Developmental Disabilities Across the World: A Scientometric Review from 1936 to 2020

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Abstract

Background: Developmental disabilities have been largely studied in the past years. Their etiological mechanisms have been underpinned to the interactions between genetic and environmental factors. These factors show variability across the world. Thus, it is important to understand where the set of knowledge obtained on developmental disabilities originates from and whether it is generalizable to low- and middle-income countries. Aims: This study aims to understand the origins of the available literature on developmental disabilities, keeping a focus on parenting, and identify the main trend of research. Methods and Procedure: A sample of 11,315 publications from 1936 to 2020 were collected from Scopus and a graphical country analysis was conducted. Furthermore, a qualitative approach enabled the clustering

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of references by keywords into four main areas: “Expression of the disorder”, “Physiological factors”, “How it is studied” and “Environmental factors”. For each area, a Document Co-citation Analysis (DCA) on CiteSpace software was performed. Outcomes and Results: Results highlight the leading role of North America in the study of developmental disabilities. Trends in the literature and the documents’ scientific relevance are discussed in details. Conclusions and Implications: Results demand for investigation in different socio-economical settings to generalize our knowledge.

What this paper adds?

The current paper tries to provide insight into the origins of the literature on developmental disabilities with a focus on parenting, together with an analysis of the trends of research in the field. The paper consisted of a multi-disciplinary and multi-method review. In fact, the review tried to integrate the analysis of the relation between developmental disabilities with a closer look at the scientific contributions to the field across the world. Specifically, the paper integrates a total of 11,315 papers published on almost a century of research (from 1936 to 2020). An initial qualitative analysis on keywords was combined to a subsequent quantitative approach in order to maximize the comprehension of the impact of almost a century of scientific contributions. Specifically, documents were studied with temporal and structural metrics on a scientometric approach. This allowed the exploration of patterns within the literature available on Scopus in a quantitative way. This method not only assessed the importance of single documents within the network. As a matter of fact, the Document Co-Citation Analysis used on CiteSpace software provided insight into the relations existing between multiple documents in the field of research. As a result, the leading role of North America in the literature of developmental disabilities and parenting emerged. This was accompanied by the review of the main trends of research within the existing literature.

Keywords: developmental disabilities, parenting, country analysis, CiteSpace, Document Co-citation Analysis, scientometric review

1. Introduction

Developmental disabilities are a group of lifelong conditions in which the individual’s physical, learning, or behavioural functioning is compromised in

4 the early stages of life with various degrees of impairment [1, 2]. This diag-
5 nostic group encompasses the so-called neurodevelopmental disorders (e.g.,
6 attention-deficit / hyperactivity disorder, learning disorders, intellectual dis-
7 abilities, autism spectrum disorder) together with other conditions, such as
8 hearing loss, blindness, stuttering and seizures [3, 4]. Today, what is known
9 is that these conditions have a complex etiology in which both genetic and
10 environmental influences interact and determine the damages or alterations
11 in the development of the nervous system, therefore leading to the disability
12 [5, 6, 7, 8, 9, 10].

13 However, this interplay between genetic and environmental factors has
14 not always been considered as the underlying determinants of developmental
15 disabilities. Until the second half of the past century, some of these conditions
16 were attributed to scarce and inadequate parental care [11]. In this regard,
17 it is worth mentioning the “refrigerator mother theory” [12], in which a lack
18 of maternal warmth was considered the main cause of autism in children,
19 leading to a sense of guilt in the blamed mothers. Although it is known
20 today that autism spectrum disorders, as other developmental disabilities,
21 is not due to a lack of maternal care, nevertheless parental practices have a
22 role in modulating the behavioral outcomes of children with these conditions
23 [13, 14, 15]. In other words, research in the last decades have focused on
24 the regulating role played by caregivers and, especially, the mother. For
25 instance, the positive interactions between caregivers and children with Down
26 syndrome facilitate the children’s language development and this has become
27 a key aspect for interventions [16]. Conversely, early episodes of child neglect
28 are linked to negative outcomes, such as lower intelligence quotient and higher
29 levels of attention deficit/hyperactivity disorder symptoms [17].

30 Despite gains made in current literature about the relationship between
31 parenting practices and child developmental disability, much is still unknown
32 about the precise interactions between parent, child, and other family and
33 external social factors. Particularly, although the “refrigerator mother the-
34 ory” has since been refuted, and attempts at explaining parenting strategies
35 and developmental disabilities have been put forth by our team [18, 19, 20],
36 important distinctions between maternal and paternal caregiving, as well as
37 caregiving from other sources, are still under-explored. For children with de-
38 velopmental disabilities, negative child outcomes are commonly experienced
39 and also contribute to a negative cycle of lower quality parenting and worse
40 prognosis for the entire family unit in the long-term [21]. This pattern of
41 relationships between parent, child and developmental disability can be seen

in, for example, the correlation between parental stress and child behavioral adjustment among the population of children diagnosed with Autism Spectrum Disorder (ASD; [22]). There is thus an impetus to understand how we may best protect this vulnerable population [23], and uplift the main stakeholders in caring for children with developmental disabilities.

Furthermore, global studies of developmental disability and parenting are warranted, due to the presence of larger cultural, socioeconomical, and environmental factors that constitute the larger spheres of influence over the parenting and caregiving microsystem [24]. These macrosystems exert direct and indirect influences on both parenting strategies and resources available for caregiving, as well as overall child development. Unfortunately, prevailing biases with many studies stems from the fact that they are conducted on largely homogeneous demographics [25], with an under-representation from nations that are typically poorer economically or fall outside of the Western world. These differences may result in alternative patterns of results not yet uncovered in current research. For example, parents from African, Middle and East Asian and societies hold beliefs about developmental disability that are different from Western cultures [26, 27], which are subsequently used to inform choices on caregiving methods and resource allocation for these children.

In general, the study of parental practises in relation to developmental disabilities has been studied over the decades and across different countries of the world. The importance of studying developmental disabilities and parenting can be understood by taking a closer look at the results from an epidemiological research conducted by Zablotzky et al. [28], in which the authors detected an increased prevalence of developmental disabilities between 2009 and 2017 among US children aged 3 to 17 years. Together with this high prevalence [29], the tendency to live longer than before for people affected by these conditions is also becoming evident [30, 31, 32]. Both these trends require serious attention for several reasons. For example, the increased prevalence of developmental disabilities is likely to lead to a larger number of service demands [33, 34] which needs to be adequately addressed in both quantitative and qualitative terms. Also, the increased life expectancy for people living with a developmental disability poses new challenges for the educational systems. As a matter of fact, although having a disorder that becomes clear in the early phases of life, this group of patients needs to acquire a set of skills to allow them to acquire autonomy throughout their whole life [35, 36]. This is especially true to guarantee a good degree of autonomy in

the long-term, when caregivers’ help may not be available anymore [37, 38]. For all these reasons, in the past years, educational systems directed their intents on trying to maximize these children’s learning process. To do so, some authors, for instance, have tried to understand if the inclusion of a child with a developmental disability in a class of typically developed children has beneficial outcomes or not [39, 40]. At the same time, other authors have studied the effects of the implementation of specific teaching programs and techniques [41, 42].

