

The Need for an Ecological Approach to Parental Stress in Autism Spectrum Disorders: The Combined Role of Individual and Environmental Factors

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Abstract This study aimed to identify parental stress predictors in ASD by considering individual and environmental factors in an ecological approach. Participants were 115 parents of children with ASD aged from 3 to 10 years. Multiple regression analyses were conducted to determine the best predictors of parental stress among child-related, parent-related and environmental factors. Poor quality interactions within the extended family, high levels of expressed emotion and absence of children's schooling were associated with higher stress, regardless of the child's age and developmental quotient [$F(3) = 37.051$; $p < 0.001$; $\text{Adj. } R^2 = 0.457$]. This study highlights the importance of considering environmental factors, specifically family variables, to understand parental stress. These key findings should be considered when designing support programs.

Keywords Autism spectrum disorders (ASD) · Parental stress · Ecological approach · Family factors

Introduction

Parents of children with autism spectrum disorders (ASD) experience higher levels of stress than those of typically developing children (Estes et al. 2009; Johnston et al. 2003). So far, many studies have sought to identify predictors of parental stress in ASD. Two major groups of factors contribute to increasing stress in parents of children with autism: (1) individual factors associated with children's and parents' characteristics; (2) environmental factors related to the social, family and services (professional support) contexts.

For individual factors, most studies have focused on children's characteristics. Associations between parental stress and a severe autism profile have been demonstrated. Severe autism profile is characterized by comorbidities (Mori et al. 2009), behavioral problems (Davis and Carter 2008; Estes et al. 2009; Hall and Graff 2011; Hastings 2003; Hastings et al. 2005; Herring et al. 2006; McStay et al. 2014; Peters-Scheffer et al. 2012; Samadi and McConkey 2014), few adaptive skills (Hall and Graff 2011) and developmental delay (Falk et al. 2014). In this case, parental stress could be explained by a poorer prognosis for the child and decreased parental self-efficacy (Hastings and Brown 2002). In contrast, some authors have concluded that high-functioning autism or an Asperger diagnosis with few behavioral disorders and better adaptive skills could also lead to significant parental stress (Hill-Chapman et al. 2013; Mori et al. 2009; Rivard et al. 2014). This could be due to the long delay for the diagnosis to be made and to the medical wandering that such parents go through. Although the disorder may not be visible, parents may have adjustment difficulties and even more the feeling of being misunderstood and judged negatively by friends and family (Rivard et al. 2014). Regarding demographic

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variables, Rivard et al. (2014) showed that fathers of daughters with ASD reported higher levels of stress than fathers of sons. In addition, two studies reported an association between stress and having a young child (Duarte et al. 2005; Falk et al. 2014), while Rivard et al. (2014) reported a positive correlation between the age of the child and the level of stress in mothers and fathers. However, these results should be interpreted with caution as the age range of children in the sample was different in these three studies. Rivard et al. (2014) assessed children from 2 years and 9 months to 5 years, whereas Falk et al. (2014) and Duarte et al. (2005) assessed children respectively from 4–17 years and 3–12 years.

Concerning parents' characteristics, mothers generally have higher levels of stress than fathers and are about four times more likely to score higher than the clinical cut-off (Samadi and McConkey 2014). However, Rivard et al. showed higher stress scores in fathers than mothers (Rivard et al. 2014). Being a young father or mother also seems to be associated with high stress levels (Dardas and Ahmad 2014; Duarte et al. 2005; Falk et al. 2014; Lau et al. 2014). In addition, single mothers have a 4.6-fold increased risk of presenting stress scores above the clinical cut-off (Samadi and McConkey 2014). With regard to parents' functioning, the presence of a broad autism phenotype was found to be positively correlated with stress and depression and increased the risk of developing anxiety disorders (Ingersoll and Hambrick 2011; Lau et al. 2014). A high level of expressed emotion (expression of hostility, rejection and/or excessive emotional involvement *in relationships between a patient and his family*) could be an important factor in creating family stress and several authors have underlined the relevance of evaluating this concept in parents of children with ASD (Benson et al. 2011; Greenberg et al. 2006; Orsmond et al. 2006).

