

A Review Paper on the Syntactic Abilities of Individuals with Down Syndrome

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Abstract

This systematic review aims to synthesize current findings on the syntactic abilities of individuals with Down Syndrome from childhood into adolescence and adulthood and discuss them in terms of the delayed or deviant pattern of development as well as in terms of the critical period for syntactic development. This literature search was conducted using research articles written only in the English language, but concerning syntax in any language, after a thorough search in the web databases, following the inclusion criteria set for this review. Studies which examine any syntactic domain of language via particular and targeted materials were included. The findings show that individuals with Down Syndrome lag behind typically developing and present a delayed pattern of syntactic development. The Down Syndrome population presents difficulties with both comprehension and production of syntax, a fact which is observed in various syntactic structures and becomes apparent in more complex ones, such as subordinate clauses, passivisation and pronouns.

Keywords

Down Syndrome, Syntactic Abilities, Syntactic Impairment, Critical Period, Delayed Pattern

1. Introduction

Down syndrome (DS) is the most common genetic cause of intellectual disability (ID), occurring in approximately 1 in 700 to 1 in 800 live births of both sexes throughout the world (Rondal, 1988, 1998; Rogers et al., 1996; Nadel, 1999). A diagnosis of DS is given when an error in cell development results in an extra copy of chromosome 21, so there are 47 chromosomes than the usual 46. DS can also be the result of mosaicism, when only some cells include an extra copy of this chromosome whilst the remainder of cells are normal, or transloca-

tion, when part of chromosome 21 attaches to another chromosome, often number 14, during cell division forming a single new chromosome. Unlike the two previously mentioned DS forms, translocation may be hereditary (Rogers, 1992; Rogers et al., 1996; Nadel, 1999; Antonarakis et al., 2004). This genetic difference affects many aspects of cognitive development and is associated with characteristic physical features.

DS has a complex phenotypic profile, affecting almost every aspect of the person's life and varies in intensity and prevalence depending on the type of DS. However, two consistent phenotypical characteristics are considered to be mental retardation and neonatal hypotonia that are associated with a number of health issues. The DS phenotype is evident in the physical features, in the neuroanatomical structure of the brain, in the medical profile as well as in the cognitive development of the individual. Apart from growth retardation, people with DS show a variety of physical features, such as epicanthic folds of the eyes, flat nasal bridge, brachycephaly, brachydactyly, open mouth, flattened facial features, unusual palm creases, narrow palate, short and thick neck and dysplastic ears. Other physical problems include congenital heart malformation, respiratory problems, gastrointestinal anomalies, oral problems, ophthalmic deficits, ear infections and thyroid dysfunction. Neuroanatomical studies indicate that children with DS have reduced cerebral and cerebellar volumes, which are associated with a malformed growth of the frontal and temporal lobes. In addition, the brain stem and the cerebellum are smaller than what would be expected based on the size of the cerebral hemispheres. The corpus callosum and the hippocampus are also smaller than normal controls (Gilger & Kaplan, 2001; Roizen & Patterson, 2003). Additionally, a strong relationship between DS and Alzheimer's disease (AD) has been found, rendering the occurrence of AD the most common neurological phenotype in adults with DS (Menendez, 2005; Zigman & Lott, 2007; Rafii et al., 2019). It is worth noting that of by the age of 60 years, 75% of individuals with DS show symptoms of Alzheimer's disease (Roizen & Patterson, 2003) and it has been suggested that beyond 35 - 40 years a 25% - 45% of the individuals with DS would develop a form of Alzheimer's disease leading to the loss of most of the skills acquired earlier in life. Moreover, studies from the 1990s indicated that about 10% - 12% of individuals with DS also have a diagnosis of autism spectrum disorders, although a more recent review indicates that there is not a general agreement regarding the prevalence of comorbid DS and autism (Sudhalter et al., 1990; Kent et al., 1999; Cohen et al., 2005).

Regarding the cognitive profile of individuals with DS, their general intellectual ability ranges from mild to severe mental retardation, with 80% of individuals showing moderate retardation. Also, a decline in the intellectual abilities has been observed as individuals with DS grow older (e.g., Hoddap & Zigler, 1990; Pennington et al., 2003). This decline, which begins early in adulthood, has been related to the gradual deterioration of several brain areas such as the hippocampus and the cerebellum (Pennington et al., 2003) or alternatively, it has been linked to the increased prevalence of dementia in adults with DS (Zigman et al.,

1996; Nieuwenhuis-Mark, 2009). DS affects a range of cognitive abilities, such as conceptual development, information processing, attention capacity, reaction time, number knowledge, memory, auditory-vocal processing, visuospatial abilities and perceptual discrimination (Nadel, 1999). Memory plays a major role in people's cognitive development since it supports the process of thinking and learning. Therefore, atypical populations, likewise individuals with DS, who have cognitive problems will also exhibit difficulties with memory. People with DS show a characteristic phenotype of memory with specific strengths and weaknesses. Various studies have shown that explicit memory is profoundly impaired, whilst they reported a relative preservation of implicit memory which imitates that of typically developing children (TDC) (Nadel, 1999; Vicari et al., 2000). Also, individuals with DS exhibit difficulties with verbal short-term memory (Jarrold & Baddeley, 1997; Seung & Chapman, 2000). On the other hand, short-term memory that is responsible for non-verbal processes, such as visuo-spatial abilities, does not create difficulties to the individuals with DS (Wang, 1996; Chapman & Hesketh, 2000; Laws, 2002; Vicari et al., 2005).

Despite considerable individual variability, individuals with DS have a characteristic profile of language development with strengths and difficulties. Receptive language is typically stronger than expressive, with phonology, syntax, and some aspects of pragmatics presenting particular developmental challenges. Their distinct linguistic profile is often attributed to hearing and oral-motor difficulties that the DS population presents. As regarding hearing skills, it has been shown that approximately 2/3 of children with DS experience hearing loss, sensorineural hearing loss, or both. Children with DS may be particularly sensitive to otitis media, possibly due to narrow auditory canals and cranial facial differences seen in this population. Otitis media has been found to occur in 96% of young children with DS, with 83% requiring tympanostomy tubes (Tedeschi et al., 2015). The association between early otitis media with effusion and language development constitutes an extra risk factor for atypical language development on the part of children with DS who are already at risk for language difficulties. In fact, hearing loss is related at the same time to difficulties in comprehension of grammatical morphemes and vocabulary for individuals with DS (Chapman et al. 1991; Miolo et al., 2005). On the other hand, regarding oral-motor skills, speech production of individuals with DS may be related to differences in oral structure and function (small oral cavity with a relatively large tongue and a narrow, high arched palate, missing, poorly differentiated, or additional muscles, differences in nerve innervation) (Miller & Leddy, 1998; Stoel-Gammon, 2001). These differences are thought to account, in part, for poor speech intelligibility through dysarthric factors such as reduced speed, range of motion, and coordination of the articulators. Symptoms of childhood apraxia of speech have also been reported (Rupela & Manjula, 2007).

Over the last decades there has been an increased interest in the study of language development of specific types of neurodevelopmental disorders mainly due to some unusual patterns between the language abilities and the general

cognitive system of children with different genetic etiologies (Bates, 2004). Interest in this cognitive domain derives from the fact that language is one of the most prominent indicators of intellectual impairment, which affects development in many ways. Language is divided into the following five aspects: pragmatics, phonology, semantics, morphology and syntax. The syntax, commonly known as grammar, encompasses the rules that govern how words are put together to form sentences. This includes elements such as word order, parts of speech, sentence organization, and word relationships.

Language development in DS has caught the attention of early studies such as Lenneberg (1967) who argued that children with DS are able to develop language but at a reduced level compared to unimpaired children and described the developmental course of language in children with DS as “stretched but normal”. Despite the fact that there is an ongoing debate regarding the characterization of syntactic abilities of people with DS as either delayed (Bridges & Smith, 1984; Rutter & Buckley, 1994; Fabbretti et al., 1997; Thordardottir et al., 2002; Eriks-Brophy et al., 2003, 2004; Schaner-Wolles, 2004, among others) or deviant (Perovic, 2004, 2006a, 2006b; Ring & Clahsen, 2005a; Penke, 2018), most of these studies lead to the conclusion that syntactic development in individuals with DS is highly problematic. This finding was observed in studies on both English and on morphologically richer languages.

Various studies, particularly the developmental literature, using different theoretical and methodological approaches have shown that one of the main characteristics of individuals with DS is language impairments which are greater than would be expected from their level of cognitive development, with expressive delays more severe (Vicari et al., 2000; Chapman et al., 2002; Laws & Bishop, 2003; Yoder & Warren, 2004). This delay in expressive performance is evident from infancy and becomes even more pronounced when syntax becomes more complex and vocabulary more demanding. Besides, more than half of the individuals with DS did not achieve the vocabulary increase that is usually observed in TD individuals at 24 months of age. For example, data from parental reports suggest that linguistic expression using gestures lags behind normal development (Miller, 1992). Also, Oliver and Buckley (1994) used parental records assessing first words and two-word phrases and they found that individuals with DS used approximately the same type of vocabulary as TD infants but with a delay up to 18 months, as well as presented remarkable individual differences in the development of the first ten words learnt, which ranged from 19 to 38 months. Particularly, the area of morphosyntax seems to be more impaired than other domains within the language system, such as lexical abilities (Chapman et al., 1991; Chapman & Hesketh, 2000; Kernan & Sabsay, 1996; Fabbretti et al., 1997; Schaner-Wolles, 2004). In summary, DS people have difficulty with the comprehension and production of syntax, with production more severely impaired than comprehension.

The aim of this article is to review studies on the syntactic abilities of individuals with DS from childhood into adolescence and adulthood as compared with

those of typical population. More specifically, these studies are discussed in relation to a) the delayed or deviant pattern of development b) the critical period for syntactic development in this impaired population and c) the syntactic phenomenon they examined.

2. Method

Studies included in this review were selected based on the following criteria:

- 1) All studies were published in journals and written in English.
- 2) Participants had been diagnosed with Trisomy 21.
- 3) Recent studies as well as older ones, without chronological limitation, included.
- 4) There was no geographic limitation or limitation in the spoken language of the participants.
- 5) The materials used in the studies concerned syntax alone or in combination with other linguistic or cognitive domains.

3. Search Procedures

The research was conducted electronically through databases mainly via Google Scholar and PubMed, which provide the opportunity to find and read all published articles online. The initial search included studies from the last decade, however the limited number of published studies during that period of time led the authors to extend the chronological limitation. In all databases, the combination of the terms Down syndrome, syntax, syntactic abilities, syntactic impairment, was used.

The search process yielded 44 studies that met the inclusion criteria and were further analyzed. The selected studies fell under the area of syntax, and were further analyzed in terms of syntax development plateaus and in terms of characterization as delayed or deviant compared to typical population. The related studies were also classified as to which syntactic phenomenon they examined and their results are discussed comparatively and presented below.

4. Results

4.1. Syntactic Development

4.1.1. Plateau-Critical Period in Syntactic Development of Down Syndrome's Individuals

Extended research has been conducted in order to examine syntactic development in adolescents and young adults with DS in response to the claim that there is a critical period for syntax development. Previous research studies utilized a great variety of methods to measure syntactic development such as Mean Length of Utterance (MLU), T-units, and measurement of specific syntactic structures. Possibly, the differences in outcomes resulted from major differences in the types of measures used in the various studies. The question whether a plateau exists in language acquisition and more specifically in the acquisition of

syntax, in the DS population is examined below via the presentation of the results of related published studies.

The notion of a critical period for language development was initially proposed by Lenneberg, who in a study with his colleagues (Lenneberg et al., 1964) reported data supporting the hypothesis of a freeze in language acquisition in DS after around 14 years old. Sixty-one individuals with DS were followed over a three-year period. Authors observed that those who had reached adolescence failed to make further progress in language structures, in contrast to younger subjects for whom some progress was observed. However, judging from the fact that only 4 subjects were beyond 14 years when tested, which was a very limited sample, a generalization was not considered safe. In addition, Fowler (1990) maintained that no notable language improvement is possible beyond early adolescence. In another study, Fowler et al. (1994) reported no further modification in MLU over a 2 to 4 years following initial measurement in four adolescents with DS with mean chronological age (CA) 12.7 years at the beginning of the study. MLU remained in the range 3, that is 3.50 words plus grammatical morphemes. However, they claimed that the language ability of individuals with DS did not improve, and that the syntactic language skills plateau in adolescence.