Within this framework, in order to contribute to the scientific knowledge on developmental disabilities and parenting, this research aims to provide insights with regards to two key aspects. Firstly, the research tries to estimate the quantity of records published on the relationship between developmental disabilities and parenting by conducting a country analysis. Secondly, this review tries to uncover the research domains that, in a dynamic way, gave rise to the existing literature on developmental disabilities. With this purpose, a scientometric approach based on the analysis of co-citations between publications was adopted to identify the relevant documents and their contribution to the trends that gave shape to the literature of the field in a data-driven approach, as in other publications [43, 44]. Specifically, multiple Document Co-citation Analysis (DCA) were performed in regards to four macro areas, namely Expression of the disorder, Physiological Factors, How it is studied and Environmental factors, identified through a qualitative approach.

2. Methods

2.1. Dataset

For this research, a sample of 11,315 publications dating from 01 January 1936 to 23 March 2020 was collected from Scopus platform. It is relevant to note that the time range of publications depended uniquely on Scopus’ availability and no a-priori temporal exclusion criteria was applied. Specifically, the material was collected by using altogether the string of keywords “TITLE-ABS-KEY (parent* AND (development* AND disorder* OR intellectual AND disab* OR genetic* OR neurodev*)) AND (LIMIT-TO (LANGUAGE, “English”))”. Research keywords were selected to cover a broad sample of publications on developmental disabilities, taking into account both the genetic and the environmental perspectives. In particular, the term referring to parenting (i.e., “parent*”) was included for the broad

115 influence that parent-related responsibilities have in the literature on develop-
116 mental disabilities. Also, when defining the research string, terms of specific
117 disorders (e.g., autism, ADHD) or specific parental aspects were excluded to
118 avoid skewing the research towards specific diagnostic labels.

119 2.2. Country Analysis

120 In order to examine the distribution of publications around the world, an
121 R (R-core base version 4.0.0.) script (involving the libraries “stringr” [45]
122 and “tidyverse” [46]) was used to extract the country’s name from the last
123 author’s affiliation string of each publication. The choice to select the country
124 from the last author’s affiliation was taken because the last author in most
125 cases tended to be the principal investigator of the research. Two R libraries
126 (specifically “rworldmap” [47] and “RColorBrewer” [48]) were subsequently
127 adopted for the design of the world map, in which, with different colours, we
128 represented the number of publications linked to the specific country. Dur-
129 ing the country name extraction, some meaningless strings were obtained and
130 were therefore discarded. These strings were meaningless for errors or incon-
131 sistencies within the registered affiliation strings. Other countries’ names
132 were converted manually when possible.

133 2.3. Document Co-Citation Analysis

134 For the scientometric analysis, all the keywords indexing the publications
135 were collected. Specifically, a number of 37,364 keywords with frequencies
136 ranging from 1 to 12,632 (a value that corresponded to the keyword “fe-
137 male”) was extracted. All the keywords with frequency of appearance lower
138 than 10 were, at this point, excluded from further analysis ($n = 33,044$ key-
139 words). In relation to the topic they represented, the eligible keywords (n
140 $= 4,320$) were inductively classified in broader categories with a qualita-
141 tive approach by 5 independent coders. Subsequently, the classification’s
142 reliability was assessed by two independent supervisors, with a number of
143 corrections that was lower than the 1.00% - making the inter-coders’ re-
144 liability higher than 99.00%. Eventually, this procedure resulted in the
145 identification of 28 categories - namely, “Caregiver”, “Education”, “Envi-
146 ronment”, “Family”, “Government”, “Interpersonal relations”, “Parenting”,
147 “Risk factor”, “Socio-cultural factors”, “Assessment”, “Classification”, “De-
148 mographic”, “Development & Prognosis”, “Epidemiology”, “Symptoms &
149 Behaviour”, “Treatment & Management”, “Country”, “Methods”, “Scien-
150 tific discipline”, “Type of article”, “Type of study”, “Body”, “Etiology”,

151 “Genetic risk”, “Genetics”, “Physiological risk”, “Physiology”, “Pregnancy”.
 152 Following the same inductive procedure, these 28 clusters of keywords were
 153 subsequently grouped in four different areas, regarding the perspective they
 154 represented in the study of developmental disabilities: “Environmental Factors” (N = 324), “Physiological Factors” (N = 1,021), “Expression of the
 155 disorder” (N = 2,400) and “How it is studied” (N = 575). The first two
 156 macro areas - Environmental Factors and Physiological Factors - emerged
 157 from grouping the keywords that referred to terms that are typically consid-
 158 ered as being part of the environmental and physiological factors respectively.
 159 Examples of those keywords for “Environmental Factors” are “maternal de-
 160 privation”, “sibling relations”, “family functioning”, and “early life stress”;
 161 for “Physiological Factors”, example of keywords are “sex factors”, “genetic
 162 predisposition to disease”, and “preterm infant”. On the other hand, the
 163 area “Expression of the disorder” emerged from a set of keywords that re-
 164 ferred to the assessment and the symptoms of developmental disabilities. Ex-
 165 amples of such keywords are “early diagnosis”, “developmental screening”,
 166 “developmental disorder”, “autism”, “brain development”, and “Babinski re-
 167 flex”. Last, the area “How it is studied” included all the keywords referring
 168 to methodological aspects and terms, such as “cohort study”, “controlled
 169 study”, “interview”, and “prospective study”. The publications collected
 170 from Scopus were divided and clustered into their areas, according to their
 171 keywords, following the PRISMA approach (see Figure 1). At this point,
 172 we used CiteSpace software (version 5.7.R2) in order to run a document co-
 173 citation analysis (DCA) for each of the four identified areas. The document
 174 co-citation method allows one to examine the frequency in which multiple
 175 documents have been cited together (or co-cited) by subsequent documents.
 176 Thus, the network generated with the DCA depends on both citing - the
 177 ones downloaded directly from Scopus - and cited documents. In this way,
 178 thematic domains in the scientific landscape emerge automatically in a data-
 179 driven fashion in the form of clusters of cited and citing documents [49].
 180 In all the CiteSpace DCAs, we adopted the TOP N node selection criteria,
 181 which creates a network by selecting the N most cited documents from each
 182 temporal slice among the data pool [50]. Specifically, we chose TOP N = 10
 183 for all the four macro-areas of our interest. This value was chosen following
 184 the recommendations by Chen [51], where reliable networks would have a
 185 number of “7-10 major clusters with 10 or more members and each of the
 186 clusters has high silhouette values (e.g. >0,70)”. Structural and temporal
 187 metrics were subsequently used to examine the final networks. Specifically,
 188

among the structural metrics, we outputted the silhouette score, the modularity Q and the betweenness centrality. The silhouette metric indicates the inner homogeneity of a cluster [51] and ranges between -1 and 1; when its value is high, the cluster can be considered internally consistent as well as distinct from other clusters [51]. The modularity Q index, instead, is a metric which ranges from 0 to 1 and indicates the extent to which the network is divisible into modules [50, 51]. A high value for the modularity Q metric would indicate that clusters within the network are easily separable from one another. Lastly, for the structural metrics, betweenness centrality indicates, for each node, the extent to which the node (i.e., publication in the network) connects otherwise separate nodes in the network [52, 50]. In other words, high values in the betweenness centrality metric indicates a crucial role for the specific document within the network. Using Kuhn’s philosophical view [53], groundbreaking publications are potentially defined by a high betweenness centrality because of their role in changing the trends and the interests of the “normal science” of their times and connecting it with a different group of researches. The temporal metric employed in this study was the citation burstness, which refers to a sudden increase of the number of citations for a specific node in the network [51]. Structural and temporal metrics, specifically betweenness centrality and citation burstness, are combined in order to obtain sigma indicator, whose values range from 0 to 1 [51], with higher values indicating a higher likelihood of research impact and innovation.

