; Maestro, Muratori, Cavallaro, et al., 2005; Mars, Mauk, & Dowrick, 1998; Osterling et al., 2002; Osterling and Dawson, 1994; Werner et al., 2000). The most reproducible discriminant criteria may be "response to name" (Baranek, 1999; Clifford et al., 2007; Osterling et al., 2002; Osterling and Dawson, 1994; Werner et al., 2000) as soon as the end of the first year of life, "looking at faces" or "eye contact" (Clifford et al., 2007; Mars et al., 1998), and "pointing" or "showing" (Mars et al., 1998; Osterling and Dawson, 1994). In regards to specificity, "quality of eye contact" and "quality of affect" were the best predictors of autism in a previous study, allowing, with peer interest and response to name, a correct classification of 79% of children with autism among three populations (AD/DD/TD) in the second year (Clifford et al., 2007).

Indeed, specificity and sensitivity also must be accounted for. First, regarding specificity, delays in verbal expression and comprehension are not specific to ASD; given their great developmental variability, they can also belie a developmental delay, a specific language disorder, or can even be seen in a typical developing child. Furthermore, although they may not be specific to autism, delays in the use and understanding of language used in combination with social and communication deficits can be extremely useful for identifying children with ASD. Second, dealing with cognitive impairment in children with autism is a critical issue. Most studies controlled mean QD of their autistic sample in retrospective measures, always finding a lower QD than in the control sample. The question arises as to whether the QD (or IQ) at the age of diagnostic and

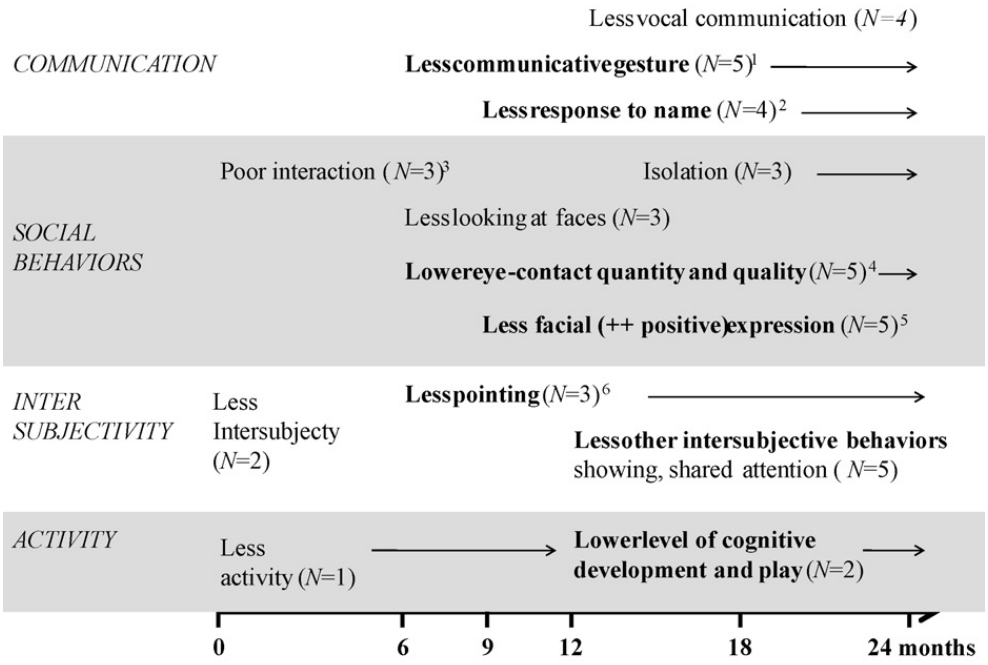

Fig. 1. Early signs of autism according to age and main developmental domain from home movie studies. Signs that are more specific to autism (compared to children with developmental delays) appear in bold. *N* indicates the number of studies reporting the corresponding item. [1]Significant in the 6–12-month period in 1 study; [2]significant in the last months of the first year in 3 studies; [3]significant in the 0–6-month period in 1 study; [4]significant in the 6–12-month period in 2 studies; [5]significant in the last months of the first year in 2 studies; [6]significant in the 6–12-month period in 1 study.