Rondal & Comblain (1996) conducted several cross-sectional studies and one longitudinal of 4 years in the language abilities of various age groups of persons with DS aged between 14 - 50 years. They used the Batterie pour l'Evaluation de la Morpho-Syntaxe (BEMS) to examine various morphosyntactic structures. The authors concluded that morphosyntax and phonology continue to be areas of relative weakness for adults with DS, whereas semantics and pragmatics remain areas of relative strength. In addition, they claimed that receptive and expressive morphosyntax and lexical skills remain stable from late adolescence through mature adulthood, at least until 50 years of age. Similarly, Iacono et al. (2010) investigated the relationship amongst age, language and related skills in adults with DS. They used measures of receptive and expressive language from studies of younger individuals with DS in exploring the relationship between linguistic and associated skills and age in young to older adults. The results of the study indicated that the group of adults with DS was heterogeneous in their ability to complete tasks and their performance on these tasks also varied. It is worth mentioning the finding that increasing CA was associated with lower performance in all measures. However, when they removed scores on the Raven's Coloured Progressive Matrices, a measure of non-verbal cognition, and on the Adaptive Behaviour Dementia Questionnaire, which measures the change in daily functioning that may be associated with AD, they observed that decrease appeared only in the test of auditory short-term memory (Digit span), and in the measure of expressive language that included morpho-syntax (MLU-50). Interestingly, a relationship between receptive language and ageing was not found. In this line, Witecy & Penke (2017) examined whether receptive syntactic skills change from childhood/adolescence to adulthood. The results of their study indicated that the development of receptive syntactic skills comes to an end in the

transition from adolescence to adulthood. Their syntactic comprehension abilities continue to improve through childhood and adolescence and that thereafter a plateau is reached and maintained. It is found that a plateau is reached in grammar comprehension in adolescents and that the abilities are preserved throughout the 20 s and 30 s.

Recently, [Koizumi et al. \(2019\)](#) examined the characteristics of syntactic development in native Japanese-speaking children with IDs compared to MA-matched TDC. They indicated that the development of syntax in children with ID, including DS, was significantly delayed than in TDC and a temporal plateau of 1 - 3 years appears from a mental age (MA) of 5 - 6 years, during which the development of syntax comprehension stops, while by reaching the MA of 7 - 9 years, grammar comprehension abilities start developing remarkably. Probably, the comprehension of basic grammar forms in children with ID might be promoted/facilitated when the MA of these children reaches this level. However, in general, the type of disability might affect the development of syntax.

On the contrary, there are studies in the recent literature on the continued development of language in late adolescent and early adulthood. [Thordardottir et al. \(2002\)](#) claimed that syntactic development in DS does not stop at late adolescence and is not limited to simple syntax. They investigated the use of complex syntax in narrative language samples of children and adolescents with DS and a group of TDC matched on MLU and found that the examined groups did not differ significantly in either the proportion of utterances containing complex sentences or in the variety of complex sentence types used. However, the group of individuals with DS actually had a higher mean and higher upper range than the control children. More specifically, the results demonstrated that the individuals with DS, as a group, use complex sentences and their use of complex syntax is commensurate with their MLU. Interestingly, individuals with DS had a higher proportion of complex sentences for short utterances, however, this is reversed for the longer utterances. Only 42% - 68% of utterances of 10 - 13+ morphemes produced by the individuals with DS were complex, compared to 69% - 89% for the control group. The authors argued that the use of complex syntactic constructions and the increase in MLU of the DS group were interrelated and, consequently, there was a syntactic development in the individuals with DS throughout adolescence. [Andreou \(2013\)](#) examined Greek-speaking individuals with DS and she concluded that their syntactic development does not reach a “ceiling” in adolescence but continues to grow especially in the expressive domain. Also, [Kernan & Sabsay \(1996\)](#) claimed that the lack of any significant correlation between chronological age and language measures in their study indicates that the linguistic ability of the adults with DS does not deteriorate with age before the age of thirty-five years in terms of expressive lexical, morphological, or syntactic ability. Similarly, in a more recent study, [Facon & Magis \(2019\)](#) examined receptive syntax and vocabulary in French children, adolescents and young adults with DS using a cross-sectional developmental approach. They compared the DS group to participants matched on CA and cognitive level

with ID of undifferentiated etiology. The authors found that chronological age was significantly related to both vocabulary and syntax comprehension with a larger effect for vocabulary than for syntax. For both measures, participants with undifferentiated etiology performed better than those with DS. However, authors observed that syntax and vocabulary had a continuous progress between childhood and adulthood for both groups.

However, Chapman's work on this issue yielded different outcomes. Chapman and his colleagues have examined language of adults and adolescents with DS in several studies and the results are presented below. In a study of 1991, they investigated the variation in receptive vocabulary and syntactic comprehension in a sample of children and adolescents with DS aged from 5 to 20 years. They observed differences within the group of DS increasing with age, between lexical and syntactic comprehension skills, while vocabulary comprehension was relatively more advanced than syntax. They also observed that the differences increased with age between nonverbal cognitive subtests of pattern analysis and short-term memory for bead arrangements. [Chapman et al. \(1991, 2002\)](#) indicated that limitations in short-term memory contribute to limited growth in both receptive and expressive language beyond single words, as children move to adolescence and adulthood, indicating a plateau. Overall, adolescents with DS were described as having an advanced vocabulary comprehension, and also appeared to have mild deficits in syntax comprehension.

[Chapman et al. \(1998\)](#) investigated cross-sectionally the hypotheses that children and adolescents with DS show a "critical period" for language acquisition and a "simple sentence syntactic ceiling" in production. The study utilized MLU from a 6-minute conversational and 12-minute narrative language samples to determine if a plateau in syntax occurred. The participants were divided into four age groups ranging from age 5 to 20. The two younger groups, who had not yet reached adolescence, exhibited an MLU of 3.0 or less, indicating that they were not yet able to use complex syntactic forms. However, several participants in the adolescent age groups (12.6 - 16.5 years and 16.6 - 20.5 years) showed a mean MLU greater than 3.0. MLU increased with CA in both conversational and narrative language samples, although increases were larger in narrative than in conversational context, most notably after the age of 16, while the individual variability became also larger at this point. The authors concluded that the findings of their study were not consistent with the hypothesis of a simple syntax ceiling. There was no evidence for a slowing of lexical or syntactic development from age group 2 (8 - 12 years) or from age group 3 (12 - 16 years). Overall, the MLU of the DS group was shorter than the controls, whereas narrative samples contained more word tokens, more word types, and longer MLU than conversation samples, for both groups. The analysis of the narrative language sample by age sub-group showed no evidence of a critical period for language development ending at adolescence, nor of a "syntactic ceiling" after which the acquisition of syntactic structures stops.

Moreover, [Chapman et al. \(2002\)](#) investigated a longitudinal change in syntax

comprehension and production skills measured four times across a 6-year period in 31 individuals with DS. Hierarchical Linear Modeling was used to fit individual linear growth curves to the measures of syntax comprehension from the Test of Auditory Comprehension of Language-Revised (TACL-R) and mean length of spontaneous utterances obtained in 12-minute narrative tasks (MLU-S). The results indicated that the rate of increase in MLU-S over the 6 years was best predicted by the relative rate of change in syntax comprehension. Syntax comprehension across the 6 years of study participation was best predicted by age at study start and measures of short-term memory (auditory and visual) estimated at study start. In later adolescence, syntax comprehension scores typically decline, whereas expressive syntax scores continue to increase. However, the rate of MLU increase was greatest for those for whom comprehension declined less. The results confirm that expressive language acquisition, as measured by MLU of spontaneous utterances in narrative samples, continued through the teenage years for most individuals with DS, although language comprehension skills, while increased in younger children, are likely to decline in the oldest age cohort. However, individuals with DS can continue to exhibit evidence of growing syntactic skills past early adolescence, indicating that there is no evidence of critical period associated with expressive language development.

Because of the lack of systematic data little is known about what happens after 50 years of age in individuals with DS. [Das et al. \(1995\)](#) recorded little or no change in nonverbal reasoning, memory, language, planning and attention, and adaptive skills up to 60 years. However, authors stated that participants beyond 60 years performed more poorly than younger individuals particularly in planning and attention. Also, [Prasher & Chung \(1996\)](#) suggest the existence of age-associated functional decline in approximately 20% of the people with DS (50 - 71 years) in short-term memory, speech, activity, practical skills and general interests. Therefore, grammar eventually deteriorates together with the progressive breakdown of conceptual aspects of language. Accordingly, language profiles associated with individuals with Alzheimer's disease only and with individuals with DS in the first stages of Alzheimer's disease would be characterized by major dissociations between morphosyntax on the one hand, and language semantic and pragmatic aspects, on the other hand.

4.1.2. Delayed or Deviant Pattern of Development?

As mentioned above, the syntactic abilities of people with DS may be characterized as delayed or deviant compared to typical population. These studies are presented below in order to provide a framework on abilities of individuals with DS in this domain.

There are two major theoretical approaches in the literature on DS: 1) the delay hypothesis (Quantitative Variation) which assumes that language development in individuals with DS passes through the same stages as those observed in TDC and the only difference is that more time is needed, thus the differences

observed in the two populations are a matter of quantitative variation (Bridges & Smith, 1984; Bol & Kuiken, 1990; Fowler, 1990; Rutter & Buckley, 1994; Fabbretti et al., 1997; Vicari et al., 2000; Eriks-Brophy et al., 2003, 2004; Estigarribia et al., 2012; Polišenská et al., 2018) and 2) the difference hypothesis (Qualitative Variation) according to which language development in individuals with DS does not follow the same stages as those observed in TDC, thus the observed differences between the two populations are a matter of qualitative variation (Perovic, 2001, 2006a, 2006b; Ring & Clahsen, 2005b; Tsakiridou, 2006; Sanoudaki & Varlokosta, 2014; Penke, 2018).

Bridges and Smith (1984) conducted a series of experiments in children with DS to investigate their syntactic comprehension compared to TDC using tests on comprehension of active and passive sentences. The results reported no difference between groups. Language comprehension in children with DS was fundamentally the same as those of TDC, but with a delay of 6 months in the case of the passive sentences and a delay of one year in the case of active sentences. Also, Bol & Kuiken (1990) adopted the delay hypothesis of language development in DS in their study, as they observed that the difference in performance between the children with DS and the normal controls was mainly with respect to “the degree to which the language is affected” and not with respect to the patterns observed. They emphasized that since the patterns were similar between the two groups the language of children with DS could be characterized as delayed rather than deviant. In this line, Rutter & Buckley (1994) found that individuals with DS were rather delayed in acquiring the morpheme rules in comparison with TDC. In addition, Fowler (1990) in her research which aimed to discover maximum limits acquisition of syntactic skills in people with DS and to explain the reasons that great deficiencies are observed in this area, was also in favor of the delay hypothesis.

Similarly, Eriks-Brophy et al. (2003, 2004) conducted experiments on comprehension and production abilities of high-functioning individuals with DS using act-out tasks and true-value judgement tasks. They examined the comprehension of active and passive constructions, wh-questions and particularly the sensitivity to A- and A'-dependencies of subjects with DS. According to the results, the delayed-but normal view of language development for subjects with DS was evident. In addition, Fabbretti et al. (1997) examined lexical and morpho-syntactic abilities of children and adolescents with DS and those of typical development using a story description task. They investigated a number of complex sentence structures such as relative clauses and gerund sentences and postulated that syntax does not pose great difficulties on people with DS. They found that the subjects of the two groups used similar types of clauses, and they had a comparable repertoire of conjunctions and clitic pronouns as well. However, the majority of the DS group presented a restricted syntactic profile which could not be indicative of people with spared syntactic abilities. Vicari et al. (2000) also supported the delay hypothesis via the examination of production and comprehension of morphosyntactic elements.