3. Results

3.1. Country Analysis

The results of the country analysis conducted using R software are displayed in Figure 2. The obtained picture represents the number of publications regarding developmental disabilities for each country of the world. In the map, we used different colours on a logarithmic scale in order to indicate the amount of papers linked to the specific country. Publication frequencies among countries range from 1 to 4,581. The map reports that, in the past century, the study of developmental disabilities has interested the majority of the countries in the world, highlighting the importance of this field of research again. A massive role in the study of developmental disabilities is played by North America. As it is reported in the map, the four countries leading the area of research in the world are all anglophones: the United

Figure 1: PRISMA diagram for the identification of the four main areas in the literature regarding developmental disabilities.

225 States ($n = 4,581$), followed by the United Kingdom ($n = 1,257$), Canada (n
226 $= 658$) and Australia ($n = 555$).

227 3.2. Expression of the disorder

228 The first area of research we identified in our keywords analysis was “Ex-
229 pression of the disorder”. Starting from 11,045 qualified references published
230 between 1956 and 2020, the resulting network computed with the DCA con-
231 sisted in 597 nodes and 1,535 links, showing a modularity Q index of 0.9043
232 and a weighted mean silhouette of 0.9712. These values indicate that the
233 network is highly divisible into modules and that, on average, these modules
234 have a high extent of inner coherence.

235 The largest cluster in the network, cluster #0, included 61 nodes and,
236 therefore, covered the 10.21% of the network. This cluster had a high sil-

Figure 2: Frequencies of publications regarding developmental disabilities around the world

houette of 0.95 and 1993 was the year in which the publications were, on average, published. The second largest cluster, cluster #1, had a size of 56 references (representing the 9.38% of the network) and a silhouette of 0.956. 2008 was the mean year of publication. An amount of 42 nodes (7.04% of the network) were gathered together forming cluster #2. The silhouette value for this cluster was 0.962 and the nodes, on average, had a publication year corresponding to 2013. Therefore, regarding the topic of the nodes, this cluster was highly consistent and, regarding the mean year of publication, could be considered as a recent view on the study of developmental disabilities. Cluster #4, at the end, included 29 references (representing the 4.86% of the number of nodes in the network) and showed a silhouette of 1 with 1998 as a mean year of publication. Given the silhouette values of these clusters, we can therefore consider them as strongly internally consistent.

Table 1 reports the 15 strongest citation bursts computed using the DCA on “Expression of the disorder”. It emerged that 54 references among the network had a burst on their history. It is notable that the 4 references with the strongest burst belonged to cluster #2. Specifically, the publication by Boyle et al. [29] had the strongest burst of the network, with a strength of 26.63, and the one which lasted the longest, with a span of 7 years. Among other clusters, Simonoff et al. [54] (cluster #1) had a publications in 2008

Reference	Strength of burstness	Year	Beginning of burstness	End of burstness	Burst duration	Sigma	Centrality
Boyle et al. [29]	26.63	2011	2013	2020	7	12.87	0.10
Association et al. [55]	23.30	2013	2017	2020	3	1.05	0.00
Richards et al. [56]	22.94	2015	2017	2020	3	1.34	0.01
Lek et al. [57]	17.93	2016	2017	2020	3	1.14	0.01
Simonoff et al. [54]	15.80	2008	2010	2015	5	2.86	0.07
Caspi et al. [58]	15.32	2003	2006	2011	5	1.03	0.00
Caspi et al. [59]	15.21	2002	2005	2010	5	3.11	0.08
Baker et al. [60]	15.15	2002	2004	2010	6	1.55	0.03
Baker et al. [61]	13.86	2003	2007	2011	4	2.59	0.07
Marshall et al. [62]	12.66	2008	2010	2012	2	1.15	0.01
Fraser et al. [63]	11.81	2013	2017	2020	3	1.08	0.01
Sebat et al. [64]	11.54	2007	2009	2012	3	1.13	0.01
Hallmayer et al. [65]	11.18	2011	2013	2014	1	1.46	0.03
Pinto et al. [66]	10.40	2010	2011	2016	5	1.17	0.02
Sanders et al. [67]	10.00	2012	2013	2014	1	1.27	0.02

Table 1: Sample of publications with high citation burstness metrics generated in the DCA for *Expression of the disorder*

with a citation burst of 15.8 and a duration of 5 years and A. Caspi (cluster #4) had two researches, published in 2003 and 2002, respectively with a citation burst of 15.33 and 15.21, both having a span of 5 years. All these publications with high magnitude regarding the citation burst can be considered as milestones in the study of developmental disabilities and parenting.

From table 2, which represents the 10 references with the highest values for betweenness centrality and the 10 with the strongest magnitude of sigma metric, the three references with the highest value of betweenness centrality were Risch et al. [68], Chakrabarti and Fombonne [69] and Piven et al. [70], all corresponding to 0.23. Moreover, the work by Risch et al. [68] and by Chakrabarti and Fombonne [69], both belonging to cluster #6, showed high centrality and high sigma values, being among the three references with the highest magnitude for each parameter of interest. In particular, they showed sigma values of 6.47 and 4.16 respectively.

3.3. Physiological Factors

The second area, labelled as “Physiological Factors”, consisted in 9,928 qualified Scopus references published from 1962 to 2020. By computing a DCA, an amount of 646 nodes connected by 1,697 links defined the final network, which, by structural metrics, was described as highly divisible into modules, each of which was, on average, highly homogeneous (modularity Q index = 0.9155; weighted mean silhouette = 0.9645).

Examining the clusters configuration among the references forming the network, it was reported that the 7.59% of the total number of nodes was covered by cluster #1, which had a size of 49 publications highly consistent

Reference	Centrality	Cluster
Risch et al. [68]	0.23	6
Chakrabarti and Fombonne [69]	0.23	6
Piven et al. [70]	0.23	0
Zwaigenbaum et al. [71]	0.17	1
Baron-Cohen et al. [72]	0.16	0
Boyle et al. [29]	0.10	2
on DSM-IV. [73]	0.10	0
Kramlinger and Post [74]	0.09	18
Plotsky and Meaney [75]	0.09	0
Caspi et al. [59]	0.08	4
Reference	Sigma	Cluster
Boyle et al. [29]	12.87	2
Risch et al. [68]	6.47	6
Chakrabarti and Fombonne [69]	4.16	6
Zwaigenbaum et al. [71]	3.23	1
Caspi et al. [59]	3.11	4
Simonoff et al. [54]	2.86	1
Baker et al. [61]	2.59	12
on DSM-IV. [73]	1.74	0
Abbeduto et al. [76]	1.55	12
Baker et al. [60]	1.55	12

Table 2: Centrality and sigma computed via DCA for *Expression of the disorder*

281 with each other (silhouette: = 0.972). On average, the papers forming this
 282 cluster were published in 2000. Thus, cluster #1 included references posi-
 283 tioning across the second and the third millennium. Cluster #2, with its 44
 284 nodes (6.81% of the network), was the second largest group of references in
 285 the network. The silhouette value for this cluster corresponded to 0.94 and,
 286 on average, its references were published quite recently, in 2012. 5.88% of the
 287 nodes ($N = 38$) gathered forming cluster #3, which showed a silhouette of
 288 0.95. For this cluster 2007 was the year in which, on average, the references
 289 were published. Last, cluster #4 had a similar size of cluster #3, with 37
 290 nodes (5.73%) and, on the other hand, a higher silhouette value of 0.974.
 291 Cluster #4 was the “youngest” major cluster of the network, having 2015 as
 292 the mean year of publication.