The second group of predictors concerns environmental factors. Regarding family context, the perceived gap between real and ideal family functioning is stressful for mothers (Johnson et al. 2011). Marital support was negatively associated with stress in fathers and mothers and with depressive affects in mothers (McStay et al. 2014). Poor parental alliance about educational tasks is itself associated with stress in both parents (Hill-Chapman et al. 2013), while support from grandparents could impact parental stress (Trute 2003). For example, Samadi and McConkey (2014) observed a higher risk of pathological stress in families living without grandparents than in those where several generations live together. With regard to the social network, perceived social support is negatively associated with stress in both parents (Falk et al. 2014; Hastings and Johnson 2001; Ingersoll and Hambrick 2011; Siman-Tov and Kaniel 2011). Finally, one of the main sources of stress experienced by parents of children with ASD is the lack of adequate

professional support (Bishop et al. 2007; Sharpley et al. 1997). For example, the quality of life and psychological well-being of mothers are more important when the child is in schooling (Baghdadli et al. 2008; Cappe 2012). In addition, the longer the delay is between the initial concerns of the parents and the diagnosis, the greater the parental stress (Osborne et al. 2008). Moreover, despite the importance of an early diagnosis, the latter is associated with significant stress for parents (Osborne et al. 2008).

While there are a number of characteristics associated with higher parental stress, there remains some disagreement between studies and a need for additional research. This is important not only to better understand and to prevent difficulties in parental adjustment but also to improve parental support programs. So far, most studies have focused on individual factors, in particular children's characteristics, and have tended to leave aside environmental variables. Some studies have investigated both individual and environmental factors (e.g. Hall and Graff 2011; Manning et al. 2011; Pakenham et al. 2005; Siman-Tov and Kaniel 2011) but to our knowledge, none of them have considered the child's and parents' characteristics, family context and services available in the same design. However, Belsky's model (1984) suggests that both environmental variables and individual characteristics influence parents' psychological well-being and consequently their functioning as parents. Indeed, parenting behaviors are associated with three distinct areas: the individual characteristics of the parent (e.g. personality traits), the environmental influences of stress and support (e.g. marital relationship, employment, family and social networks) and the individual characteristics of the child (e.g. temperament and sex). Based on this model, the present study examines the joint impact on self-reported parental stress in ASD of individual factors (children-related and parent-related factors) as well as environmental factors (family environment and services provided for children with ASD). There were two main objectives: to assess the respective weight of individual and environmental factors on parental stress; to identify the best predictors of parental stress among the study variables.

Methods

Participants and Procedures

All study participants were recruited between 2011 and 2014 in five centers specializing in the diagnosis of ASD, seven parents' associations, five centers providing care for children and two schools. The study included 115 participants who were the parents of 78 children between the ages of 3–10 years. One should note that some participants were couples, so there are more parents than children. The mean

age of the children was 6.3 years (SD = 2.3) and the sample included 63.5 % of mothers (N = 73) and 36.5 % of fathers (N = 42). In 64.4 % of cases, both parents of the child participated and 94.7 % of parents resided together in the family home. All of the children met the diagnostic criteria for autistic disorder (47.43 %), Asperger’s disorder (9 %), or pervasive developmental disorder-not otherwise specified (PDD-NOS), according to the DSM-IV-TR (American Psychiatric Association 2003). The child’s diagnosis was made by a child psychiatrist using the Autism Diagnostic Interview—Revised (Le Couteur et al. 1989; Lord et al. 1994) and the Autism Diagnostic Observation Schedule (Lord et al. 1999).

Demographic data are presented in Tables 1 and 2.