Moreover, Koizumi et al. (2019) examined the characteristics of syntactic development in native Japanese-speaking children with IDs compared to MA-matched TDC. The results showed that the development of syntax in children with ID was significantly delayed than in TDC with the same MA, particularly of 1-3 years. MA seems to be related to syntactic development in children with ID, whereas CA was related to syntactic development in TD children. The authors claimed that the DS participants showed a significant delay in syntactic development and MA and the type of disability might affect the development of syntax. They also indicated a significant delay mainly in the expressive aspects of language. Moreover, Polišenská et al. (2018) described the receptive language skills of children with intellectual disability, including DS, as delayed but following the same trajectory compared to TDC. Estigarribia et al. (2012) provided a model of predictors of expressive syntax in boys with fragile X syndrome (FXS), boys with DS, and TD boys and found that the relative importance of predictors did not differ by group. However, there was no evidence of deviant pathways of development.

Another portion of studies indicated an alternative view of results on the development of morphosyntax in individuals with DS who present a particular developmental trajectory that deviates from that of normal development. Perovic (2001, 2006a, 2006b) was one of the researchers who supported the deviant syntactic behavior and suggested a specific syntactic deficit in DS due to an unusual pattern of performance in the interpretation of reflexive pronouns. Perovic (2001) examined the comprehension of reflexives and pronouns in English-speaking subjects with DS, indicating that the DS subjects had specific difficulties assigning appropriate interpretation to reflexives, that according to standard Binding Theory reflexives are governed by Principle A. On the contrary, they had no difficulties in sentences with pronouns that are governed by Principle B in the same framework¹. Those findings led her to propose a specific syntactic deficit in the language of DS's participants, which is not observed in control group, hence, her findings support the difference hypothesis.

Moreover, Perovic (2006a) made an experimental investigation into the knowledge of binding in a group of 4 girls with DS and a group of 4 TD children. Similarly, the participants with DS were found to have difficulties comprehending reflexives, but not pronouns. In contrast with pronouns, which are interpreted by invoking extra-syntactic mechanisms, the interpretation of reflexives depends on a syntactic relation between the reflexive element and its antecedent. Such a pattern is exactly the opposite to the one found in TD English children, who had trouble applying the co-reference rule that regulates the interpretation of the pronouns. This result provides evidence that language in DS is not merely delayed, but also deficient. In her study of 2006b examined 6 Ser-

¹Binding theory concerns syntactic restrictions on nominal reference. It particularly focuses on the possible coreference relationships between a pronoun and its antecedent. In standard Binding Theory, Binding Principle A governs the distribution and interpretation of reflexives, whereas Binding Principle B is concerned with pronouns (Chomsky, 1981).

bo-Croatian speaking adults with DS and TD controls matched on non-verbal MA using a truth-value judgment task for testing full and clitic forms of pronouns and reflexives. Results revealed that adult speakers of Serbocroatian with DS had difficulties forming the syntactic dependency of anaphoric binding. They showed particular difficulties in those involving the anaphor “sebe” which can only be interpreted as a deficit in establishing the syntactic relation between the anaphor and its antecedent. Furthermore, she noticed that the parallel between the Serbo-Croatian speakers’ pattern here and that of English speakers in [Perovic \(2001\)](#) is observable in the mismatch name reflexive conditions only, perhaps due to different language-particular strategies that the speakers of English and Serbocroatian use to interpret the anaphor.

[Ring and Clahsen \(2005b\)](#) replicated Perovic’s findings and proposed a syntactic account of the difficulties of individuals with DS affecting syntactic binding of reflexive and non-reflexive pronouns and passive clauses. Comparisons between the examined groups showed that the DS participants performed significantly worse than the controls on the reflexive conditions, whereas they did not significantly differ from controls on non-reflexive pronouns. Also, the DS participants performed significantly worse than the controls in all conditions of passivization, with more difficulties interpreting passive sentences than active ones. They concluded that distinct patterns of linguistic impairment were found in children with similar mental ages and IQs. The lower performance of DS cohort could not be attributed to their lower cognitive level, while Williams Syndrome (WS) individuals did not confront the same difficulties. Recently, [Penke \(2018\)](#) suggested a deviant development rather than a delay in the DS’s language that derives from her study, because of the dissociation of performance in the German adaption of the Test for Reception of Grammar (TROG-D), which was used as a standardized measure of general language level in participants with DS, and in the verbal agreement task, as well as the type of errors committed in subject-verb agreement from the two groups.

Regarding the Greek language, [Stathopoulou \(2007\)](#) investigated the production of Greek relative clauses in eight adolescents with DS compared to sixteen typically developing children of similar mental age. The results of the study revealed a highly significant difference between the mean correctness scores of the examined groups. The children with DS exhibited significantly lower performance than that of mental aged controls across all types of relative clauses, while both groups exhibited the same pattern of performance on the four relative clauses types (SS > OO = OS > SO²). Therefore, this finding provides evidence that language development in Greek-speaking individuals with DS could be characterized as “delayed”. Nevertheless, a significant difference in performance between SS and OS relatives, as well as between SO and OO relatives in the control group, could provide evidence for the deviance hypothesis, instead of a simple delay. However, further research is needed. [Tsakiridou \(2006\)](#) investigated

²SS = Subject head-Subject gap, SO = Subject head-Object gap, OS = Object head-Subject gap, OO = Object head-Object gap.

the performance of Greek adolescents with DS on the production of 4 types of wh-questions (referential subject/object questions, non-referential subject/object questions) and their performance was compared to that of TDC. She concluded that DS subjects had severe problems in producing wh-questions and the error analysis revealed quantitative and qualitative differences between the groups. However, the findings supported the difference hypothesis of language development. Also, [Sanoudaki & Varlokosta \(2014\)](#) examined the comprehension of strong pronouns, reflexive pronouns and pronominal clitics of Greek-speaking individuals with DS and a control group of TD children. The data provided evidence for deviant pronoun comprehension in individuals with DS compared to the TD group. Of particular importance is the fact that the deviant pattern in pronoun comprehension was detected in Greek, a language whose pronoun comprehension in typical development does not follow the cross-linguistic pattern.

4.2. Syntactic Abilities in Down Syndrome³

The area of morphosyntax seems to be more impaired than other domains within the language system, such as lexical abilities, both in receptive and expressive domains ([Chapman et al., 1991](#); [Kernan & Sabsay, 1996](#); [Fabbretti et al., 1997](#); [Vicari, 2002](#); [Eadie et al., 2002](#); [Grela, 2002](#); [Abbeduto et al., 2003, 2007](#); [Laws & Bishop, 2003](#); [Zampini & D'Odorico, 2011](#); [Draghi & Zampini, 2018](#); [Frizelle et al., 2018](#); [Facon & Magis, 2019](#); among others).

Moreover, it is claimed that syntax comprehension skills of children, adolescents, and young adults with DS are lower than expected according to their nonverbal cognitive ability, especially as regards to comprehension of grammatical morphology and syntactic phenomena ([Rosin et al., 1988](#); [Chapman et al., 1991](#); [Abbeduto et al., 2003, 2007](#); [Laws & Bishop, 2003](#); [Joffe & Varlokosta, 2007](#); [Price et al., 2007](#); [Caselli et al., 2008](#); [Andreou, 2013](#); [Witecy & Penke, 2017](#)). However, as mentioned above, there are contradicted studies about syntax, as to whether it can be characterized by slower growth or decline in late adolescence and early adulthood ([Chapman et al., 2002](#); [Chapman, 2006](#); [Laws & Gunn, 2004](#)) or may continue to grow into late adolescence and young adulthood giving opportunities for intervention ([Thordardottir et al., 2002](#); [Andreou, 2013](#); [Witecy & Penke, 2017](#); [Facon et al., 2019](#)). Also, researchers have reported that within the morphosyntactic domain, people with DS exhibit linguistic patterns that deviate from the patterns that were attested in children with normal development ([Perovic, 2001, 2002, 2004](#); [Ring & Clahsen, 2005a](#); [Tsakiridou, 2006](#); [Sanoudaki & Varlokosta, 2014](#); [Penke, 2018](#)).

Considerable evidence points to productive syntax deficits in young individuals with DS that cannot be explained by cognitive level, for example the emergence of two-word combinations is delayed in young children with DS, and children and adolescents with DS continue to produce shorter, less complex

³[Table 1](#) presents a summary of the studies included in this review and concerns the syntactic ability of DS's population.

noun and verb phrases, sentence structures, questions, negations and omissions of grammatical words than TD individuals of the same nonverbal MA as they get older (Rosin et al., 1988; Chapman et al., 1998, 2002; Vicari et al., 2000; Chapman & Hesketh, 2000; Tsakiridou, 2006; Fabbretti et al., 1997; Stathopoulou, 2007; Price et al., 2007, 2008; Caselli et al., 2008; Zampini & D’Odorico, 2011). However, contrary to the above studies, Thordardottir et al. (2002) found that individuals with DS and those with typical development had parallel performance in conjoined and subordinate sentence forms, in the proportion of utterances containing complex sentences and in the variety of used types of complex sentences. The analysis of developmental patterns suggested a similar order acquisition across groups, that is conjoined sentences, infinitive clauses with equivalent subjects, non-infinitive wh-clauses, relative clauses, gerund clauses, full propositional complements, multiple embeddings, infinitive clauses with a different subject (infrequent), unmarked infinitive clauses (infrequent), and wh-infinitive clauses (infrequent).

More specifically, the studies included in this review relied on various syntactic constructions and their results are a point of interest. For example, subordinate and relative clauses, as well as negated constructions were not observed or observed much less frequently in DS individuals’ language (Rondal & Comblain, 1996; Fabbretti et al., 1997; Joffe & Varlokosta, 2007; Stathopoulou, 2007; Witcyc & Penke, 2017). Regarding syntactic structures, one domain that appears to be particularly disadvantaged is the interpretation of passives (Bridges & Smith, 1984; Eriks-Brophy et al., 2004; Ring & Clahsen, 2005b; Joffe & Varlokosta, 2007; Price et al., 2007; Witcyc & Penke, 2017).

4.2.1. Performance in Active/Passive Structures, in Subordination and in Pronouns

Bridges & Smith (1984) assessed the ability of Down’s syndrome children to act out active and passive semantically biased and neutral sentences in a comprehension task and found that although Down’s syndrome children closely resembled controls both in the percentage of correct responses and in individual patterns of error, their performance on active sentences was better than on passive ones. They concluded that there was evidence of a slight (6 to 12 months) delay in the appearance of syntactic strategies of comprehension by the Down’s syndrome children compared to TDC. The results of the study of Eriks-Brophy (2004) support the view of Bridges and Smith (1984) that construction develops in a normal but delayed manner in DS. Individuals with DS benefit from the elimination of the by-phrase in non-actional passives, while the greater difficulty of non-actional passive with a by-phrase could be attributed to inability to transmit a non-agentive theta role through the by-phrase. Also, Ring & Clahsen (2005b) found that the DS individuals encounter difficulties in the comprehension of active and passive sentences. The accuracy scores on actives were higher than the accuracy scores on full and short passives for both the DS and TD children, although the DS participants performed significantly worse than the

controls in all conditions. However, DS participants had more difficulties interpreting passive than active sentences. Similarly, [Joffe & Varlokosta \(2007\)](#) revealed that DS group understood significantly less passives than the TD controls, with significantly better performance in active sentences and they also obtained significantly higher transitive responses with full and short passives than ambiguous passives. In addition, [Witecy & Penke \(2017\)](#) found that German children, adolescents, and adults with DS presented particular difficulties in the comprehension of subordination and coordination, in sentences with passive voice or topicalization, and that relative clauses with pronouns in accusative or dative case proved to be problematic. Further, sentences with the negative element “nicht” (not) were understood best, whereas sentences with the disjunctive conjunction “wedernoch” (neither nor) were most error-prone. Meanwhile, the authors pointed out that difficulties increased with sentence length and grammatical complexity, but were also apparent in simple sentences.

As reported above, in the study of [Stathopoulou \(2007\)](#) the children with DS encountered difficulties across all types of relative clauses. Interestingly, they adopted an avoidance strategy by producing responses, such as simple active sentences and coordinated constructions, as well as elliptical responses, instead of the targeted relative clauses, as indicated from the error analysis. In addition, [Tsakiridou \(2006\)](#) proved the difficulty of DS's subjects to produce wh-questions. Their correct answers in all four tested structures were low, whereas children with TD performed at ceiling. Similarly, [Joffe & Varlokosta \(2007\)](#) investigating the production, comprehension and repetition of a range of wh-question types (wh-subject/object, which NP-subject/object) of individuals with DS, observed that DS group as well as WS group and TDC performed better on comprehension than elicitation and also significantly better on repetition than elicitation. On the contrary, [Fabbretti et al. \(1997\)](#) using a story description task investigated a number of complex sentence structures such as relative clauses and gerund sentences. The examined groups used similar types of clauses, more often simple clauses than complex, with DS subjects produced significantly larger number of simple clauses. Most of the participants with DS used more verbs and half of them produced more coordinated clauses than their normal matches, but these differences between the two groups were not significant. Similarly, there were no significant differences concerning the production of complex clauses considered as a whole, or the use of embedded clauses, which were very rare in both groups.