Reference	Strength of burstness	Year	Beginning of burstness	End of burstness	Burst duration	Sigma	Centrality
Boyle et al. [29]	24.42	2011	2013	2018	5	8.01	0.09
Richards et al. [56]	22.89	2015	2016	2020	4	2.10	0.03
Lek et al. [57]	17.01	2016	2017	2020	3	1.13	0.01
Caspi et al. [59]	15.50	2002	2005	2010	5	2.61	0.06
Marshall et al. [62]	14.11	2008	2009	2012	3	1.75	0.04
O’Roak et al. [80]	13.74	2012	2014	2016	2	1.16	0.01
Caspi et al. [58]	12.56	2003	2006	2011	5	1.09	0.01
Li and Durbin [81]	12.11	2009	2012	2016	4	1.46	0.03
Baker et al. [60]	11.95	2002	2007	2010	3	1.00	0.00
Association et al. [55]	11.62	2013	2018	2020	2	1.60	0.04
Fraser et al. [63]	11.53	2013	2017	2020	3	1.00	0.00
Sebat et al. [64]	11.37	2007	2009	2012	3	1.36	0.03
Baker et al. [61]	11.10	2003	2007	2011	4	1.36	0.03
Pinto et al. [66]	10.67	2010	2011	2016	5	1.12	0.01
Hallmayer et al. [65]	10.54	2011	2013	2014	1	1.62	0.05

Table 3: Sample of publications with high citation burstness metrics generated in the DCA for *Physiological Factors*

55 nodes showed a citation burst in the area regarding “Physiological Factors”. References reported in Table 3 are the 15 with the strongest magnitude of burst. It is notable that, also in this cluster, the reference with the strongest citation burst among the network, with a value of 24.42, was authored by Boyle et al. [29]. When considering the duration of burstness, Zwaigenbaum et al. [71] (strength of burstness = 7.35) was the node with the longest timespan, which corresponded to 6 years. Several references had a burst duration of 5 years: Boyle et al. [29], Caspi et al. [59] (strength of burstness = 15.50), Caspi et al. [58] (strength of burstness = 12.56), Pinto et al. [66] (strength of burstness = 10.67), Rauch et al. [77] (strength of burstness = 9.35), Fombonne [78] (strength of burstness = 5.05), Glascoe [79] (strength of burstness = 4.28) and Chakrabarti and Fombonne [69] (strength of burstness = 4.18).

Table 4 shows the 10 references with highest values of betweenness centrality or sigma metrics. Specifically, the works by Zwaigenbaum et al. [71] (centrality = 0.12; sigma = 2.36) and Boyle et al. [29] (centrality = 0.09; sigma = 8.01) appeared in both sections of the table among the three references with the strongest magnitude for the metric considered. Therefore, these two publications were highly influential in the field of developmental disabilities and also introduced scientific novelties in this area of research.

3.4. How it is studied

The third area obtained with the qualitative clustering of keywords was “How it is studied”. For the DCA, the eligible publications indexed using these keywords were 10,513 and they were published between 1956 and 2020.

Reference	Centrality	Cluster
Zwaigenbaum et al. [71]	0.12	2
Chakrabarti and Fombonne [69]	0.10	1
Boyle et al. [29]	0.09	2
Lefebvre et al. [82]	0.09	8
Auranen et al. [83]	0.09	8
Baio et al. [84]	0.08	4
Fombonne [78]	0.07	1
Fombonne [85]	0.07	1
Caspi et al. [59]	0.06	12
Sand et al. [86]	0.06	1
Reference	Sigma	Cluster
Boyle et al. [29]	8.01	2
Caspi et al. [59]	2.61	12
Zwaigenbaum et al. [71]	2.36	2
Richards et al. [56]	2.10	2
Marshall et al. [62]	1.75	3
Hallmayer et al. [65]	1.62	2
Association et al. [55]	1.60	4
Chakrabarti and Fombonne [69]	1.48	1
Li and Durbin [81]	1.46	2
Rauch et al. [77]	1.45	2

Table 4: Centrality and sigma computed via DCA for *Physiological Factors*

317 CiteSpace computed a network formed by 658 nodes connected with each
318 other by 1,755 links and with modularity Q index and weighted mean sil-
319houette of 0.8953 and 0.9678 respectively. These values indicate a network
320highly divisible into highly homogeneous clusters.

321 In this macro-area of research, cluster #0, the biggest one of the network,
322 was a group of 70 nodes (10.64% of the network) highly related with each
323 other (silhouette = 0.912). The publications grouped in this cluster were on
324 average published in 2008, allowing us to consider this as a recent area of
325 research. Cluster #1 consisted, instead, of 54 nodes (covering the 8.21% of
326 the network) having a silhouette value of 0.953 and 1993 as the mean year of
327 publication. Given the year that on average the references were published,
328 this cluster is the oldest one in the first four clusters. Cluster #2 with a size

Reference	Strength of burstness	Year	Beginning of burstness	End of burstness	Burst duration	Sigma	Centrality
Boyle et al. [29]	24.90	2011	2013	2020	7	110.03	0.21
Richards et al. [56]	23.08	2015	2016	2020	4	2.80	0.05
Lek et al. [57]	16.81	2016	2017	2020	3	1.05	0.00
Caspi et al. [59]	16.31	2002	2005	2010	5	1.93	0.04
Simonoff et al. [54]	16.00	2008	2010	2015	5	1.93	0.04
Association et al. [55]	15.35	2013	2018	2020	2	1.00	0.00
Caspi et al. [58]	14.34	2003	2006	2009	3	1.33	0.02
Marshall et al. [62]	13.94	2008	2009	2012	3	1.30	0.02
O’Roak et al. [80]	13.80	2012	2014	2016	2	1.18	0.01
Adzhubei et al. [87]	13.25	2010	2013	2018	5	1.10	0.01
Baker et al. [61]	13.11	2003	2004	2011	7	1.32	0.02
Fraser et al. [63]	12.13	2013	2017	2020	3	1.08	0.01
Baker et al. [60]	11.74	2002	2004	2010	6	1.05	0.00
Hallmayer et al. [65]	11.48	2011	2013	2014	1	1.34	0.03
Sebat et al. [64]	11.23	2007	2009	2012	3	1.16	0.01

Table 5: Sample of publications with high citation burstness metrics generated in the DCA for *How it is studied*

of 45 nodes represented the 6.84% of the network. This cluster showed a high silhouette value of 1 and a recent temporal location with 2015 as its mean year of publication. Lastly, cluster #3 was composed by 33 nodes highly consistent with each other (silhouette value = 0.995) and a mean publication year corresponding to 1999.

For “How it it studied”, 65 nodes in the network showed a citation burst (see Table 5 in which the 15 references with the strongest citation burst are reported). It is relevant that, among the 10 publications with the highest burst magnitude, 4 belonged to cluster #5. Specifically, the first authors of these references are, in order of strength, Richards et al. [56] (strength of burstness = 23.08), Lek et al. [57] (strength of burstness = 16.81), O’Roak et al. [80] (strength of burstness = 13.80) and Adzhubei et al. [87] (strength of burstness = 13.25). Not only the work by Boyle et al. [29] was the one with the strongest burst but also the one with the longest burst duration (having a span of 7 years, as the node by Baker et al. [61]).