Measures

Outcome Measure: Parental Stress

The *Parenting Stress Index, Short Form* (Abidin 1995; Bigras et al. 1996) is a 36-item subset of the 120-item full-

length measure. This parent-report questionnaire is designed for parents of children aged from birth to 12 years. It assesses the parents’ level of stress in the parent–child relationship as well as the level of parental distress [parental distress (PD), dysfunctional interaction (parent–child dysfunctional interaction (PCDI)] and parenting difficulty associated with the child (difficult child (DC)]. Raw total scores above 90 indicate a clinically significant high level of stress scores (Abidin 1995). It has been shown to have good reliability and validity and has been used in a variety of parenting studies to assess parental stress in families that have a child with a developmental disability. In our sample, Cronbach’s alphas ranged between 0.82 (PCDI scale) and 0.92 (total scale).

Individual Predictors

This category of predictors refers to “the individual characteristics of the parent” and “the individual characteristics of the child” areas in Belsky’s model of parenting (Belsky 1984).

Table 1 Sample characteristics (individual factors)

Variables	ASD (n = 115) M ± SD or %
Parent sex [n (%)]	
Female	73 (63.5)
Male	42 (36.5)
Parent age (in years) [min–max]	38.4 ± 5.1 [29–59]
Broad autism phenotype (FAQ)	43.60 ± 14.35 [4–78]
Mothers	42.65 ± 13.60 [5–78]
Fathers	44.92 ± 15.43 [4–70]
Marital status	
Couple	108 (94.7)
Single	7 (5.3)
Child with ASD sex [n (%)]	
Girl	18 (23.1)
Boy	60 (76.9)
Child with ASD age (in years) [min–max]	6.3 ± 2.3 [3–10]
Child’s diagnosis	
Autism	37 (47.43)
Asperger’s syndrome	7 (9)
PDD-NOS	34 (43.59)
Developmental quotient (DQ)	53.50 ± 21.88 [15–104]
Communication level ^a	
Level 1	25 (34.25)
Level 2	27 (36.99)
Level 3	15 (20.55)
Level 4	6 (8.22)

DQ (Developmental age (in months)/Chronological age (in months) × 100, FAQ French Autism Questionnaire, PDD-NOS pervasive developmental disorder not otherwise specified

^a Five missing data for this variable

Table 2 Sample characteristics (environmental factors)

Variables	ASD ($n = 115$) $M \pm SD$ or %
Family functioning (SAFE)	
Marital interaction	24.72 \pm 5.87 [6–30]
Marital organization	23.28 \pm 7.54 [6–30]
Parent–child interaction	25.64 \pm 4.10 [11–30]
Parent–child organization	27.73 \pm 4.52 [6–30]
Extended family interaction	24.03 \pm 6.12 [0–30]
Extended family organization	23.52 \pm 8.30 [6–30]
Expressed emotion (FAS)	21.89 \pm 12.34 [3–70]
Age of child at diagnosis (in months)	50.7 \pm 24.2 [10–120]
Time since diagnosis (in months)	24.07 \pm 29.5 [0–108]
Psycho-educational interventions [n (%)]	70 (92.10)
Child's schooling [n (%)]	64 (85.33)
Parent support [n (%)]	23 (22.11)
Parent working time (based on 35 h per week)	
Unemployed	38 (23.1)
Part-time	29 (25.2)
Full-time	48 (41.7)