Regarding the examination of complex syntactic structures, [Polišenská et al. \(2018\)](#) observed that the participants of all groups in her study presented similar order of difficulty, with simple Subject-Verb-Object (SVO) active sentences producing the best performance, whereas comprehension of relative clauses proved the most difficult. The analysis revealed no significant difference between the groups on function words and relative clauses, but there were significant differences on negation and the SVO category with the group of children with ID finding those structures more difficult. [Grela \(2003\)](#) found that there were no

differences for the omission of subject arguments between the DS group and TD controls, although the DS individuals were more likely to omit subject arguments in comparison to direct object arguments, when arguments for transitive verb productions were compared. Significantly, controls were more likely to use anomalous argument patterns than the children with DS.

Moreover, [Frizelle et al. \(2018\)](#) studied the ability of children with DS to understand specific complex syntax, such as relative clauses, complement clauses and adverbial clauses, using a newly devised animation task. The relative clauses were all full bi-clausal relatives, each attached to the direct object of a transitive clause. The five types included subject (transitive and intransitive), object, indirect object and oblique. Sentential complements included four complement-taking verbs, three of which were mental state verbs (think, know, pretend) and one of desire (wish). Adverbial clauses included two temporal (before, after), one causal (because) and one conditional (if). Data indicated that children with DS performed at a significantly lower level than both control groups, all three groups performed best on relative clauses and children's performance on adverbial and complement clauses was similar within each group. With the exception of intransitive subject relative clauses, children with DS performed at floor on all other complex sentences. Their findings suggest that the children with DS have a disproportionate difficulty understanding complex sentences. In this line, [Witecy and Penke \(2017\)](#) observed that complex sentences were in general understood poorly. With respect to performance on simple sentences, they found that as the number of constituents increases, comprehension becomes more difficult. Sentences with three elements were understood worse than those with two elements and double object constructions were especially challenging for the participants with DS.

[Grela \(2002\)](#) found that children with DS infrequently used sentence complements, sentential embeddings, or compound sentences. Also, [Galeote et al. \(2013\)](#) noticed that the morphosyntactic complexity increased very gradually in both groups of children up to the 300-word level. From that level on, significant differences appeared between the two groups of children, TD and DS. Accordingly, even though the children of both groups showed no differences in the combining of words, nor in MLU of the three longest phrases, the syntax of children with DS was less complex. Moreover, [Zampini & D'Odorico \(2011\)](#) conducting a qualitative analysis of the complex sentences uttered found that there were significant differences in the use of simple and complex sentences. Furthermore, they observed a lower number of subordinate clauses in children with DS. Particularly, the children with DS produced only non-finite clauses, whereas 28% of the complex sentences produced by the TDC were finite clauses. Also, 59% of the utterances produced by the children with DS contained at least one verb, whereas the TDC produced 88% utterances with verbs. Additionally, [Price et al. \(2008\)](#) highlighted that DS group produced not only shorter, less complex utterances overall, but less complex noun phrases, verb phrases, and

sentence structures, as questions/negations than did the TD group. Recently, [Koizumi et al. \(2019\)](#) found that children with ID performed significantly lower than TD children of the same age, especially for morphologically and syntactically more complex aspects of language, such as conjunction particles, passive sentences and comparative expressions. In regard of DS children, they indicated significantly lower scores in conjunction particles, particle strategies and sentence structures. Their percentage of correct answers to long sentences with grammatically complex structures was significantly lower than in children with other types of disabilities and the number of acquired particles in children with DS was significantly smaller as well.

Examining the omissions of grammatical words, it is necessary to underline that individuals with DS tended to omit function words as reported from a plethora of studies. [Witecy & Penke \(2017\)](#) observed that the comprehension of function words proved to be challenging for the adult participants with DS, while [Fabbretti et al. \(1997\)](#) noticed that DS individuals omitted more often function words even at higher MLU levels. Also, [Chapman et al. \(1998\)](#) found that omissions of word tokens and types were more frequent in the participants with DS than the younger control sample matched on MLU, as well as most omitted words were function words, including forms of the copula, auxiliary, modal auxiliary, articles, prepositions, pronouns, adverbial adjunct, conjunctions, and infinitive in both examined groups.

Recent studies on DS's language have revealed patterns that they are not attested in the developmental path of TD children in the comprehension of pronouns ([Perovic, 2006a](#); [Ring & Clahsen, 2005a](#); [Witecy & Penke, 2017](#)). Individuals with DS appear to have difficulties in the comprehension of reflexive pronouns instead of personal pronouns. Concretely, [Perovic \(2002, 2006a\)](#) highlighted a specific syntactic deficit in the language of DS, related to the inability to establish a certain syntactic dependency, namely the binding relation between an anaphor and its antecedent. Subjects had specific difficulties giving appropriate interpretation to reflexives, as opposed to pronouns. [Perovic \(2006b\)](#) examined Serbo-Croatian speaking adults with DS using a truth-value judgment task. Results from the independent samples t-tests confirmed that the scores of participants with DS differed significantly to those of the TD controls for name reflexive and for quantifier-reflexive, both on mismatch conditions. DS cohort showed particular difficulties forming the syntactic dependency of anaphoric binding. Also, they showed a generally good performance on pronominal clitic conditions, apart from their performance on quantifier pronominal clitic condition, which was low. Similarly, [Ring and Clahsen \(2005b\)](#) using the sentence-picture judgment task STOP (Syntactic Test of Pronominal Reference, [van der Lely & Stollwerck, 1997](#)) and the sentence picture matching task TAPS (Test of Active and Passive Sentences, [van der Lely, 1996](#)) found that the DS individuals encounter difficulties in the interpretation of sentences with reflexive pronouns, whereas their performance on sentences with non-reflexive pronouns

was overall more accurate. Also, [Sanoudaki & Varlokosta \(2014\)](#) revealed a different pattern in DS from patterns observed in TD children in pronoun interpretation. The DS group encountered problems in the interpretation of reflexive pronouns, while the performance of the two groups did not reveal any differences in their interpretation of other elements, including pronominal clitics, strong pronouns, and reflexives preceded by two nouns. Moreover, [Bol & Kuiken \(1990\)](#) observed problems with personal and possessive pronouns, as well as poor control over demonstrative and interrogative pronouns in DS group. A more recent study, that of [Witecy & Penke \(2017\)](#) demonstrated that individuals with DS had considerable difficulties with the comprehension of sentences containing personal pronouns, either it was subject or object pronouns. [Fabbretti et al. \(1997\)](#) noticed that the two examined groups of their study had a comparable repertoire of conjunctions and clitic pronouns.

4.2.2. The Use of Verbs and Nouns

It is suggested that verbs are more complex than nouns, carrying both semantic and syntactic information and consequently, they are more difficult to learn them on average, even for TD children. Verbs are, however, fundamentally linked to nouns because they require arguments, or additional words, to help complete their meanings. Also, verbs are responsible for linking words within a sentence, they play a key role in syntax and possible disorders and may impact the syntactic development. [Kernan and Sabsay \(1996\)](#) comparing the linguistic and cognitive abilities of adults with DS to those with mental retardation of unknown etiology found that adults with DS performed significantly lower on syntax in all subcategories except for nouns and simple sentence structure. Also, in the study of [Polišenská et al. \(2018\)](#) examined groups showed significantly better performance for nouns compared with verbs, particularly 81% versus 59% correct answers for the ID group, compared with 88% versus 65% for the TD group.

Moreover, [Galeote et al. \(2018\)](#) aimed to analyze the acquisition of different classes of words in Spanish-speaking children with DS, with special emphasis on nouns and verbs. Their results indicated considerable similarity between children with DS and their TD peers. Although the post hoc comparisons showed no differences between the two groups of children for any of the word classes, children with DS tended to produce fewer predicates and closed-class words. Nevertheless, the specific analysis of verbs showed that children with DS produced fewer words of this kind, even though this result presented statistically significant value only at a higher lexical level of 251 - 400 words. At the first three levels (≤ 10 , 11 - 50, and 51 - 100 words) no differences were observed between the proportions of nouns, predicates and closed-class words, all of which were very low. Nouns began to emerge at the level of 101 - 250 words and their proportion became distinguishable from that of predicates and closed-class words. Predicates emerged at the level of 251 - 400 words, although their proportion was still below that of nouns. Importantly, at the final level (≥ 401 words) the proportion of predicates was equivalent to that of nouns. The study of [Checa](#)

et al. (2016) analyzed the composition of early vocabularies in a large sample of 108 Spanish-speaking children with DS and compared it with that of children with TD. The categories examined were nouns, predicates, closed-class words, and social words. The performance of children with DS was similar to that of children with TD with the same vocabulary size. The only significant difference was the larger production of nouns by children with DS. The most surprising among their findings was the absence of any differences between the two groups of children in the production of closed-class words. The development of the other classes of words was also similar. Social words were the most frequently produced category at the first lexical levels (<100 words), with a linear decline as vocabulary size increases. Nouns showed continuous growth across the first levels, and by the level of 101 - 250 words, they were more numerous than all the other classes of words, whereas predicates showed a slow but continuous growth and their presence become evident after the level of 101 - 250 words. Closed-class words showed minimal production, especially at the initial levels, although they showed a slow and constant growth.

Bello et al. (2014) investigated the lexical comprehension and production abilities as well as gestural production and they found that nouns are understood and produced in higher percentages compared to predicates. Overall, both groups produced significantly more correct answers in comprehension than in production task. Zampini & D'Odorico (2011) found no significant differences in the proportion of common nouns and verbs-adjectives, however the children with DS produced a significantly higher proportion of simple terms, as routines-people, and a significantly lower proportion of adverbs-function words. The analysis of the argument structures of verbs with two or more arguments showed that subject-verb-indirect object and subject-verb-direct object were the most frequent multi-argument structures for both groups. It was of particular interest that children with DS seemed to have greater difficulties in expressing sentences in a grammatically correct form, though they were able to combine words.

As it is reported, verb production is also affected by the syndrome in many ways. Some studies show that individuals with DS produce fewer verbs overall relative to TD children, whether matched on MLU (Hesketh & Chapman, 1998), receptive vocabulary (Michael et al., 2012), or nonverbal cognitive ability levels. Loveall et al. (2019) examined verb production by individuals with DS relative to both TD peers matched by nonverbal cognitive ability level and to individuals with mixed-etiology ID of other origins matched by chronological age. Results of this study indicated that participants with DS produced narratives with less verb density than participants with TD, they had smaller verb type-token ratios than participants with intellectual disability and they demonstrated relatively strong verb diversity. Although individuals with DS may have a large number of verbs in their vocabularies, they did not use them as regularly in their narrations. Hesketh & Chapman (1998) examined the production of grammatical and lexical verbs in narratives of individuals with DS and TDC and their results revealed

that the individuals with DS produced significantly fewer lexical or grammatical verbs per utterance, but with greater diversity of lexical verbs. Also, individuals with DS produced a significantly smaller percentage of lexical verbs that were metacognitive or metalinguistic in nature and a significantly greater number of utterances that did not include a verb. Authors suggested that the syntactic deficit in DS did not arise from a failure to construct syntactically complex utterances, but may reflect their difficulty in accessing verbs when constructing utterances as a result of deficits in auditory short-term memory.

However, [Grela \(2002\)](#) failed to find significant differences between individuals with DS and TD children matched on MLU in their production of verbs, probably due to differences in the elicitation materials used across studies. [Hesketh & Chapman \(1998\)](#), [Michael et al. \(2012\)](#) and [Loveall et al. \(2019\)](#) all used narrative tasks, but [Grela's \(2002\)](#) data included language transcripts. Also, differences may occur due to different CA, as the participants in the study of [Grela \(2002\)](#) may not have had sophisticated enough expressive language to reveal differences in verb use. Also, studies have found that participants with DS may produce a greater variety of verbs than TD controls of similar developmental level, specifically lexical verbs ([Grela, 2002](#); [Hesketh & Chapman, 1998](#)).