Table 6 reports the references with the highest values of betweenness centrality and sigma (specifically, the top 10 references for each metric). As for the previous cluster, the works by Zwaigenbaum et al. [71] (centrality = 0.25; sigma = 5.54) and Boyle et al. [29] (centrality = 0.21; sigma = 110.03) resulted as influential and innovative papers for their times. Specifically, the publication by Boyle et al. [29] had the highest sigma value among the network, almost 20 times bigger than the one computed for the second reference cited in the table. Other references that appeared in both sections of the table were the ones authored by Baird et al. [88] (centrality = 0.22; sigma = 2.49), on DSM-IV. [73] (centrality = 0.13; sigma = 2.11) and Chakrabarti

Reference	Centrality	Cluster
Zwaigenbaum et al. [71]	0.25	0
Baird et al. [88]	0.22	8
Boyle et al. [29]	0.21	0
Osterling and Dawson [89]	0.21	15
Baron-Cohen et al. [72]	0.16	1
on DSM-IV. [73]	0.13	1
Chakrabarti and Fombonne [69]	0.09	8
Rutter et al. [90]	0.09	3
Dawson [91]	0.09	0
Kramlinger and Post [74]	0.09	15
Reference	Sigma	Cluster
Boyle et al. [29]	110.03	0
Zwaigenbaum et al. [71]	5.54	0
Richards et al. [56]	2.80	5
Baird et al. [88]	2.49	8
on DSM-IV. [73]	2.11	1
Simonoff et al. [54]	1.93	0
Caspi et al. [59]	1.93	3
Chakrabarti and Fombonne [69]	1.84	8
Risch et al. [68]	1.73	8
Trouton et al. [92]	1.55	3

Table 6: Centrality and sigma computed via DCA for *How it is studied*

and Fombonne [69] (centrality = 0.09; sigma = 1.84).

3.5. Environmental Factors

The last area of interest, “Environmental factors”, was delineated by a number of 9,541 qualified Scopus references published between 1964 and 2020. The TOP N = 10 criteria created a network composed by 622 nodes with 1,498 connections. The final network showed a modularity Q index of 0.9014 and weighted mean silhouette of 0.9581. Considering these two metrics, the network was highly divisible into modules that, on average, were highly consistent.

Examining the clusters configuration underlying the macro-area, we could observe that cluster #0, the largest one with a size of 47 nodes, covered the

7.56% of “Environmental Factors”. Furthermore, this cluster resulted to have a silhouette index of 0.966 and a mean year of 2009. Cluster #1 and cluster #2 had a mean year of publication placed in the past century (1997, 1996, respectively). The second largest group of nodes, cluster #1, consisted in a gathering of 41 references (6.59% of the network) with a good consistency (silhouette = 0.89). Cluster #2 was formed by 35 nodes highly consistent with each other (silhouette = 0.938). This cluster had a coverage of 5.63% of the network and it could be considered as the oldest one among the four largest clusters of the network. Finally, cluster #3, with a size of 31 nodes consisted in the 4.98% of the network. The silhouette value, specifically 0.997, for this cluster was high, indexing a high inner consistency for the cluster. 2014 was the year in which, on average, the references of this cluster were published. Hence, among the four largest clusters, cluster #3 was the youngest one.

Among the 55 references with a citation burst, table 7 reports 15 of them. Overall, it is relevant that 19 references over the 55 with a citation burst belonged to cluster #0, which, despite being quite recent, was highly influential in the study of the environmental factors of developmental disabilities and parenting. Specifically, the work by Boyle et al. [29] was, once again, the one with the highest magnitude of citation burst in the network, with a strength of 26.57. Its timespan of 5 years was the second longest burst duration after the publication authored by Zwaigenbaum et al. [71], which showed a burst duration of 6 years and a strength of 7.47. Within the network, other references had their burst spanning for 5 years. Specifically, ordered by strength of burstness, these references were authored by: Caspi et al. [59] (strength of burstness = 15.58), Caspi et al. [58] (strength of burstness = 13.35), Adzhubei et al. [87] (strength of burstness = 11.91), Simonoff et al. [54] (strength of burstness = 10.34), Glascoe [79] (strength of burstness = 4.89) and Fombonne [78] (strength of burstness = 4.51).

Table 8 shows references with highest betweenness centrality and highest sigma values. Specifically, the node with the highest value in regards of the centrality was authored by Hayes and Watson [96] (centrality = 0.20). Similarly, high centrality values were obtained for the works by Chakrabarti and Fombonne [69] (centrality = 0.17), which belonged to cluster #1, Dawson et al. [97] (centrality = 0.16) and Zwaigenbaum et al. [71] (centrality = 0.15), both belonging to cluster #0. Considering sigma metric, the research by Boyle et al. [29] resulted to be the one with the highest value (sigma = 10.86). Therefore this reference represented a novelty in the study of developmental

Reference	Strength of burstness	Year	Beginning of burstness	End of burstness	Burst duration	Sigma	Centrality
Boyle et al. [29]	26.57	2011	2013	2018	5	10.86	0.09
Richards et al. [56]	17.69	2015	2017	2020	3	1.69	0.03
Caspi et al. [59]	15.58	2002	2005	2010	5	1.69	0.03
Association et al. [55]	15.56	2013	2018	2020	2	1.00	0.00
Baker et al. [61]	13.55	2003	2007	2011	4	5.84	0.14
Caspi et al. [58]	13.35	2003	2006	2011	5	1.32	0.02
Marshall et al. [62]	12.98	2008	2009	2012	3	1.30	0.02
Ozonoff et al. [93]	12.08	2011	2014	2018	4	1.13	0.01
Adzhubei et al. [87]	11.91	2010	2013	2018	5	1.03	0.00
Sebat et al. [64]	11.34	2007	2009	2012	3	1.22	0.02
Baker et al. [60]	11.32	2002	2007	2010	3	1.02	0.00
Fombonne [94]	11.20	2009	2012	2014	2	1.41	0.03
Estes et al. [95]	11.06	2009	2013	2015	2	1.38	0.03
Simonoff et al. [54]	10.34	2008	2010	2015	5	1.45	0.04
Hallmayer et al. [65]	10.07	2011	2013	2014	1	1.33	0.03

Table 7: Sample of publications with high citation burstness metrics generated in the DCA for *Environmental Factors*

disabilities, as it was already reported in the other clusters.