SAFE systemic analysis of the family environment, FAS Family attitude scale

Firstly, regarding the individual characteristics of the parent, age, sex and marital status were considered. Concerning parents' functioning, the Broad Autism Phenotype (BAP) was assessed by the French Autism Questionnaire (FAQ), which is the only self-administered tool translated and validated in French (Piana et al. 2007; Rousselot-Pailley et al. 2011). It is an adaptation for parents of the Autism Spectrum Quotient developed by Baron-Cohen et al. in a population of patients with Asperger syndrome (Baron-Cohen et al. 2001). The questionnaire consists of 40 items that explore four areas: socialization, imagination, rigidity and communication. Each domain consists of 10 randomized questions, five positive and five negative. In the validation study, factor analysis was used to gather together these four areas in two domains of 20 questions: "communication and socialization" and "imagination and rigidity" (Piana et al. 2007). For each item, the parent must check one of four responses: do not agree at all, disagree, agree or agree strongly. The answers are scored from 0 to 3, 3 for the most atypical replies, 0 for the least atypical. This gives a final score between 0 and 60 for each of the two areas. Finally, an overall score between 0 and 120 can be calculated by summing the scores for each domain. Thus, the higher the score, the more the subject is considered to have "autistic traits". An overall score in adulthood and childhood can be calculated. For this study we used only the adulthood score. The FAQ has good psychometric properties with an intraclass coefficient (test–retest reliability) between 0.76 and 0.99 and an internal consistency ranging from 0.71 to 0.83. Cronbach's alphas found in our sample were correct, between 0.66 and 0.85.

Secondly, regarding the individual characteristics of the child, age and sex were considered. Moreover, we collected information about functioning in children with ASD: diagnosis, developmental quotient (DQ) and communication level (expressive and receptive communication skills). All clinical data on children were collected from the medical records and by direct assessments made by professionals specialized in ASD.

The developmental quotient (DQ) was calculated as follows: $(DA/CA) \times 100$, where DA is the child's developmental age (in months) and CA the child's chronological age (in months). The child's developmental age was measured with the psychoeducational profile-third version (Schopler et al. 2008) or the Wechsler Preschool and Primary Scale of Intelligence-third version (Wechsler 2004). Communication level was assessed by speech and language therapists specialized in ASD. Each child was assigned to one of the four following categories: (1) verbal and nonverbal communication of the child is evenly impaired on expressive and receptive dimensions, (2) the child has a few words and/or a few sentences: expressive and receptive levels are associated with the context and with the child's interests, (3) the child uses good syntax but some abnormal features may be present (e.g. echolalia, verbal stereotypia, etc.): communication is primarily functional but there is no conversation about the sharing of ideas, (4) language is normal from a syntactic point of view and has a communicative function. The child is able to take part in a conversation even though some features may be present.

Environmental Predictors

This category of predictors refers to “the environmental influences of stress and support” area in Belsky’s model of parenting (Belsky 1984).

To assess environmental factors, we measured parents’ working time, services available for children and the family context. Firstly, we collected the following four factors from the medical records of the child: age of child at diagnosis (in months), time since diagnosis (in months), whether the child had received psychoeducational interventions (no: 0 vs. yes: 1), whether the child was in schooling (no: 0 vs. yes: 1). Secondly, we measured family functioning and level of expressed emotion. We collected information on family functioning by using the systemic analysis of the family environment (SAFE) (Yingling et al. 1998) translated into French by Scaiola and Favez (Favez 2010). The SAFE is a self-administered questionnaire developed on the basis of the Family Adaptation and Cohesion Scale (FACES III; Olson and Gorall 2003; Vandeleur et al. 1999). It assesses three family subsystems: the marital dyad, the parent–child dyad and the extended family (each parent with his/her own parents). The SAFE is composed of 21 pairs of semantically opposite terms that are presented at the two ends of each segmented line in five compartments. The parent must place a cross next to one of the two terms depending on which corresponds to his family. Two factors of “functioning” are evaluated for each subsystem. Organizational structure (OS) refers to egalitarian organization within the couple in the extended family hierarchy in parent–child relationships. The corresponding items are listed from 6 to 30: the higher the score, the better the organizational structure. Interactive processes (IP) concern communication, listening, understanding, cooperation, support and problem-solving methods. The corresponding items are rated from 1 to 5: the higher the score, the better the quality of interactive processes. The scores for these two factors determine the quality of family functioning in four categories: competent, discordant, confused and chaotic. For this study, we opted for a dimensional approach by treating separately the two sub-scores for each dimension. Therefore, we used six subscores of the SAFE as potential predictors: marital interaction, marital organization, parent–child interaction, parent–child organization, extended family interaction and extended family organization. In the results reported by Yingling in 2004, the SAFE has good convergent validity. In our sample, there was good internal consistency (alphas ranging from 0.85 to 0.94). Finally, the level of expressed emotion was assessed with the family attitude scale (FAS), the only self-administered questionnaire available and validated in French (Kavanagh et al. 1997; Vandeleur et al. 2013). It consists of 30 items of which 20 are negative and 10 positive. Each item is evaluated according to its frequency from 0 (never) to 4 (every day), the score being