Studies examining verb comprehension in DS have not found significant differences between groups with DS and TD ([Loveall et al., 2016](#); [Michael et al., 2012](#)) but have found differences between individuals with DS and mixed-etiology ID ([Loveall et al., 2016](#)). More specifically, [Loveall et al. \(2016\)](#) were especially interested in the comprehension of verbs, because of their importance to later syntactic development. They compared groups with DS, TD, and mixed-etiology ID and found that, relative to age-matched peers with ID, youth with DS performed lower on verb items. Further, this difference was maintained even when they were compared for overall receptive vocabulary and phonological memory. The two groups, however, did not perform differently on noun or attribute items, and there were not observed group differences between the groups with DS and TD. Also, [Michael et al. \(2012\)](#) examined the use and comprehension of verbs differing in argument structure. DS and TD groups performed similarly on single-word tasks, but the DS group omitted verbs from targeted sentences in their narratives and showed poor grammaticality judgment abilities. Interestingly, they did not differ significantly from the TD group in comprehension of isolated nouns or verbs, and in naming of single nouns or verbs, as well. Both groups had difficulty retrieving verbs to label stimulus pictures. Individuals with DS performed significantly worse when asked to judge sentence grammaticality and omitted verbs in elicited narratives significantly more often than TD individuals, specifically when productions of 2-place and 3-place verbs were attempted. Individuals with DS also omitted other necessary elements of argument structure, such as subjects, in sentences containing 2-place and 3-place verbs significantly more often than individuals with typical development. Authors concluded that performance was not related to working memory skills and individuals with DS display a specific expressive deficit in verb and argument struc-

ture retrieval (but not comprehension) that varies as a function of verb type (1-place, 2-place, and 3-place).

5. Conclusion

The developmental literature has shown that syntax constitutes a particular linguistic challenge for individuals with DS who are relatively more impaired in the domain of language than in other areas of cognition. The syntactic processing abilities of the DS population as compared to typically developing individuals were explored in this review paper. Also, the purpose of this paper was to discuss the findings of published studies on the syntactic abilities with reference to the deviant or delayed pattern of development, as well as to the critical period of language development, and more specifically of syntactic development, in the DS population.

In the studies included, researchers used a plethora of elicitation materials, methods of analysis and also different groups of subjects to make comparisons. Chronological age, mental age, developmental age, MLU, or receptive vocabulary size were among those measures used for matching the examined groups. This variability among matching measures probably accounts for the differences in the studies' outcomes. Additionally, the different numbers of the examined samples may not guarantee the generalization of the findings. Furthermore, different results in the studies on the syntactic abilities of the DS population from different countries may have emerged from the specific characteristics of the language spoken by the samples, in terms of morphosyntax. Most studies in the relevant literature have been carried out with English-speaking individuals, and an important question that arises is whether their results apply for other languages. For this reason, this review paper included studies from various countries with different speaking languages, thus giving information on the language abilities and more specifically on the syntactic abilities, of the DS population in English (Bridges & Smith, 1984; Laws & Bishop, 2003; Joffe & Varlokosta, 2007), German (Witecy & Penke, 2017; Penke, 2018), Italian (Fabbretti et al., 1997; Vicari et al., 2000; Caselli et al., 2008; Zampini & D'Odorico, 2011; Bello et al., 2014), Spanish (Checa et al., 2016; Galeote et al., 2013, 2018), French (Facon & Magis, 2019), Slovak (Polišenská et al., 2018), Greek (Tsakiridou, 2006; Stathopoulou, 2007; Andreou, 2013; Sanoudaki & Varlokosta, 2014), Serbo-Croatian (Perovic, 2006b), American (Hesketh & Chapman, 1998; Thordardottir et al., 2002; Chapman et al., 2002; Chapman, 2006; Michael et al., 2012; Loveall et al., 2016, 2019; among others) and Japanese (Koizumi et al., 2019). No restriction was mooted during the selection process of the studies and therefore this review provides evidence from a variety of languages in addition to English, giving the opportunity for comparisons and further knowledge on the syntactic performance of this population in various languages.

The data from the studies presented, showed a disadvantage of the DS population in syntactic processing, at both production (Hesketh & Chapman, 1998; Vicari et al., 2000; Ring & Clahsen, 2005a; Tsakiridou, 2006; Joffe & Varlokosta,

2007; Stathopoulou, 2007; Caselli et al., 2008; Zampini & D’Odorico, 2011; Andreou, 2013; Bello et al., 2014; Koizumi et al., 2019; Loveall et al., 2019) and comprehension (Chapman et al., 1991, 2002; Rondal & Comblain, 1996; Vicari et al., 2000; Perovic, 2001, 2006a; Ring & Clahsen, 2005a, 2005b; Andreou, 2013; Bello et al., 2014; Joffe & Varlokosta, 2007; Sanoudaki & Varlokosta, 2014; Loveall et al., 2016; Witecy & Penke, 2017; Polišenská et al., 2018; Koizumi et al., 2019) levels, compared to typically developing individuals. This disadvantage has been interpreted by the researchers as either delayed or following a completely different pathway. From the examination of the published studies, we conclude that the pattern of syntactic development in the individuals with DS seems to be more delayed than deviant (Bridges & Smith, 1984; Rutter & Buckley, 1994; Fabbretti et al., 1997; Thordardottir et al., 2002; Eriks-Brophy et al., 2004; Schaner-Wolles, 2004, among others) or deviant (Perovic, 2004, 2006a, 2006b; Ring & Clahsen, 2005a; Penke, 2018). In a remarkable number of studies there is a considerable individual variability, but the great majority of the studies examined, revealed that the language characteristics of individuals with DS follow a common profile with TDC. Receptive language is typically stronger than expressive language, and vocabulary is stronger than syntax in both receptive and expressive domains. With regard to the critical period for language development in the DS population, some authors concluded that there was a plateau in the syntactic development, that ended near adolescence, and therefore, it was thought that little progress in the syntactic domain was possible after that period (Lenneberg et al., 1964; Fowler, 1990; Fowler et al., 1994; Rondal & Comblain, 1996; Iacono et al., 2010; Witecy & Penke, 2017; Koizumi et al., 2019). However, the majority of the reported outcomes supports the opposite view (Kernan & Sabsay, 1996; Chapman et al., 1998, 2002; Thordardottir et al., 2002; Andreou, 2013; Facon & Magis, 2019). Language learning continues in both processes, that is in production and in comprehension, for older adolescents and young adults. The appearance of plateaus in syntax development may be partly linked to the nature of the sample, particularly their age, or to the materials used. For example, individuals with DS tend to use more complex syntactic structures in the narrative tasks used in some studies than in different tasks used by others.

Particularly, concerning their syntactic ability DS individuals tend to produce shorter and less complex utterances compared to typically developing population (Rosin et al., 1988; Chapman et al., 1998; Price et al., 2008; Zampini & D’Odorico, 2011; Galeote et al., 2013; Frizelle et al., 2018), although advances in syntactic complexity may continue into late adolescence and young adulthood. It is also reported that DS group produced not only shorter, less complex utterances overall, but less complex noun phrases, verb phrases, and sentence structures, like questions and negations than did the TD group (Rosin et al., 1988; Chapman et al., 1998, 2002; Vicari et al., 2000; Chapman & Hesketh, 2000; Tsakiridou, 2006; Fabbretti et al., 1997; Stathopoulou, 2007; Price et al., 2007, 2008; Caselli et al., 2008; Zampini & D’Odorico, 2011). Moreover, difficulties emerged in subordination and in coordination, in relative clauses, in adverbial clauses, in

finite clauses and in negated constructions (Rondal & Complain, 1996; Joffe & Varlokosta, 2007; Stathopoulou, 2007; Zampini & D’Odorico, 2011; Witecy & Penke, 2017; Polišíenská et al., 2018). Additionally, they tended to use infrequently sentence complements, sentential embeddings, or compound sentences (Grela, 2002; Thordardottir et al., 2002; Frizelle et al., 2018). Obviously, the above difficulties increased with sentence length and grammatical complexity, but were also apparent in simple sentences. Overall, the Subject-Verb-indirect/direct Object was the most frequent multi-argument structure for DS and TDC groups (Zampini & D’Odorico, 2011; Frizelle et al., 2018; Polišíenská et al., 2018). On the contrary, results from the Italian language show that syntax does not pose great difficulties on people with DS, since while DS subjects produced significantly larger number of simple clauses, they are able to produce a number of complex sentence structures such as relative clauses and gerund sentences (Fabbretti et al., 1997). However, it was of particular interest that children with DS seemed to have greater difficulties in forming grammatically correct sentences. Similarly, results from English-speaking people indicate that there were similar omission patterns of subject arguments for both TD and DS children when comparisons were made across verb categories with no difference as argument structure complexity increased (Grela, 2003). However, children with DS were presented more likely to omit arguments in the subject position than in the direct object position, whereas TD controls used a greater number of anomalous arguments (Grela, 2003; Zampini & D’Odorico, 2011; Michael et al., 2012).

Regarding complex syntactic structures, it is worth mentioning that the Slovak DS population was observed to have similar order of difficulty with those of TD, with simple Subject-Verb-Object active sentences producing the best performance, whereas comprehension of relative clauses proved the most difficult (Polišíenská et al., 2018). The results from the studies examined showed that DS children exhibited significantly lower performance than that of MA controls across all types of relative clauses, with the exception of intransitive subject relative clauses, and they adopted an avoidance strategy by producing other types of responses instead of the targeted relative clauses (Stathopoulou, 2007; Frizelle et al., 2018; Polišíenská et al., 2018). Also, relative clauses with pronouns in accusative or dative case proved to be problematic (Witecy & Penke, 2017). In addition, DS individuals had severe problems with producing wh-questions, while similarly to TDC performed better on comprehension than elicitation and also significantly better on repetition than elicitation (Eriks-Brophy et al., 2004; Tsakiridou, 2006; Joffe & Varlokosta, 2007).

Moreover, another domain that appears to be particularly disadvantaged in the DS population is the interpretation of passives (Bridges & Smith, 1984; Eriks-Brophy et al., 2004; Ring & Clahsen, 2005b; Joffe & Varlokosta, 2007; Witecy & Penke, 2017; Koizumi et al., 2019). Their performance on active sentences was better than that on passive ones and they also obtained significantly higher transitive responses with full and short passives than ambiguous passives (Joffe & Varlokosta, 2007). In addition, they appeared to encounter difficulties in

the comprehension and interpretation of sentences with pronouns, mainly with reflexive pronouns instead of personal pronouns, probably due to their inability to establish a certain syntactic dependency, namely the binding relation between an anaphor and its antecedent (Bol & Kuiken, 1990; Perovic, 2001, 2002, 2006a, 2006b; Ring & Clahsen, 2005b; Sanoudaki & Varlokosta, 2014; Witecy & Penke, 2017). It is worth mentioning that TDC also present difficulties with personal pronouns and that the performance of DS individuals did not reveal any differences from TDC in their interpretation of other elements, such as pronominal clitics (Perovic, 2006b; Fabbretti et al., 1997; Sanoudaki & Varlokosta, 2014). It must be noted that there are conflicting conclusions in the studies examined concerning pronouns, as in some of them the DS population presented difficulties with personal (either it was subject or object pronouns) and possessive pronouns, as well as poor control over demonstrative and interrogative pronouns (Witecy & Penke, 2017) and in others DS individuals presented comparable performance in clitic pronouns (Fabbretti et al., 1997; Perovic, 2006b). Regarding the Greek language difficulties are not observed in the DS cohort with pronouns, except for reflexive pronouns (Sanoudaki & Varlokosta, 2014). This is an important finding because of the different pattern in the comprehension of pronouns in the Greek language compared to other languages.