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evaluation (often between 3 and 6 years of age) is the same as in infancy, before the full installation of autistic symptoms. Studies focusing on the cognitive development of children with autism (Losche, 1990; Rosenthal et al., 1980) showed that their development was often impaired very early. Thus, some early signs found in the autistic vs. typical infants' comparison could prove to be signs of delayed development. Comparisons with delayed children are thus very valuable to highlight the signs that are more specific to autistic disorders. Unfortunately, only a few studies compared these three samples: autistic vs. delayed vs. typical children (Baranek et al., 2005; Baranek, 1999; Clifford et al., 2007; Clifford and Dissanayake, 2007; Osterling et al., 2002; Ozonoff et al., 2007). They showed that some early signs are related to delay rather than to autism itself. Even though autistic and delayed children have similar repetitive behaviors, cognitive delays and even more or less delay in the emergence of intersubjective skills, children with autism differ from delayed ones in socialization, affect quality, and to a certain extent, intersubjective skills. In order to further extend our knowledge as to which signs are specific to autism, another focus of interest should be home movie studies of high-functioning autistic cases.

With regard to sensitivity, as seen above, longitudinal studies have shown a great variability in the developmental profiles within the ASD group. Variability includes not only late-onset cases, but also early-onset cases, where there can be a possible decrease in skills throughout the second year and fluctuating cases with persisting islands of good interaction before the full installation of the autistic state. Moreover, babies who have become autistic can look and smile at others, look back during protoconversation, and have eye contact and warm connections with others, even if these behaviors are less frequent than in typical babies and need to be provoked by others in order to surface. Essentially, infants with autism fail to transform simple social behaviors into a series of successively more complex interpersonal relationships (Muratori & Maestro, 2007). For this reason, the risk of false negatives is great with regards to basic signs, suggesting that a good screening should search for more complex intersubjective impairments, such as initiation of interaction. Screening may be conducted twice to enhance the chances of detecting fluctuating and LOA cases. On the basis of the Pisa team's work (Maestro et al., 2001, 2002, 2006; Maestro, Muratori, Cavallaro, et al., 2005) that found early reduction of social and intersubjective manifestations, we can expect very early detection, as soon as 6 months of age. The French prospective "Preaut" study, currently ongoing, is attempting to detect signs as early as 4 and 9 months of life on the basis of dynamic intersubjective signs, like the manifestations of the desire to raise pleasure (to be a source of joy) in others (Cullere-Crespin, 2007; Laznik, 2007).

In summary, which warning signs should be preferentially used for an early screening? While pointing is an easy potential early marker, as it appears as soon as the beginning of the second year, it may lack specificity. In contrast, decreases in orienting to name, looking at others and affect quality can distinguish autistic from delayed and typical children, especially in the first year. While failure to look at faces may not be sensitive enough, and lower affect quality may be difficult to

Table 3
Early screening for risk of autism according to prospective and home movie studies.

	Signs	Sensitivity		Specificity
		Prospective studies	Home movie studies	
First semester	Less social attention and activity		3/3	
	Less intersubjectivity		2/2	
	Hypoactivity/hypotonia	1/2	1/1	
End of the first year	**Less looking at/less orienting toward others**	**2/3**	**6/9**	++
	Poor interaction		3/3	
	Less facial expression	1/2	2/2	–
	Less social smile		3/6	
	Less affect quality		1/2	++
	Less communicative gestures	3/3 (S = 0.33)	2/4	–
	Less social vocalization		2/2	
	Poor response to name	**2/2 (S = 0.5)**	**4/5**	++
	Less pointing	1/1	3/3	+/–
	Less other intersubjective behaviors	2/2	5/6	–
Second year (18–24 months)	**Less looking at people**	**3**	**5/6**	++
	Lower eye contact quality		2/3	++
	Less positive affect		1/2	++
	Less communicative gestures/postures	3/3	2/3	
	Less vocal communication	4/4	4/4	
	Language comprehension	3/3	1/1	
	Less response to name	2/2	3/4	
	Less pointing	2/2	3/3	+/–
	Other ISB: showing, RJA, anticipatory postures	**5/5**	**4/4**	+++

ISB: intersubjective behaviors; RJA: response to joint attention.
Specificity in autistic/delayed comparison: (–) not specific in home movie studies; (+/–) partially specific in home movie studies; (++) specific in home movie studies; (+++) specific in home movies + prospective studies.
Sensitivity: rate of studies that found significance for this item; S = sensitivity as calculated in one study. Most pertinent items (as regards sensitivity, reproducibility and specificity) appear in bold.