4. Discussion

4.1. Country Analysis

Examining the distribution of articles across the world is important in order to analyse the areas interested in developmental disabilities with a focus on parenting in a socio-cultural perspective, with a good insight into where our knowledge comes from and how representative it is of the world surrounding us. What emerged from the country analysis was that the geographical distribution of publications resulted to be strongly centered on data provided by the four main anglophone countries of the world: the United States, the United Kingdom, Canada and Australia. Specifically, researchers working in North America have provided almost half of the analyzed publications. This is meaningful, for it indicates that a large majority of what we know today about developmental disabilities comes from a single country. Hence, the problem and challenge for future works is to understand the degree in which what we have learnt on developmental disabilities from studies conducted in North America is generalizable and applicable to the population living in the rest of the world. As a matter of fact, the results of the current paper are in line with the “WEIRD population problem”. Indeed, as reported by Henrich et al. [25] and Nielsen et al. [100], psychology highly relies on data collected from Western, Educated, Industrialized, Rich and Democratic (WEIRD) societies. This becomes a problem if we consider that people from WEIRD societies are, using the words of Henrich and colleagues, “some of the most

Reference	Centrality	Cluster
Hayes and Watson [96]	0.20	3
Chakrabarti and Fombonne [69]	0.17	1
Dawson et al. [97]	0.16	0
Zwaigenbaum et al. [71]	0.15	0
Baker et al. [61]	0.14	10
Smedje et al. [98]	0.13	10
Johnson et al. [99]	0.10	0
Baio et al. [84]	0.10	5
Baird et al. [88]	0.10	1
Boyle et al. [29]	0.09	0
Reference	Sigma	Cluster
Boyle et al. [29]	10.86	0
Baker et al. [61]	5.84	10
Hayes and Watson [96]	5.39	3
Zwaigenbaum et al. [71]	2.81	0
Chakrabarti and Fombonne [69]	2.73	1
Dawson et al. [97]	2.52	0
Risch et al. [68]	1.88	1
Johnson et al. [99]	1.82	0
Caspi et al. [59]	1.69	14
Richards et al. [56]	1.69	15

Table 8: Centrality and sigma computed via DCA for *Environmental Factors*

psychologically unusual people on Earth”, for they represent the 12% of the world’s population. Therefore, the reliance on data collected in WEIRD societies is linked to the under-representation of the rest of the world, especially for low- and middle-income countries.

The same applies to the study of developmental disabilities, a series of conditions with a complex etiology in which several genetic and environmental factors are involved. As a matter of fact, genetic causes of developmental disabilities show some variations across countries [101, 102]. For instance, in West African countries a relevant percentage of children is affected by inherited haemoglobinopathies which lead to an increased risk for health and development complications [103]. At the same time, environmental factors affecting the development are different across countries [102]. For instance,

in low- and middle-income countries, pregnant women are more likely to expose the fetus to imbalanced intake of macro- and micronutrient [104, 105], which in turn can affect the child’s optimal development [106]. As for the nutritional intake, factors such as infections and environmental toxins (e.g., rubella, syphilis, HIV, polio) exposure, which can strongly impact the fetus development [107, 108, 109], shows variations across countries that can not be understood if looking uniquely to data coming from North America. For instance, in low-income countries of Africa, the main cause of disability is the exposure to infectious diseases, such as malaria, polio and leprosy [110]. Also, rubella is another infectious cause of disability and its exposure is more common in low-income countries than wealthier ones [111, 112].

By understanding these factors underlying developmental disabilities in low- and middle-income countries, more efficient screening and disorder’s management practices would be guaranteed. This is especially important in light of the evidence indicating that prevalence rates of developmental disabilities seem to be higher in low-income countries when compared to wealthier ones [102]; and the same correlation is found if considering the socioeconomical status of the family within a specific country [113, 114].

In conclusion, researches aiming to examine the gaps in the existing literature in less explored population would be precious in order to better understand developmental disabilities under an idiographic, country- and culture-based approach. The single individual would be back at the center of the attention and considered as a complex result of the interaction between biological, social and psychological factors.

4.2. Document Co-Citation Analysis

In this section, the content of the most important clusters within each of the four identified macro-areas is summarized. For the overlap of documents between macro-areas, in each of the following sections, only the documents belonging to the major clusters and that were related to the specific macro-area were selected and presented (N = 49 for Expression of the disorder; N = 61 for Physiological factors; N = 61 for How it is studied; N = 39 for Environmental factors). Moreover, clusters are presented in chronological order.

4.2.1. Expression of the disorder

“Expression of the disorder” refers to a group of researches where the focus is on the description of the disorders, whether for assessment or treat-

ment/management purposes, as it emerges from the publication by Beitchman et al. [115], which was among the major citers of the cluster. Cluster #0 consisted in publications aiming to describe disorders with difficulties in communication, such as language disorders in particular, but also autism spectrum disorders (as testified by the publication of Howlin et al. [116], which was the major citer node in the cluster). For both classes of disorders, the cluster included publications which aimed to implement new assessment opportunities. In fact, part of the scientists interested in understanding autism have focused their work on the early detection of the disorder. Particularly, Baron-Cohen et al. [72] showed the possibility of the early detection of autism in 18-month-old toddlers, thanks to the development of the Checklist for Autism in Toddlers (CHAT). Osterling and Dawson [89], during the same years, used home videotapes in order to identifying atypical behaviours in autistic 1-year-old children. On the other hand, for what regards specific language impairment, the publication authored by Tomblin et al. [117] focused on developing a system (the EpiSLI) allowing the diagnosis of the disorder in kindergarten children. As a matter of fact, from what it is reported in the network, the interest on language disorders also branched towards the description of development of the disorder. Studies in the network focusing on this topic were mainly authored by H.W. Catts and J.H. Beitchman. Specifically, the former focused on showing a relationship between speech-language impairment in kindergarten and reading disabilities on the follow-up on first and second grades [118]. The latter, instead, authored three works, in which follow ups were conducted in order to assess the outcomes in speech and language-impaired children [119, 120, 121]. The second major citer in the cluster (the publication authored by Cohen et al. [122]) focused their attention on the social cognitive processing and psychiatric disorders in children with identified and unsuspected language impairments. Other relevant papers in the cluster focused on the management of the disorders. Specifically, for what concerns language impairment, Dale et al. [123], Hemmeter and Kaiser [124] and Girolametto et al. [125] explored the results for some intervention technique, such as parent-child book reading, milieu teaching and interactive focused stimulation. On the side of autism, Koegel et al. [126] addressed the problem of stress in mothers of autistic children.

Cluster #4 consisted in publications exploring the Gene-Environment paradigm in order to understand normal and pathological behaviours. For what concerns the expression of the disorder, fewer works focused on the assessment of disorders. Specifically, these authors mainly analysed the efficacy

of diagnostic instruments, such as the Rutter scales [127], The Strength and Difficulties Questionnaire [128] and the ASEBA Form [129].

A large amount of publications gathered together to form Cluster #1 focused their attention on the genetic analysis of autism (as highlighted by some of the major citing publications [130, 131, 132]). For what regards the “Expression of the disorder”, some works in the cluster have deepened the understanding of the epidemiology of developmental disabilities. In fact, this second cluster included works which aimed to study the distribution of autism spectrum disorders [133, 134, 135], attention deficit hyperactivity disorder [136] and/or other developmental disabilities [94] across the world. In regards to the assessment and the diagnosis of the disorders, the studies of Zwaigenbaum et al. [71] and Johnson et al. [99] resulted to be central (as testified by their citation burst) for the study of autism, whereas, for developmental disabilities in general, a screening instrument (Bayley Scales of Infant and Toddler Development) was developed by Bayley [137]. The presence of other disorders in patients with autism was also taken into account by other scientists. For instance, some of them focused their studies on the comorbidity of psychiatric disorders [54] or also other intellectual disabilities [138] on patients with autism. The importance of the work by Simonoff and collaborators (2008) is highlighted by the high citation burst detected for this reference. Finally, management of autism was considered by the publications of Osborne et al. [139], Dawson [91], Whittingham et al. [140], Dawson et al. [97], in which the authors examined the efficacy of different types of management or prevention of the disorder, such as the Early Start Denver Model (ESDM), early teaching interventions and the Stepping Stones Triple P.