It is worth pointing out that DS individuals presented significantly better performance on nouns with continuous growth from the first lexical levels compared with verbs (Kernan & Sabsay, 1996; Hesketh & Chapman, 1998; Michael et al., 2012; Checa et al., 2016; Polišenská et al., 2018). Nouns were also understood and produced in higher percentages compared to all the other classes of words. It is documented that DS individuals produced fewer or no utterances with verbs overall relative to TD population, although this result was found statistically significant only at higher lexical levels (of 251 - 400 words) (Galeote et al., 2018). At this point, we should mention that although individuals with DS may have a large number of verbs in their vocabularies, with greater diversity of lexical verbs, however, they did not use them regularly (Loveall et al., 2019). Moreover, they were able to produce transitional forms and made significantly greater use of some of them, for example formulas and dummy element productions, than TDC in some cases (Zampini & D'Odorico, 2011).

It must be noted that since we find impaired syntax and syntactic processing in the DS cohort, it is important to consider possible intervention strategies that may be used in the education context mainly, to enhance syntactic performance on the part of this population. There is an urgent need for setting up more targeted and effective intervention programs, which focus on specific syntactic phenomena with the aim of improving syntactic understanding and production in individuals with DS. The improvement of language abilities of this impaired population via syntactic therapy may also improve considerably their communicational abilities.

Moreover, although a large body of research examining language skills for individuals with DS is available, the majority focuses only on the language abilities

of young children. Therefore, more research is needed in older individuals and especially more longitudinal studies which will be valuable in order to perceive any discrepancies and to get comparisons about the improvement or not of the same individuals over the years. In addition, it is necessary to conduct research in languages other than English, which are morphologically richer and subsequently discuss the results. At this point, it is worth noting that most studies have examined the general linguistic profile of the DS population and very few studies to date have examined the domain of morphosyntax especially in the Greek language. Therefore, more research is needed in the Greek language and the findings, which are likely to be completely different from other languages, could be used in order to make intervention programs focused on the morpho-syntactic domain for the Greek DS population.

In conclusion, the present review paper gathered information from published studies on the syntactic abilities of individuals with DS and after an analysis and comparison of their findings, the results obtained provide detailed knowledge of syntactic processing among the DS population. The use of this knowledge by therapists/clinicians who deal with DS individuals would be beneficial as it could encourage better treatments and effective, differentiated intervention programs for improving the syntactic domain. Furthermore, our results highlight the importance of conducting research on different populations and languages, the findings of which will give the opportunity to compare the outcomes and find the particular difficulties of each language or similarities in the performance on specific syntactic phenomena.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Table 1. Studies on the syntactic abilities of individuals with DS.

Study	Participants	Materials	Results
1. Andreou (2013)	12 GreekDS (CA: 6 - 7.11 years)/12 Greek DS adolescents (CA: 14 - 15.11 years)/12 Greek TDC (CA: 6 - 7.11 years)	Psychometric Criterion of Language Adequacy: a) test of Morphosyntactic Comprehension; b) test of Morphosyntactic Production	Children with DS: significant lower scores than adolescents with DS and TDC in receptive syntax tasks, but no differences from adolescents with DS in expressive syntax tasks. Most errors made of DS individuals concerned the verb morpheme production. Syntactic development in DS continues to grow in adolescence, especially in the expressive domain.
2. Bello et al. (2014)	14 Italian DS (mean CA: 54 months, mean DA: 34 months)/14 Italian TDC (mean CA: 29 months, mean DA 38 months)	PiNG Italian MB-CDI	DS: general weakness in lexical comprehension and production. Significantly higher percentage of errors than TD, as well as no-responses. Also, more representational gestures + more unimodal gestural answers. Nouns are understood and produced in higher percentages than predicates.
3. Bridges & Smith (1984)	24 English DS (mean CA: 11.1 years, VCA 2.5 - 5.2)/24 TD (mean CA: 3.0 years, VCA 2.5 - 5.2) matched on verbal comprehension	Comprehension task of active/passive/neutral sentences	Better performance on active sentences than on passive for both groups. Also, similarities in terms of percentage correct responses and patterns of errors. DS: a slight delay (6 - 12 months) in the appearance of syntactic strategies of comprehension compared with those non-retarded children.
4. Caselli et al. (2008)	16 Italian DS (CA: 6.7 - 14.2 years)/16 with SLI (CA: 3.5 - 5.7 years)/32 TDC (CA: 3.8 - 5.7 years)	Stanford-Binet Scale Leiter PPVT Boston Naming Test (BNT) Linguistic Comprehension Test (LCT) Phrase Repetition Test (PRT)	DS + SLI: worse performance than TD. Although no significant differences in lexical and morphosyntactic comprehension abilities, significant differences did emerge in morphosyntactic production capacities. DS: more errors than SLI children, who, in turn, made more errors than TDC. DS: more omissions, a significantly higher number of articles, verbs, and prepositions than SLI children, whereas no difference was found for nouns and for modifiers. DS + SLI (but not with TD) omitted more articles in sentences than in syntagms. Qualitative analysis of the morphosyntactic errors revealed strong similarities between the DS + TD groups.
5. Chapman (2006)	20 American DS (CA: 12 - 21 years)/16 with cognitive impairment of unknown origin (CA: 12 - 21 years)	3-hour protocol: hearing screening, the Bead Memory and Pattern Analysis subtests of the Stanford Binet, PPVT-3, the vocabulary subtest of the Test of Auditory Comprehension of Language-3, interview language samples, narrative language samples, Kaufman-ABC number recall task (digit span) and the Nonword Repetition Test	DS: The auditory-verbal working memory deficit appears to be part of its specific phenotype, as well as the loss of comprehension skills in adolescence, and is poorer for both syntax comprehension and vocabulary comprehension than the group with cognitive impairment of unknown origin. The significantly better performance of the DS and cognitively impaired groups on the PPVT-3, relative to syntax comprehension, appeared attributable to CA and the additional life experience. Deficits in auditory-verbal working memory, syntax and vocabulary comprehension, and narration of picture-books without an opportunity to preview them are all specific to the adolescent group with DS.

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6.	Chapman et al. (2002)	31 American DS (CA: 5 - 20 years)	3-hour protocol: hearing screening, TACL-R, PPVT-R, MLU-S from 12-min narrative language samples, Stanford Binet (4th ed.) Bead Memory and Pattern Analysis subtests, digit span subtest of the Illinois Test of Psycholinguistic Ability (ITPA), and the Nonword Repetition Test	<p>Individual differences in expressive language syntax at study start are best predicted by syntax comprehension.</p> <p>Syntax comprehension across the 6 years of study participation is best predicted by age at study start and measures of short-term memory (auditory + visual), while change in syntax comprehension across this time is predicted by age at study start. The expressive language acquisition continues in adolescence for most individuals with DS, and is predicted by syntax comprehension and its growth trajectory. The rate of MLU increase is greatest for those for whom comprehension declined less. However, no evidence of a critical period. DS speakers: more advanced content than is typical for their average utterance length, thus need for more complex expressive syntax. Measures of syntax development which focused on comprehension rather than on production might depict different longitudinal outcomes of loss, plateauing, or gain depending on age.</p>
7.	Chapman et al. (1998)	47 American DS (CA: 5.6 - 20.6 years)/47 TDC (CA: 2.2 - 6.1 years)	3-hour protocol: hearing screening; picture descriptions; story retelling; Form L of the PPVT-R; 6 min. conversation and 12 min. narration with the examiner; an object hiding task evaluating fast mapping for a novel noun (Chapman et al., 1990); the Expressive Vocabulary, Bead Memory, and Pattern Analysis subtests of the Stanford-Binet, 4 th edition; conversation and snack with a parent; a speech motor evaluation; delayed story recall; event narration; the TACL-R; the delay condition of the object-hiding task administered earlier.	<p>No evidence for a slowing of lexical or syntactic development from age group 2 (8 - 12 years) on or from age group 3 (12 - 16 years) on, no evidence of a critical period for language development ending at adolescence, nor of a “syntactic ceiling” at MLU corresponding to simple sentences for the DS group. DS: specific language impairment compared to control children, in number of different words and total words (in the first 50 utterances) and in MLU. Clear evidence of a deficit in the DS group’s expressive language performance across measures of syntactic complexity, word frequency, diversity in a fixed number of utterances, and rate of word production, despite more frequent utterances per minute, in both conversational and narrative samples.</p>
8.	Chapman et al. (1991)	48 American DS (CA: 5.6 - 20.6 years)/48 TDC (CA: 2 - 6 years)	3-hr protocol: hearing screening, picture descriptions, story retelling, Form L of the PPVT-Revised, conversation and narration with the examiner, an object hiding task (Chapman et al., 1990), the Expressive Vocabulary, Bead Memory, and Pattern Analysis subtests of the Stanford-Binet, 4th ed., conversation and snack with a parent, a speech motor evaluation, delayed story recall, event narration, the Test for Auditory Comprehension of Language Revised, and the delay condition of the object hiding task	<p>Differences within the group of DS between lexical and syntactic comprehension skill increasing with age, as well as between nonverbal cognitive subtests of pattern analysis and short-term memory for bead arrangements. CA and mean MA, collectively, accounted for 80% of the variability in syntax comprehension and hearing status predicted an additional 4%. Overall, adolescents with DS can be described as having advanced vocabulary comprehension, and also have appeared to have mild deficits in syntax comprehension. Their results are consistent with findings of sequential processing deficits or visual storage deficits.</p>

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9.	Checa et al. (2016)	108 Spanish DS/108 Spanish TDC [both MA 9 - 29 months]	Brunet-Lézine Psychomotor Development Scale-Rev CDI-Down	<p>Similar performance of children with DS + TD with the same vocabulary size. The only significant difference: larger production of nouns by children with DS. DS: greater competency in the cognitive than in the linguistic domain.</p> <p>No differences between them in the production of closed-class words.</p> <p>DS: greater diversity (more types) of lexical verbs, although the use of these verbs (tokens) was less frequent among the children with DS, who produced more utterances without a verb.</p>
10.	Eriks-Brophy et al. (2004)	8 high-functioning DS (CA: 11 - 33 years)	<p>An act-out task and a written forced-choice comprehension task</p> <p>PPVT</p> <p>TACL</p> <p>Gates-MacGinitie reading test</p> <p>Truth Value Judgement</p>	<p>Some, if not all, persons with DS could deal well with the passives.</p> <p>In line of Bridges and Smith (1984) construction develops in a normal, but delayed manner in DS. DS: benefit from the elimination of the by-phrase in non-actional passives.</p> <p>Standardized tests are not always good predictors of grammatical ability, as emerged from the comparison in the comprehension and production abilities of two subjects.</p>
11.	Fabbretti et al. (1997)	10 Italian DS (CA: 6.1 - 15.4 years)/10 MLU-matched TDC (CA: 2.6 - 6 years)	Story description tasks	<p>Strong individual differences in DS sample.</p> <p>Two groups comparable lexical + morphological repertoire, but DS delayed performance (conjunctions and clitic pronouns).</p> <p>DS: more omissions of function words, greater use of simple clauses, more prompting in narrative task with unrelated descriptions, more inaccurate language production.</p>
12.	Facon & Magis (2019)	62 French DS (mean CA: 14.8 years)/62 ID (mean CA: 14.92 years) matched on CA and non-verbal cognitive level	<p>French version of the Test for Reception of Grammar</p> <p>Raven's Colored Progressive Matrices</p> <p>French version of the PPVT</p>	<p>Continuous progress of vocabulary and receptive syntax from childhood to adulthood. Although the chronological effect size was small for syntax and moderate for vocabulary (4% and 15% of the explained variance, respectively), results showed a linear increase of tests cores between childhood and adulthood for those with undifferentiated etiology and those with DS.</p> <p>The results also showed that the relationship between CA and test scores was significantly stronger for vocabulary than for syntax and that participants with undifferentiated etiology performed better than participants with DS, whatever the test.</p> <p>Significant effects of CA and diagnosis, but the CA × diagnosis interactions were nonsignificant.</p> <p>Comprehension of vocabulary and syntax does not asymptote prematurely in individuals with DS.</p>