reversed for positive items. A total score is calculated from 0 to 120: the higher the score, the greater the level of expressed emotion. The psychometric properties of the FAS are very satisfactory with internal consistencies (Cronbach’s alpha) >0.95 in the princeps study and in a French sample study (Vandeleur et al. 2013). Alpha is also >0.93 in our own sample.

Data Analysis

Analyses were conducted with SPSS 20[®] Software (IBM Corp. 2011). First, we performed univariate linear regressions to test the association between the individual and environmental variables with parental stress. Multiple regression analyses were conducted with a descending stepwise method to determine the best predictors of parent-reported stress. To assess the joint influence of all factors, we incorporated all of the child-related, parent-related and environmental factors identified as significant in the first step ($p < 0.05$). Among the variables, many are qualitative variables. To integrate them into the regression models, it was first necessary to create dummy variables with one category as the reference (Bressoux 2010, p. 115). Descending method was preferred to the ascending method because there remains some disagreement between studies about determinants of parental stress. So, in case of exploratory hypotheses, the ascending method could be too strict and could fail to detect an effect that is present.

We conducted a statistical power analysis retrospectively with G*Power (Faul et al. 2009). For a moderate size effect ($f^2 = 0.15$) with 115 participants and five predictors, the power estimated by the software was 0.89, which corresponds to an adequate power. For each analysis, the following reliability criteria were taken into account (Bressoux 2010; Tabachnick and Fidell 2012): normal distribution of residuals, homoscedasticity and nonlinearity of residuals, verification of outliers. For multivariate regressions, the collinearity of the variables was also verified with the tolerance criterion ($TOL < 0.20$; Bressoux 2010, p. 143).

Results

First, 70 % of parents of children with ASD (42 % of mothers and 27 % of fathers) reported stress levels above the clinical cut-off on the PSI-SF, with a mean total score of 101.64 ± 20.93 [56–154]. There was no difference between mothers and fathers for the total PSI score [$F(5) = 1.022$; $p = 0.410$; $\beta = -0.045$; $t = -0.359$; $p = 0.721$].

In addition, linear regression analyses did not show any significant association between children’s individual characteristics and parental stress (Table 3). On the other hand, there was an association between parental stress and parents’

Table 3 Linear regression analyses with individual factors

	Beta	Sig.	95.0 % CI for beta		Adjusted R ²
			Lower bound	Upper bound	
<i>Child-related</i>					
Sex					
Girl	Ref	–	–	–	–
Boy	–0.016	0.878	–10.387	8.894	–0.01
Age	–0.066	0.519	–2.536	1.289	–0.006
Diagnosis					
Autism	Ref	–	–	–	–
AS	–0.029	0.782	–17.415	13.142	–0.011
PDD-NOS	0.086	0.416	–5.152	12.369	
DQ	–0.158	0.141	–0.349	0.05	0.014
CL					
1	Ref	–	–	–	–
2	–0.040	0.732	–11.982	8.445	–0.021
3	–0.110	0.344	–16.798	5.925	
4	–0.008	0.943	–16.661	17.918	
<i>Parent-related</i>					
Sex					
Woman	Ref	–	–	–	–
Man	–0.011	0.915	–9.020	8.099	–0.010
Age	–0.216	0.032*	–1.665	0.078	0.037
Marital status					
Couple	Ref	–	–	–	–
Single	–0.003	0.974	–19.544	18.901	<0.001
BAP	0.259	0.016*	0.083	0.795	0.056