Cluster #2 had three main trends on the references that were composing it. First, the interest on the genetics underlying different developmental disabilities or psychiatric conditions (testified by the top citing nodes among the cluster [141, 142]). Second, the focus on the usefulness of the genetics diagnosis in several disorders. Third, the epidemiology of autism and developmental disabilities. Reserving the first point for the discussion regarding physiological risks, second and third trends deserve to be examined with a closer eye, for the role played by the development of the DSM-5 [55], which was the reference with the second largest citation burst among the network. As regards the assessment, some scientists reported the importance of a molecular analysis for the diagnosis of suspected genetic disorders [143, 144, 145, 146, 147]. The most important citing work within the cluster [148] focuses on the genomic diagnosis of children with intellectual disabilities and developmental

550 delay. Furthermore, in relation to the introduction of DSM-5, Reilly et al.
 551 [149] analysed the exclusion of Specific Language Impairment from the new
 552 diagnostic manual. The third branch of researches in the cluster focused on
 553 studying the distribution of disorders across the world. In particular, the
 554 reference authored by Boyle et al. [29], Elsabbagh et al. [150] and Zablotsky
 555 et al. [151] focused on the prevalence of different developmental disabilities,
 556 whereas Kim et al. [152], Baio et al. [84] mainly concentrated their work
 557 on autism. The work authored by Boyle and collaborators (2011) had the
 558 largest citation burst of the network.

559 4.2.2. *Physiological factors*

560 “Physiological factors” is an area of research which, as suggested by the
 561 name, consists in the interest on different fields such as genetics, physiology,
 562 anatomy in order to investigate the underlying basis of typical and atyp-
 563 ical behaviours. In particular, publications in cluster #1 mainly focused on
 564 the physiological risk and the possible outcomes linked to low birth weight
 565 [153, 154, 155] or preterm birth [156, 157, 158, 159, 160]. In the study by
 566 Mercer et al. [161], which was among the major citing nodes of the clus-
 567 ter, parents of children with autism spectrum disorders were asked to report
 568 which in their opinion were the causes of the condition of their children. In
 569 general those parents reported a strong self-reported feeling of guilt for their
 570 children’s condition, and the factors that they considered as causes of autism
 571 spectrum disorders were genetic influences, perinatal and prenatal factors,
 572 nutrition and also vaccines. As a matter of fact, the link between vaccines
 573 and autism spectrum disorders finds its origins from the retracted publica-
 574 tion by Wakefield et al. [162], where a link between the triple vaccine for
 575 measles, mumps and rubella (MMR) and autism was presented. From the
 576 publication of this controversial article, scientists started to try replicating
 577 the results, without much success [163, 164, 165]. Autism itself was largely
 578 studied in the cluster and especially in regards to the concept of broader
 579 autism phenotype together with the heterogeneity in the manifestations of
 580 such condition [166, 70]. Moreover, Risch et al. [68] focused on the genetic
 581 causes underlying the disorder. This last work obtained the highest citation
 582 burst among the cluster.

583 Exploring the genetic risks underlying the development of autism spec-
 584 trum disorders was also the main purpose of the major part of the references
 585 belonging to cluster #3. In particular, autism’s genetics has been described
 586 in the articles by Muhle et al. [167] and Abrahams and Geschwind [168]. As

587 a matter of fact, researchers focused on the study of CNVs [64, 62, 169, 66]
588 whereas some of them specifically looked at microdeletions and microdu-
589 plications [170, 171, 172]. The interest towards the genetic of autism was
590 accompanied by the exploration of the possible existing broader autism phe-
591 notype, with studies that found evidence it especially when examining fathers
592 [173, 174]. Globally, the works by Sebat et al. [64], Marshall et al. [62] and
593 Pinto et al. [66] were highly relevant in the cluster, as reported by their high
594 citation bursts.

595 References composing cluster #2 were mainly centered on examining
596 the genetic risk in several disorders, such as Cerebral Visual Impairment
597 [175], X-linked intellectual disability [176], Rett syndrome [177] and autism
598 spectrum disorders [178]. Moreover, the genetic heritability in autism spec-
599 trum disorders was quantified in a twin study conducted by Hallmayer et al.
600 [65]. Other group of researchers specifically focused on *denovo* mutations
601 [179, 80, 67, 180, 181] or copy number variations (CNVs) [130, 182, 183, 184]
602 underlying the same condition. Within the cluster, the genetic configuration
603 of several disorders has been explored as well. In fact, the commentary by In-
604 sel et al. [185] expressed the appreciation of the scientific community towards
605 a new way of classifying disorders, focusing more on pathophysiological crite-
606 ria rather than the classical behavioral diagnostic categories. Following this
607 trends of research, *denovo* mutations, which are mainly of paternal origin and
608 whose number depends on paternal age [186], have been analysed in epileptic
609 encephalopathies [187, 142], non-syndromic intellectual disability [77] and in-
610 tellectual disabilities [144]. Conversely, copy number variations (CNVs) were
611 studied in genomic disorders [188] and developmental delay [189]. Not only
612 the interest within this cluster was focused on the underlying risks for the
613 development of several developmental disabilities, for several tools and tech-
614 niques were also described in order to help scientists and clinicians to conduct
615 genetic analysis [81, 190, 191]. These techniques were explored in relation to
616 the possibility of conducting genetic diagnosis of developmental disabilities
617 (see the following citing references [192, 148]). Finally, an innovative model
618 to explain psychopathology through the differential susceptibility to the en-
619 vironment was introduced by Belsky and Pluess [193] on the research domain
620 of Gene-Environment interaction.

621 References in cluster #4 did not focus on the investigation of the phys-
622 iological etiology behind a specific disorder. Rather, some authors explored
623 psychiatric outcomes in relation to specific physiological risks, such as preterm
624 birth, parental age or maternal genetics [194, 195, 196].

625 *4.2.3. How it is studied*

626 In the network of “How it is studied”, cluster #1 did not consist in ref-
627 erences in which authors specifically focused on one developmental disabili-
628 ty. Rather, several clinical conditions were examined recurring to different
629 methodologies. In particular, family and twin study designs were used in or-
630 der to examine, for instance, the heritability of specific language impairment
631 [197, 198, 199], developmental language disorder [200, 201], developmental
632 dyslexia [202] and autism [203]. Moreover, longitudinal studies were run
633 to deepen the comprehension of developmental trajectories [121, 204, 205]
634 (see also the major citing document within the network [116]) and reviews
635 [206, 207, 208, 209] were written in regards to several developmental disorders
636 such as autism, speech and language delay and attention deficit disorder.

637 Cluster #3, on the other hand, reported the emergency of Gene-by-
638 Environment study designs. As a matter of fact, these paradigms were
639 used to explore the etiology not only in regards to developmental disabili-
640 ties but for a wider range of disorders, allowing the researchers to take
641 into account the interaction between genetic and environmental factors. For
642 instance, Gene-by-Environment studies were used to explore the roots of an-
643 tisocial behaviour [59], depression [58, 210, 211] and behavioural inhibition
644 [212]. In particular, the study by Caspi et al. [59] had a high impact in
645 the literature, as testified by its citation burst. This burst likely represents
646 the novelty that the Gene-by-Environment paradigm also introduced in the
647 study of developmental disabilities. As a matter of fact, this interest on the
648 methodology emerges from a closer look on the citing documents within the
649 cluster in which developmental disabilities, such as reading disability and
650 attention deficit/hyperactivity disorder, are studied following this trend of
651 research [213, 214]. As a matter of fact, the cluster includes reviews studying
652 in depth the Gene-Environment approach [215] and its implication on the
653 investigation of psychopathology [90].