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13.	Frizelle et al. (2018)	33 Irish DS (mean MA: 79.27 months)/32 with cognitive impairment of unknown etiology (mean MA: 83.91 months)/33 TDC (mean MA: 79.21 months)	Leiter-3 Subtests from WMTB-C A version from WMTB-C Hearing screen TROG-2 A devised animation task (TECS-E)	DS: performed at a significantly lower level. All three groups performed best on relative clauses, while children's performance on adverbial and complement clauses was similar within each group. DS: disproportionate difficulty understanding complex sentences. Understanding of syntax in DS is not completely explained by poor cognitive or memory skills, rather it appears to be a specific deficit that may distinguish these children from other with neurodevelopmental disorders.
14.	Galeote et al. (2018)	108 Spanish DS (mean CA: 41.11 years, mean MA: 21.26 years)/108 TD (mean CA: 20.19 years, mean MA: 20.23 years)	Brunet-Lézine Psychomotor Development Scale-Revised for MA, MacArthur-Bates CDIs (CDI-Down)	DS: fewer predicates and closed-class words than their peers with TD, also fewer verbs (statistically significant at the lexical level of 251 - 400 words). The proportion of social words was the highest across all lexical levels. At the first three levels (≤ 10 , 11 - 50, and 51 - 100 words) no differences between the proportions of nouns, predicates and closed-class words, all of which were very low. At the final level (≥ 401 words) equivalent proportion of predicates and nouns.
15.	Galeote et al., 2013	92 Spanish DS/92 TDC (both MA: 20 - 29 months)	Adaptation of the CDI	DS: shorter utterances, with less morphosyntactic complexity and less morphological suffixes than TDC, despite having the same MA. Similar developmental pattern, although slower in DS. No differences between children with DS and vocabulary-matched children with TD in their abilities to combine words and their MLU. DS: lower performance in terms of morphosyntactic complexity and morphological suffixes. The differences tended to appear around a lexical mass of 200 - 300 words.
16.	Grela (2003)	7 American DS (CA: 6.2 - 12.2 years)/7 TDC (CA: 2.4 - 2.8 years)	Language transcripts	DS children omitted subject arguments as frequently as TDC. Both groups were likely to omit subject arguments in intransitive as in transitive verb constructions. DS omitted more subject arguments than arguments in the direct object position. TDC more likely to produce anomalous arguments than children with DS.
17.	Grela (2002)	7 American DS (CA: 6.2 - 12.2 years)/7 TDC (CA: 2.4 - 2.8 years)	Language transcripts	DS: produced a larger variety of lexical verbs as frequently as their normally developing counterparts, but infrequently used sentence complements, sentential embedding, or compound sentences. Comparable level of syntactic development for both groups. Asynchrony between lexical and syntactic development, and when compared to syntactic development, children with DS show a relative strength in expressive vocabulary.

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18.	Hesketh & Chapman (1998)	29 American DS/29 TDC matched on linguistic level	Narrative language sample	No difference between groups on syntactic complexity for utterances with lexical and grammatical verbs. The syntactic deficit in DS did not arise from a failure to construct syntactically complex utterances, but may reflect difficulty in accessing verbs when constructing utterances due to deficits in auditory short-term memory.
19.	Joffe & Varlokosta (2007)	10 English WS (CA: 6.9 - 13.10 years, mean MA: 4.8 years)/10 DS (CA: 5.11 - 14.0 years, mean MA: 4.6 years)/10 TDC (CA: 3.3 - 6.5 years, mean MA: 5.0 years)	WISC III/WPSSI-R TROG2 Test of Active and Passive Sentences (TAPS) A wh-question elicitation task based on Thornton's (1990) elicitation technique and on Varlokosta (2004) assessed knowledge of wh-movement A wh-question comprehension task based on Varlokosta (2004) assessed understanding of wh-questions A wh-question repetition task	WS + DS similar performance on the standardized measure of grammatical ability and on the experimental tasks that tapped comprehension of passives, and production and comprehension of wh-questions, however, both groups scored significantly below their MA-matched peers mostly in the syntactic tasks. DS: poorer performance than other groups on the repetition of wh-questions. WS + DS: difficulties with the comprehension and production of past tense, significantly better performance in active sentences, no difference in the understanding of ambiguous sentences, poorer performance on both full and short passives (worse on sentences with irregular verbs), while experienced difficulties in wh-question interpretation and production. DS: significantly more reversal responses. Wh-subject questions were the easiest for all groups and which NP-object the most difficult.
20.	Kernan & Sabsay (1996)	28 American DS (CA: 18 - 35 years)/28 with mental retardation of unknown etiology (CA: 22 - 35 years)	K-ABC Raven Coloured Progressive Matrices Auditory Sequential Memory and the Visual Sequential Memory tests of the Illinois Test of Psycholinguistic Abilities (ITPA AS, ITPA VS) Wepman-Morency Auditory Memory Span Test (WM AMST)	DS: significantly poorer performance on the global measures of morphology and syntax, and in all subcategories except for nouns and simple sentence structure. Different linguistic and cognitive profiles of two groups, though differences in cognitive abilities could not account for the difference in linguistic ability nor the impaired hearing or middle ear infection during childhood. The linguistic ability of the adults with DS does not deteriorate with age before the age of 35 years in terms of expressive lexical, morphological, or syntactic ability. ITPA auditory sequential memory test: best predicted the morphology, syntax, and total language scores for the adults with DS.

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21.	Koizumi et al. (2019)	51 Japanese ID (18 ASD - 18 DS - 15 ID without ASD and DS)/78 TDC [3 - 6 years]	Picture Vocabulary Test-Revised Japanese Test for Comprehension of Syntax and Semantics (J.COSS; Nakagawa et al. 2010) A syntax production test used by Saito (2002, 2003). Tanaka-Binet Intelligence Scale	Development of syntax in children with ID significantly delayed than in TDC of the same MA (by 1 - 3 years), and a temporal plateau appears from an MA of 5 to 6 years, during which the development of syntax comprehension is halted. Children with ID with MA of 7 - 9 years old: comprehension of basic grammar forms. DS: significant delay in syntactic development (conjunction particles, particle strategies, sentence structures). Syntax production abilities of ID children: lower than expected based on their MA and considerably delayed than comprehension abilities. MA of 7 - 8 years for ID children for development of syntax production and comprehension abilities. Most errors in the transformation of the passive + causative voice to the active voice. DS children: more difficulties in comprehending morphologically and syntactically complex aspects than other impaired children.
22.	Laws & Bishop (2003)	16 English DS (CA: 10 - 19 years)/17 SLI (CA: 4 - 7 years)/18 TDC (CA: 4 - 7 years)	BPVS-II Raven's Coloured Progressive Matric TROG K-ABC (Expressive Vocabulary Subtest) CELF-R (Recalling Sentences Subtest) MLU from narratives 2 subtests of Rice/Wexler Test of Early Grammatical Development CNRep Word Repetition	Grammar understanding (TROG) was equally impaired in both groups, but receptive vocabulary (BPVS-II) was more problematic for the children with SLI than for the DS group. SLI+DS: have language skills that significantly lag behind nonverbal mental level. Both groups were impaired on tests of grammatical morphology and phonological memory. Both groups present similarities: vocabulary was an area of relative strength, whereas syntax was poor. Expressive language was more severely affected than receptive. Deficits in production of grammatical markers of verb tense. Poor performance on tests of word and nonword repetition. DS: did not differ from MA-matched controls in receptive and expressive vocabulary and in production of irregular past tense morphemes. They tended to use the wrong verb ending in elicited responses. From MLU of 4.5 or more the number of regular and irregular past tense forms produced correctly did not significantly differ from controls.
23.	Loveall et al. (2019)	35 American DS (CA: 11 - 21 years)/27 with ID (CA: 13 - 20 years)/29 TDC (CA: 4 - 6 years)	Narrative story generation task	DS: narratives with less verb density than participants with TD and smaller verb type-token ratios than participants with intellectual disability. Although individuals with DS may have a large number of verbs in their vocabularies, they did not use them although the mean productivity of multiword utterances increased over the three time points (36, 42 and 48 months). Different growth patterns of early syntactic development could be identified. Significant relationships between early syntactic skills and both the child's vocabulary size and developmental age. The number of functions expressed by word combinations appeared to be related to both the vocabulary size and developmental age for all three levels of CA.

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24.	Loveall et al. (2016)	50 American DS (CA: 10 - 21 years)/29 with ID (CA: 10 - 21 years)/29 TDC (CA: 4 - 9 years)	PPVT-4 Leiter-R Nonword Repetition subtest of the CTOPP	ID performed significantly better than both DS + TD on verb items but not on nouns or attributes. DS + TD: same pattern of lexical knowledge, performing better on nouns than both verbs and attributes, while ID participants performed similarly on nouns and verbs, but worse on attributes. CA and cognitive ability are significant correlates of receptive vocabulary for participants with DS. The pattern of results in the DS-TD contrast changed after adding phonological memory as a covariate, DS performed significantly better than the group with TD on overall receptive vocabulary but there were no group differences on verb knowledge.
25.	Michael et al. (2012)	9 American DS (CA: 11.11 - 32.10 years)/9 receptive vocabulary age-matched and gender TDC (CA: 3.2 - 13.6 years)	1st session: PPVT-4, digit-span task, a word-span task, a sentence-repetition task, a single word-naming task, and the hearing screening. 2 nd session: digit-span task with nonverbal response, a word-span task with nonverbal response, a spatial-memory task, a single-word comprehension task, a grammaticality judgment task, and a narrative task. Three memory tasks: a digit span task, a word-span task, and a spatial-memory task (TAPS-3)	DS: significantly worse than the TD group on the sentence memory task, while performed similarly to the TD group on all other measures of memory skills. So, their memory deficits are not tied to linguistic stimuli or verbal responses, per se, but may instead be tied to language processing. DS: significantly worse than TDC in judging sentences grammatically. DS: significantly more omissions of verbs in elicited narratives. Specific expressive deficit in verb and argument structure retrieval (but not comprehension) that varies as a function of verb type.
26.	Penke (2018)	32 German DS (CA: 4.07 - 19.00 years)/16 German TDC (CA: 3.01 - 5.00 years)	An elicitation task on subject-verb agreement; A picture-naming task targeting stem-final consonants and express verbal agreement; A measure of phonological short-term memory (Nonword-Repetition subtest of Sprachentwicklungstest für drei- bis fünfjährige Kinder); TROG-D	DS: large variability in performance on subject-verb agreement (11 of individuals had successfully acquired subject-verb agreement and 16 individuals did not reach the acquisition criterion). A substantial number of children/adolescents with DS displayed a deficit in verbal agreement inflection that cannot be attributed to phonetic/phonological problems. Performance with verbal agreement and nonword repetition were related. Individuals with DS who displayed problems with the verbal agreement system had no significantly lower production scores of stem-final consonants. The morphosyntactic features expressed by the verbal agreement markers had not been acquired by the individuals of the DS-AGR subgroup who did not reach the acquisition criterion of subject-verb agreement. Deviant development rather than a delay in the DS's language.