AS Asperger syndrome, PDD-NOS pervasive developmental disorder-not otherwise specified, DQ (Developmental age (in months)/Chronological age (in months)) × 100, CL communication level, BAP broad autism phenotype

* $p < 0.05$

age, younger parents being more likely to demonstrate higher stress ($\beta = -0.216$; 95 % CI -1.66 to 0.08 ; $p = 0.032$). In addition, a high parental stress score was associated with a high broad autism phenotype score ($\beta = 0.259$; 95 % CI 0.08 to 0.79 ; $p = 0.016$). With regard to family context factors, high expressed emotion ($\beta = 0.653$; 95 % CI 0.60 to 0.93 ; $p < 0.001$), poor quality of parent–child interaction ($\beta = -0.338$; 95 % CI -2.93 to -0.81 ; $p = 0.001$) and poor quality of parent–grandparent interaction ($\beta = -0.296$; 95 % CI -1.81 to -0.38 ; $p = 0.003$) were respectively associated with a higher total parental stress score. Analyses on services available showed that an early diagnosis ($\beta = -0.233$; 95 % CI -3.55 to -0.03 ; $p = 0.020$) and lack of schooling for the child ($\beta = -0.221$; 95 % CI -22.13 to -1.38 ; $p = 0.027$) were respectively associated with high parental stress.

Linear regression results concerning individual and environmental factors are shown in Tables 3 and 4.

Finally, multiple regression analysis was performed with the following measures: parent age, BAP, expressed

emotion, parent–child interaction, extended family interaction, extended family organization, age of child at diagnosis, child’s schooling. Analyses showed that parent–grandparent interaction, expressed emotion and children’s education were associated with parental stress whilst controlling for developmental quotient and children’s age [$F(3) = 37.051$; $p < 0.001$; Adj. $R^2 = 0.457$]. Despite the lack of significant link, development quotient and children’s age were added to the final model as adjustment variables for their theoretical relevance. The model accounted for 45.7 % of the variance in parental stress as shown in Table 5.

Discussion

The main aim of this study was to identify the best predictors of parental stress in ASD by taking into account both individual and environmental factors in an ecological approach. Multiple regression analysis showed that poor quality interactions within the extended family, high levels

Table 4 Linear regression analyses with environmental factors

	Beta	Sig.	95.0 % CI for beta		Adjusted R ²
			Lower bound	Upper bound	
Family context					
Marital interaction	−0.053	0.602	−0.903	0.526	−0.007
Marital organization	−0.066	0.516	−0.737	0.373	−0.006
Parent–child interaction	−0.338	0.001**	−2.926	−0.808	0.105
Parent–child organization	−0.057	0.581	−1.377	0.777	−0.007
Extended family interaction	−0.296	0.003**	−1.813	−0.384	0.078
Extended family organization	−0.273	0.006**	−1.178	−0.199	0.065
Expressed emotion	0.653	<0.001***	0.593	0.953	0.421
Services available					
Age of child at diagnosis (in months)	−0.233	0.020*	−0.355	−0.031	0.045
Time since diagnosis (in months)	−0.165	0.122	−0.808	0.097	0.016
Psycho-educational interventions [<i>n</i> (%)]	−0.146	0.147	−14.943	2.266	0.011
Child’s schooling [<i>n</i> (%)]	−0.221	0.027*	−22.129	−1.372	0.039
Parent support [<i>n</i> (%)]	−0.035	0.732	−12.019	8.47	−0.009
Parent working time (based on 35 h per week)	−0.080	0.431	−3.425	1.472	−0.004