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operationalize for screening purposes, the failure to respond to name appears to be an early, easy, discriminant and reproducible sign of ASD. On the basis of both home movies and prospective studies, we gathered early signs that could be used for early screening of infants at risk for ASD, shown in Table 3.

4.3. Developmental issues

Home movie studies validate the existence of LOA cases, reported and described by parents as a "regression". These infants seem to develop normally during the first year, even showing social and communicative skills, which later disappear during the second year. Furthermore, the developmental course of autism seems to be very different from one child to another, and even sometimes fluctuates for the same child. Thus, in the first few years, it might be useful to classify children according to the type of onset (previously assessed through home movies) before practicing statistical measures on any particular symptom. For example, it appears useful to study late and early onsets separately.

The early dynamic course of skills and autistic signs raises a more theoretical issue: are social skills a primary disorder or a downstream effect of another primary phenomenon? Mundy and Crowson (1997) proposed a cybernetic model in which a primary deficit in social attention (or Trevarthen's primary innate intersubjectivity, 1979), and especially a difficulty in eye contact, causes a scarcity in social information and a subsequent difficulty in joint attention skills. Likewise, according to Hobson's theory (1993), the difficulty in affective expression at a dyadic level causes subsequent difficulty in joint attention skills. More recently, Pelphrey and Carter (2008) have proposed that social deficits are central to autism in the sense that early failures in social engagement play a causal role in the emergence of the communication deficits and repetitive, stereotyped behaviors and interests. Our review, showing very early social signs, and a secondary *decrease of communicative skills*, lends support to these hypotheses. In dealing with language acquisition, the fact that some autistic infants were able to listen and understand language early on, and even produce words, but with an early decrease observed in gestural communication and intersubjectivity, suggests the existence of dysfunction located upstream of language treatment. Thus, instead of a perceptive impairment, failure in language acquisition appears as a lack of interest in humans. However, an alternative hypothesis may be that there is a failure in neural commitment to language processing that occurs around the first year of life (Kuhl, 2004).

However, given that we know now that social anomalies of the autistic infant are present very early in life, a further issue will be to consider how these early anomalies modify parental attachment and behaviors. From the first months, Massie (1978b) found a significant lack of attachment behaviors (visual-touch-holding) from the mothers, often with gaze aversion, which contrasts with the good attachment behaviors made toward the next-born child (Massie, 1978a). On the other hand, unconscious compensatory behaviors from parents were also observed from the first months: attempts to establish communication, increasing the saliency of a given stimulus (Doussard-Roosvelt, Joe, & Bazhenova, 2003) through repetitive cuing, with for example repeated prompting (Adrien, Faure, et al., 1991; Adrien et al., 1992; Baranek, 1999; Trevarthen & Daniel, 2005). Under certain conditions like physical games (Trevarthen & Daniel, 2005), repeated prompting (Baranek, 1999), and motherese (Laznik, 2007), the child become able to respond. Thus, the interactions appear to be amended in a complex way that may imply bidirectional processes.

5. Conclusions

We conclude that home movie studies converge with the findings of prospective studies on early signs of ASD and should be considered as interesting tools for study of the first months of life. However, early diagnosis of ASD remains a complex challenge. The home movie studies may also be promising for future research by creating and using computerized methods of study for specific markers that could dramatically reduce the time needed for "manual" investigations (Mahdhaoui et al., in press). Other methodological perspectives include studies of high-functioning autistic infants, development of longitudinal studies, and separate studies of early- and late-onset cases. Lastly, considering the early lack of social interest and the sporadic use of social skills, further research should focus on interactive sequences, exploring what context allows an autistic infant to engage in a dyadic exchange and communication. This last point seems to be of seminal importance from both theoretical and therapeutic perspectives.

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