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27.	Perovic (2006a)	4 English DS (CA: 17 - 21 years)/4 TDC (CA: 5.11 - 7.10 years)	Picture Truth Value Judgement task	<p>DS: difficulties comprehending reflexives, but not pronouns indicating a selective grammatical deficit in DS which is syntactic in nature. The opposite pattern from TDC. DS's language: not merely delayed, but also deficient due to inability to establish the syntactic relation between the anaphor and its antecedent. Modules of the computational system, such as morphosyntax, are relatively more impaired than those associated with the general processing system, such as lexical knowledge or pragmatics.</p> <p>No statistically significant differences between the two groups. Control participants performed at ceiling on all conditions, as well as participants with DS also performed well on a number of test conditions. They were able to answer both yes (match) and no (mismatch) questions appropriately. They also scored high on experimental match conditions with full forms of the pronouns and the reflexive and match conditions with clitic forms. DS differed significantly to those of the TD controls for name reflexive and for quantifier-reflexive, both mismatch conditions. DS: particular difficulties with the anaphor "sebe".</p>
28.	Perovic (2006b)	6 Serbo-Croatian DS (mean CA: 23.3 years)/TDC (CA: 5 - 6.11 years)	Picture Truth Value Judgement task	<p>DS: specific difficulties assigning appropriate interpretation to reflexives (Principle A of standard Binding Theory), as opposed to pronouns, constrained by Principle B.</p>
29.	Perovic (2002)	4 English DS (CA: 17 and 21 years)/TDC in various groups from Chien & Wexler (1990)	Picture Truth Value Judgement task adapted from Chien & Wexler (1990)	<p>This pattern is the reverse of the well-known "Delay of Principle B" effect confirmed in typical acquisition. On conditions involving pronouns (NPM, NPX, QPM, QPX), the subjects performed at ceiling but their performance is strikingly different on conditions that involve reflexives. Specific syntactic deficit in the language of DS, related to the inability to establish a certain syntactic dependency.</p>
30.	Perovic (2001)	4 English DS (CA: 17 - 21 years)/TDC in various groups from Chien & Wexler (1990)	Picture Truth Value Judgement task adapted from Chien & Wexler (1990)	<p>The process of acquisition of Binding in DS qualitatively different compared to typical linguistic development. Specific syntactic deficit in DS, inability to establish a certain syntactic dependency (an anaphor and its antecedent). Performance at ceiling on conditions involving pronouns, but below chance on at least one (match or mismatch) condition with reflexives. DS: significantly worse performance on anaphors as opposed to pronouns, revealing a pattern opposite to the well-known "Delay of Principle B Effect".</p>

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31.	Polišenská et al. (2018)	14 Slovak ID children (CA: 5.3 - 6.11 years)/14 TDC (CA: 3.0 - 7.0 years) matched on nonverbal reasoning abilities	Slovak standardized adaptation of the Raven's CPM Slovak version, part of LITMUS COST IS0804 Battery TROG-2 Slovak version of the original Italian task TOR 3 - 8 for listening comprehension	All groups performed the best at the word level, followed by sentence level and, finally, story level. Strong link with CA and all levels of comprehension only in the TD group, whereas no link with CA at the word level. Strong relationships between verbs, nouns, and sentences in both groups showing close ties between lexicon and grammar. TDC: relationships between knowledge of verbs, sentence, and story levels, but the group of children with ID lacked this relationship. Sentences in the story longer (9.32 words on average) and more complex, including many coordinate and subordinate clauses. Better comprehension of nouns than verbs. Both typical and clinical groups: clear benefit of a simple SVO structure and struggled with relative clauses, while structures with negations in particular caused more difficulties in ID group. No difference from TDC in other categories of sentence comprehension (function words and relative clauses). Interestingly, children with ID did not show a lower performance on relative clauses compared with TDC, although this group of syntactic structures was the most challenging for both groups.
32.	Price et al., 2008	35 American FXS boys without autism (CA: 2.9 - 14.4 years)/36 boys with FXS with autism spectrum (CA: 3.5 - 14.0 years)/31 boys with DS (CA: 4.3 - 16.0 years)/46 TD boys (CA: 2.1 - 6.6 years)	Brief IQ composite of the Leiter International Performance Scale-R ADOS Conversational language samples (MLU, IPSyn)	FXS + DS: shorter, less complex utterances overall and less complex noun phrases, verb phrases, and sentence structures than did the TD boys. FXS with ASD group + DS group, but not the FXS-only group, produced fewer complex questions/negations than did the TD. Compared with the DS group, both FXS groups produced longer, more complex utterances overall. FXS + DS have distinctive language profiles, although both groups demonstrated syntactic delays. Boys with DS showed greater delays.
33.	Price et al., 2007	35 American FXS boys without autism (CA: 3.9 - 15.9 years)/24 FXS with autism spectrum (CA: 4.5 - 15.1)/19 FXS with autism (CA: 5.4 - 15.5 years)/45 boys with DS (CA: 5.4 - 16.0 years)/40 TD boys (CA: 3.1 - 8.6 years)	TACL-3: Vocabulary, Grammatical Morphology, and Elaborated Phrases and Sentences. Leiter-R: figure ground, form completion, sequential order and repeated patterns.	No difference in FXS group, but there were differences between syndromes. DS: lower scores in language comprehension than boys with FXS without autism and TD, but not significant difference from FXS-Spec. or FXS-Aut. Also, lower receptive morphology and syntax skills than those of TDC. Differences among FXS and DS in receptive language levels, demonstrating unique language profiles for each syndrome.

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34.	Ring & Clahsen (2005a)	8 English DS (CA: 12.0 - 14.3 years, MA: 5.4 - 6.10 years)/various groups of unimpaired children matched for MA (CA: 4.10 - 6.11 years)	Four elicitation tasks examining the past tense (use of existing regular and irregular past tense verbs/distinction between existing irregular verbs and homophonous denominal verbs), noun plurals (production of existing regular and irregular plurals), and comparative adjectives	DS: significantly higher percentage of unmarked forms in both regular and irregular conditions. A similar pattern is seen in the Past Tense 2 task, the DS group produced significantly more unmarked forms in both conditions. Similarly, in the comparative adjective task the DS group used significantly more uninflected forms in two of the three conditions than the control group. The results are parallel for non-tense related morphemes indicating that the linguistic impairment in DS is broader than in SLI and not restricted to the finiteness cluster. No significant difference of examined groups in the use of corrected forms for regular or denominal verbs, nor in the correct production of irregular forms for irregular verbs.
35.	Ring & Clahsen (2005b)	8 English DS (CA: 12.6 - 13.4 years)/10 with WS (CA: 11.4 - 13.9 years)/10 - 12 participants of 5-, 6-, and 7-year old unimpaired children	Wechsler Intelligence Scale for Children TROG STOP (Syntactic Test of Pronominal Reference) TAPS (Test of Active and Passive Sentences)	No significant differences between the different age subgroups, either for the DS or the control participants and no significant differences between the match and the mismatch conditions. DS: particular difficulties in the interpretation of sentences with reflexive pronouns, whereas more accurate performance on sentences with non-reflexive pronouns. DS performed significantly worse than the controls in all conditions, but they had more difficulties interpreting passive than active sentences. Distinct patterns of linguistic impairment indicating that different genetic etiologies are associated with different specifically linguistic patterns of impairment and no with low levels of general intelligence.
36.	Rondal & Comblain (1996)	11 DS (mean CA: 9.10 years)/16 DS (mean CA: 18.4 years)/15 DS (mean CA: 30.8 years)/11 non intellectually impaired children (mean CA: 3.8 years)	MLU TVAP TVP BEMS (8 receptive subtests)	The language of most DS adults formally restricted morphosyntactically. Their utterances were short, mono-propositional with limited and inconsistent use of grammatical morphology. Infrequent use of articles and verbs were not regularly inflected. DS adults: 50% or less correct responses in sentence comprehension (personal pronouns, articles, verbal inflections, subordinate clauses, negative + passive sentences). Slightly better receptive performance in relative clauses. No evidence for progress in receptive-expressive morphosyntactic aspects of the language of the DS adults compared to DS adolescents.
37.	Rosin et al. (1988)	10 American DS (CA: 10.6 - 17.5 years, mean MA: 6.2 years)/10 MR (CA: 12.5 - 18.7 years, mean MA: 6.3 years)/Normal 1 (CA: 5.1 - 6.11 years, mean MA: 6.7 years)/Normal 2 (CA: 12.2 - 18.6 years, mean MA: 17.45 years)	Hearing Columbia Mental Maturity Scale-3 rd ed. Slosson Intelligence Test PPVT R Miller Yoder Language Comprehension Test Token Test for children MLU Intelligibility Rating Goldman Fristoe Test of Articulation Oral Motor Evaluation Aerodynamic measures	DS: significantly different from the other groups for MLU, comprehension of syntax, single word articulation, selected diadochokinetic tasks, and some aerodynamic tasks. DS: problems with sequential processing (both comprehension and production) which influences the entire communication profile. They were less intelligible. Intelligibility improvement as mental maturity increased. Different pattern for the DS subjects, different communication profiles and shorter MLU.

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38.	Sanoudaki & Varlokosta (2014)	7 Greek-speaking DS (CA: 23 - 34 years)/14 Greek-speaking TDC (CA: 4.5 - 5.11 years)	Picture selection task (Gerken & Shady, 1998). Diagnostic Test of Verbal Intelligence (DVIQ; Stavrakaki & Tsimpli, 2000)	DS: problems in the interpretation of reflexive pronouns compared to TD group, while the two groups did not differ in their interpretation of other elements (pronominal clitics, strong pronouns, and reflexives preceded by two nouns). Deviant pattern in pronoun comprehension.
39.	Stathopoulou (2007)	8 Greek DS (CA: 12.1 - 18.7 years)/16 Greek MA-matched normal children (CA: 5.0 - 7.6 years)	Toy elicitation task (Crain & Thornton, 1998). Four types of relative clauses were examined: subject and object gap relatives with subject and object heads. 12 min. narrative language samples	DS children significantly lower performance than MA controls across all types of relative clauses. Both groups exhibit the same pattern of performance on the four RC types (SS > OO = OS > SO). DS participants difficulty producing complex sentence structures.
40.	Thordardottir et al. (2002)	24 American DS (CA: 12.5 - 20.4 years)/22 TDC matched on MLU (CA: 2.1 - 4.0 years)	12' narrative language samples	DS: a greater number of complex sentences than controls. The analysis of developmental patterns suggested a similar order of acquisition across groups. Syntactic development in individuals with DS continues into late adolescence and is not limited to simple syntax (MLU increases).
41.	Tsakiridou (2006)	4 Greek DS (CA: 20 - 28 years, mean MA: 7.3 years)/16 TDC [from Stavrakaki, 2004]	Games were designed in which the adolescent asked a puppet a question about a scenario acted out with toys (Subject wh-questions, Object wh-questions)	DS: severe problems with producing wh-questions, particularly in who-subject, which and who-object questions. TDC performed at ceiling producing far more less errors than their DS's counterparts. The error types produced by DS's subjects have not been attested in typical development. The main error types: A'-chain errors (problems with binding an empty category), case errors (problems with checking operations) and morphological errors (omission of determiners, tense errors-present instead of past tense-, gender errors).
42.	Vicari et al. (2000)	15 Italian DS (CA: 4 - 7 years, mean MA: 30.6)/15 TDC matched on MA (mean CA: 29.2 months, mean MA: 29.6)	PVB TCV TRF MLU-w	DS: generally, lower performance in language abilities. No dissociation between lexical and cognitive abilities in the two groups, but specific morphosyntactic difficulties in comprehension and production. Two groups of children, with equivalent vocabularies, differed in the type of sentences used. DS: simpler more telegraphic sentences, difficulty in comprehending utterances involving very simple grammatical contrasts. DS: far more errors in all word categories (articles, nouns, verbs, modifiers and prepositions), mostly omissions. DS: significantly lower length in their spontaneous production. Dissociation between lexical and grammatical development in the DS population.

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43.	Witecy & Penke, 2017	31 German DS (CA: 4.6 - 19.0 years)/27 German DS (CA: 20.8 - 40.3 years)	Reasoning Scale of the Snijders-Omen Nonverbal Intelligence Test (SON-R 2.5 - 7) TROG-D Repetition subtest of the SETK 3 - 5 Number recall subtest of the K-ABC	<p>The development of receptive syntactic skills comes to an end in the transition from adolescence to adulthood.</p> <p>Difficulties increased with sentence length and grammatical complexity, but were also apparent in simple sentences.</p> <p>More grammatical than lexical errors.</p> <p>No difference in comprehension of nouns, verbs and adjectives. The comprehension of sentences in perfect tense more error-prone than the comprehension of noun plural morphology.</p> <p>Difficulties in comprehension of function words, disjunctive conjunction, personal pronouns, subordination and coordination, the interpretation of subject relative clauses, passive voice, topicalization and relative clauses with pronouns in accusative or dative case.</p>
44.	Zampini and D'Odorico (2011)	12 Italian DS (CA: 40.13 - 64.17 months, DA: 24.09 - 37.00 months)/12 TD (CA: 29.27 - 31.08 months, DA: 17.29 - 20.14 months)	Italian version of the MacArthur CDI (Il Primo Vocabolario del Bambino (PVB) Brunet-Lezine Psychomotor Development Scale 20' spontaneous verbal production	<p>DS: simpler vocabulary composition than TDC at the same lexical size.</p> <p>Although no significant differences in the proportion of common nouns and verbs-adjectives, DS produced a significantly higher proportion of simple terms, as routines-people, and a significantly lower proportion of adverbs-function words.</p> <p>DS did not produce all the kinds of transitional forms, but only forms with a lower level of complexity, such as formulas and dummy element productions.</p> <p>Although, they were able to use word combinations, they produced a low number of morphologically complete sentence (only non-finite clauses), and they had greater difficulties in expressing sentences in a grammatically correct form.</p> <p>Subject-Verb-Indirect Object and Subject-Verb-Direct Object were the most frequent multi-argument structures for both groups.</p>