*** *p* < 0.001; ** *p* < 0.01; * *p* < 0.05

Table 5 Predictors of parental stress, multiple regression analysis

Adjusted R ² : 0.457	Beta	Sig.	95.0 % confidence interval for beta		Partial correlations
			Lower bound	Upper bound	
Parents–grandparents interaction	−0.247	0.005*	−1.459	−0.276	−0.312
Expressed emotion	0.535	<0.001***	0.481	0.924	0.579
Child’s schooling	−0.251	0.004*	−21.059	−4.16	−0.317
Child’s age	−0.032	0.707	−1.805	1.23	−0.042
DQ	−0.066	0.439	−0.214	0.094	−0.087

DQ (Developmental age (in months)/Chronological age (in months)) × 100

*** *p* < 0.001; * *p* < 0.05

of expressed emotion and the absence of child’s schooling were associated with higher parental stress scores, regardless of the child’s age and developmental quotient.

Among all the factors included in this study, environmental variables were the most associated with parental stress. Parental stress was not only related to the characteristics of the stressor but also to the resources available in the parents’ environment. This finding is consistent with the Double ABC-X model (McCubbin and Patterson 1983) and confirms the value of a holistic approach to understanding family adaptation (e.g. Bristol 1987; Pozo et al. 2014). Studies to date have mainly focused on the influence of children’s characteristics (e.g. behavioral problems, severity of autism) on parental stress (e.g. Hastings and Brown 2002; Rivard et al. 2014; Tobing and Glenwick 2002). Our study also emphasizes the need to take environmental resources into account, particularly those related to family relations and communication. The level of

emotion expressed to the child and the quality of interaction between parents and grandparents should receive particular attention from professionals in order to better understand parental stress. They constitute risk factors of parental adjustment and should be further addressed in parental support programs. The perceived quality of parent–grandparent relationships should therefore be carefully considered. In our study, it was more predictive than marital interaction, which was previously shown to be an important determinant (e.g. McStay et al. 2014). So far, there have been few studies on the impact of relationships with grandparents on parental stress in ASD, yet grandparents are known to be a source of emotional and instrumental support in several developmental disabilities (Katz and Kessel 2002; Sandler et al. 1995; Trute 2003). Hastings and colleagues found that conflict or disagreement with grandparents was related to mothers’ stress in Down’s syndrome (Hastings et al. 2002). In ASD,

emotional support seems to be more associated with parental stress than instrumental support (Trute 2003). This criterion may seem more secondary than the individual characteristics of parents or children with ASD, but it was one of the best determinants of stress in our study. This result could be due to the fact that grandparent interactions are one indicator of broader informal support. Alternatively, it may be that positive grandparent interactions are related to the availability of respite care, which is associated with reduced stress (Harper et al. 2013). In clinical practice, perceived relationships with grandparents should be evaluated more systematically in order to identify and prevent high-risk parental adjustment. The crucial role of grandparents on parental stress is also underestimated in support programs. Several authors underline the importance of developing programs to support grandparents in order to provide them with the knowledge and skills to care for children (Hastings et al. 2002; Katz and Kessel 2002; Trute 2003). It is also relevant to examine the content of parent support programs with regard to communication and the management of relationships with grandparents.

Secondly, our results show the association between high levels of expressed emotion (EE) and high parental stress (explained 42 % of variance). This link has already been reported in mothers of children with intellectual disabilities (Hastings et al. 2006). In our sample there were as many fathers as mothers with high scores of expressed emotions, so it is crucial to consider parents' perception and emotions felt about children with ASD. In a longitudinal study, Greenberg et al. described the critical impact of parents' expressed emotion on children's behavior (Greenberg et al. 2006). In view of that paper and our results, it seems essential to continue research about expressed emotions in parents of children with ASD. It would be relevant to test their moderating role in the relationship between children's behavior and parenting stress that is often highlighted in the literature (Barker et al. 2011a; McStay et al. 2014; Peters-Scheffer et al. 2012). This seems at least as important as investigating the real clinical profile of the child. Indeed, we found no link between parental stress and the characteristics of the child's disorder such as diagnosis, developmental quotient and the level of communication. This result was very surprising because many studies have highlighted the association between the characteristics of the child's profile and parental adjustment, including stress (e.g. Hastings et al. 2005; Ingersoll and Hambrick 2011; Lin 2011; McStay et al. 2013). Unlike Mori et al. (2009), we did not find a higher level of stress in parents of children with Asperger syndrome compared to parents of children with a diagnosis of autism. Nor are our findings consistent with those of Falk et al. (2014) who reported a link between children's developmental level and parental stress. One explanation could be related to the kind of