654 From the analysis of the references composing cluster #0 in the area
655 of “How it is studied”, it emerged that the focus was mainly on studying
656 autism spectrum disorders in regards to their genetic basis. Specifically, this
657 was achieved by using several methodologies, such as comparative genomic
658 hybridization [64, 170, 172, 182], dense genotyping arrays [66], whole-exome
659 sequencing [179, 67] and genome-wide analysis [169, 130]. Together with
660 these techniques of analysis, the genetic heritability of autism has been ex-
661 plored using twin studies [135, 65], siblings studies [216, 93] and relatives

studies in general (as for the major citing reference [173]). These studies, in which a recurrence of autism-like traits within families of patients with a diagnosis of autism is reported, are consistent with the concept of the broader autism phenotype. Cluster #0 was not only composed by experimental studies. Rather, it consisted in several reviews that examined a specific aspect of developmental disabilities. For instance, some of these reviews focused on conditions such as autism [168, 217], ADHD [218, 136], specific language impairment [149] and pervasive developmental disorders [94].

In general, the references in cluster #2 summarized the knowledge obtained from previous studies on developmental disabilities by recurring to literature [219, 220, 221] and systematic reviews, alongside meta-analysis [150, 96, 222, 223, 224, 225, 226, 227]. Furthermore, in this study cohort study designs were adopted to study the consequences of an early gestational age [194], low birthweight [228], efficacy of oral cannabis extracts for treatment of refractory epilepsy [229], the tendency to vaccinate children in a lesser extent after they receive a diagnosis of autism spectrum disorder [230] and the effects of parental age on the risk across pediatric neuropsychiatric disorders [196].

4.2.4. *Environmental Factors*

In cluster #2, stress profile among mothers of children with autism was studied by Koegel et al. [126]. With regards to the same condition, Bailey et al. [203] conducted a twin study in which the main focus was to understand the genetic causes underlying autism. Specifically, the authors suggested that obstetric hazards should be considered as consequences of genetically influenced abnormal development rather than independent etiological factors. Other environmental influences in the etiology of developmental disabilities were analyzed within the cluster. For instance, Milberger et al. [231] reported that maternal smoking during pregnancy conferred a particular risk towards attention deficit hyperactivity disorder. At the same time, a correlation between alcohol exposure in uterus and attention deficit hyperactivity disorder and autism was reported in the article by Aronson et al. [232].

Stress in parents of children having one of three specific developmental disabilities (i.e., fragile-X, Prader-Willi and Williams-Beuren syndrome) was examined in cluster #1 by Sarimski [233]. Furthermore, among the network, specific environmental factors were studied in order to better understand typical and atypical development. For instance, Bolton et al. [166] focused on the role of obstetric complications on the outcomes autism spectrum disorder.

699 ders, whereas, although not focusing on a disability, Plotsky and Meaney [75]
700 studied the link between early maternal separation and stress responsiveness
701 in rats.

702 The analysis of environmental factors in cluster #0 included the concept
703 of differential-susceptibility for psychopathology. Differential-susceptibility
704 has been widely studied by Belsky and Pluess [193] and it refers to the idea
705 that some individuals, which are carriers of “plastic genes”, are not only
706 more vulnerable than others in front of adverse events, but they could also
707 benefit the presence of supportive and enriching experiences. In the frame-
708 work of Gene-by-Environment interplay in psychopathology, Hicks et al. [234]
709 investigated the emergence of externalising disorders and identified several
710 environmental risk factors. Within this cluster, the interest towards genetic
711 factors underlying several developmental disabilities is well represented when
712 analysing the citing nodes [184, 235, 236] together with the interest towards
713 environmental factors [237]. For instance, in regards to autism, Grubbs
714 [238] identified in the immune system disruptions and in the zinc homeostasis
715 two factors that potentially could impact synaptic transmission. Alongside
716 these works, several researches addressed the link between parental mental
717 health and developmental disabilities on the offspring. In particular, parents
718 of children with autism spectrum disorders and/or developmental disabili-
719 ties showed to have an increased risk regarding their mental health and their
720 family functioning [239, 240, 241, 242, 243, 95]. In fact, the study by Dardas
721 and Ahmad [244], which is among the major citers in the cluster, highlighted
722 the need to provide care also to parents of children with autism for their
723 role as caregivers. As their citation bursts point out, the works by Herring
724 et al. [239], Mandell et al. [245] and Estes et al. [95] were relevant within the
725 network.

726 References in cluster #3 studied the relationship between developmental
727 disabilities and parental stress. For instance, Neece et al. [246] showed the
728 bidirectional influences existing between parental stress and behavioral prob-
729 lems in both typically and atypically developed children. In other words, they
730 showed that parental stress and children behavioral problems have a mutual
731 influence on each other. In regards to developmental disabilities, some ref-
732 erences showed the negative impact that some of these conditions have on
733 parental stress and family functioning [247, 96]. Conversely, other references
734 have showed the risk for the child with a developmental disability to live in
735 conditions of unsupportive parenting [248]. For this reason, studies have pro-
736 vided insight into the need of developing programs aimed to support these

families [249, 250, 251, 252, 253, 254, 255], for instance by considering the protective role of having a supportive partner [256, 257]. In regards to the experience of caregivers of children with intellectual disabilities, the reviews by Marsh et al. [258] and by Hu [259] provided insight into the role of fathers.

5. Limitations

Some limitations need to be taken into account when interpreting the presented results. First of all, the sample of publications collected in order to conduct this study was derived uniquely from one platform, Scopus. Future research should try to explore whether the patterns observed in the literature vary across database platforms. Secondly, the country analysis was based on the country within the last author’s affiliation string. If this in most cases reflects the affiliation of the principal investigator, there could be a bias in which data collections conducted in a country that was different from the last author’s affiliation would not be well represented in the map of the present study. Another aspect that is worth noting in regards to the country analysis is that it originated from the research on Scopus where only the publications written in English language were selected. This, on one side, is a strength for it gives a standardized and rigorous way to consider uniquely the international scientific literature on the field. Nevertheless, some important publications written in other languages may have been excluded from the research and from the country analysis. It is to note, though, that the vast majority of publications that results with the string “TITLE-ABS-KEY (parent* AND (development* AND disorder* OR intellectual AND disab* OR genetic* OR neurodev*))” are written in English. Thus, even if the contribution of other countries may have been slightly underrepresented, the results can be considered as representative of the scientific panorama on developmental disabilities research. Another limitation derives from the fact that the method we used for clustering the papers into the four main areas largely depended on the keywords used to index a document. Publications usually have more than one keywords, some of which are very general. This brought us to have a large overlap of papers that composed the four macro areas. Finally, the scientometric approach is strongly grounded on the patterns of citations between documents. As a matter of fact, this approach focuses only on a quantitative evaluation of these patterns while not considering the reasons behind them (e.g., whether a document is largely cited because it is a milestone in the field or did not find agreement in the scientific landscape).

Moreover, a method that relies on citations between documents inevitably provide a clearer light on past publications and research trends rather than on more recent ones [49].

Authors Contribution

Conceptualization, G.E., P.S. and A.C.; methodology, A.C.; formal analysis, A.C.; investigation, A.C.; data curation, A.C. and G.G.; writing—original draft preparation, A.C.; writing—review and editing, A.C., A.B., M.L., G.G., P.S., D.D., V.A. and G.E.; visualization, A.C.; supervision, G.E.; funding acquisition, G.E. All authors have read and agreed to the published version of the manuscript.

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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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