measure we used. The tools used in previous studies to evaluate the child's profile were mostly self-reports from questionnaires completed by parents (Davis and Carter 2008; McStay et al. 2013; Samadi et al. 2013), while our two measures (levels of development and communication) were based on direct assessments conducted with the child by a professional. Therefore, it is possible self-administered questionnaires are really sensitive to parental stress, a bias that might partly explain the association found by the others authors. Alternatively, differences with previous studies could be due to our statistical approach (descending stepwise method) and not the actual variables.

This study has several limitations. First, in the category of child individual factors, a more direct measure of behavioral disorders and the severity of the symptoms would have been very helpful. This is particularly important given the robust associations found in previous research on parenting stress among parents of children with autism (e.g. Barker et al. 2011b; Davis and Carter 2008; Hall and Graff 2011; McStay et al. 2013). In addition, the impact of diagnosis might have been weakened by the important size of PDD-NOS group (43 %) which is known to be quite heterogeneous. Therefore, our findings about the importance of environmental factors should be interpreted with caution. Moreover, the cross-over design and statistical approach do not capture dynamically the issue of parental stress and cannot lead to conclusions about causality. Thus, the term "predictors" should not be seen as implying causality but rather as a correlation." Then, one can criticize the use of descending method for multiple regression analysis because it doesn't rely on hypothesis-driven variable selection. Nevertheless, as there remains disagreement between studies about determinants of parental stress, descending method was preferred in order to avoid "type II errors".

As regards the variables evaluated, several require further consideration to analyze the determinants of stress such as the social network and social support. The link between these variables and parental adjustment has already been demonstrated in the literature (Barker et al. 2011b; Benson and Kersh 2011; Cappe et al. 2011; Falk et al. 2014; Giallo et al. 2013; Ingersoll and Hambrick 2011; Siman-Tov and Kaniel 2011). In addition, parents of couples participated in the study, which implies a bias of overrepresentation of some families. We decided to consider a parent as a single statistical individual. In future it would be interesting to complement our analysis and student parent dyads by using the Actor and Partner Interdependence Model (Kenny et al. 2006). This is a specific model for the dyad that allows intra-dyadic analysis through a multilevel modeling approach and the concept of non-independence of the subjects: "If the two scores from the two members of a dyad are non-independent, then those two scores are more similar to (or different from) one

another than are two scores from two people who are not members of the same dyad” Kenny et al. 2006).

Despite its limitations, this study has the advantage of considering both individual and environmental variables as potential vulnerabilities and protective factors of parental adjustment. Our results suggest two important clinical implications in working with parents who have a child with autism. Firstly, it is particularly important to identify parents’ resources through a systematic evaluation of their needs (Derguy et al. 2015). This step makes it possible to prevent and detect risk situations and to guide parents towards appropriate support interventions. Secondly, parents’ support programs should not only address the management of the child’s behavior but should also help parents to identify and to develop new environmental resources.

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Author Contributions C. Derguy conceptualized and designed the study, coordinated and conducted the participant recruitment, data collection and statistical analyses, and drafted the manuscript. K. M’Bailara provided expertise in the conceptualization of the study, coordinated the data collection, revised and reviewed the manuscript. G. Michel & M. Bouvard provided expertise in the conceptualization of the study and coordinated the data collection. S. Roux provided expertise in data management and statistical analyses. All authors approved the final manuscript as submitted.

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