

Article

Intra- and Inter-Group Differences in the Cognitive Skills of Toddler Twins with Birth Weight Discordance: The Need to Enhance Their Future from Early Education

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Abstract: Strengthening of early schooling enhances Equal and Inclusive Education (Sustainable Development Goal 4). Early education protects infant development and learning, especially for children suffering from pathologies and risk factors, such as twin birth weight discordance (BWD). These children—particularly the lighter twin—frequently show disadvantages in their cognitive skills. However, research about this issue is particularly scarce. The aims of this study were to (1) analyze the development of cognitive skills in each type of birth weight discordant twins (heavier and lighter ones) at 18, 21, and 24 months; and (2) discover whether there were differences between the two groups of twins in their cognitive skills. A nomothetic, follow-up, and multidimensional observational design was used. The cognitive skills of 32 birth weight discordant twins were observed while they played at 18, 21, and 24 months. The T-pattern analysis was performed using Thème software (Reykjavík, Iceland) to detect the sequential and temporal structure of infant behavior; indicative of cognitive skills. Results showed: (1) longitudinal intra-group differences in both groups of twins; and (2) some inter-group differences, mainly favoring the heavier twins. These results must be considered for designing early educational practices that allow all twins to be prepared for successful future learning.

Keywords: early cognitive development; logic skills; interference suppression; discordant birth weight twins; systematic observation; T-pattern analysis; early childhood education; educational practice; learning; quality education

1. Introduction

There is a large body of research evidence demonstrating education is one of the keys to society's progression [1]. Governments, political organizations and other agencies have made this issue a central element to their action plans. This is the case, for example, of the United Nations and its 2030 Agenda for Sustainable Development adopted in 2015 to ensure sustainable social and economic progress worldwide [2]. With the vision of achieving this considerable challenge, the 2030 Agenda establishes 17 Sustainable Development Goals (SDGs) which need to be reached by 2030; one of them being 'quality education'. This goal (SDG 4) specifically intends to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [2] (p. 14). In line with scientific literature, it is about ensuring an education that guarantee the access, permanence, learning, and participation of every student, recognizing their diversity, and favoring a pedagogical work that offers the supports more pertinent to their identities, abilities, needs, and real motivation to enhance their progress [3–5]. This Goal consists of 10 targets. One of the targets (target 4.2) highlights the relevance of early childhood education as a preparatory stage for later learning and, therefore, outlines its need to be accessible to all children and its need to "by 2030, ensure that all girls and boys have access to quality early childhood

development, care and pre-primary education so that they are ready for primary education” [2] (p. 17). There are many scientific studies that show that quality preschool education improves children skills needed to further school [6–8]. Quality early childhood education programs identify the needs of children and support them to improve their skills. Thereby, early childhood education allows children enter to education system with all the skills, capabilities, health and development to take advantage of the school learning environment [6]. Consequently, improving children’s school readiness through early childhood education is key to reducing the achievement differences seen later in education [6]. In addition, early childhood education produces lasting impacts. In some cases, their effects continue through adulthood. Quality preschool education creates improved life outcomes [7,8]. This highlights that one of the actions needed in relation to equal and inclusive education is the strengthening of intervention and of early schooling (0–3 years).

1.1. Early Childhood Education

The first years of life, especially up to the age of 3, are essential and decisive in the development and learning of the child. These years are the basis of all subsequent development and learning. They constitute an early sensitive period in which the brain is rapidly developing and is maximally susceptible to environmental influences [9]. As such, providing environments that involve appropriate physical and social experiences for developing skills in young children is a major objective for early childhood education [10,11]. However, it must not be forgotten that the individual differences in the ability to benefit from instruction (the zone of proximal development) and the general individual differences between children are considerable in the first few years of life [12]. These differences are usually due to differences in intelligence. “Differences in intelligence are largely the reason why some children master the curriculum more readily than other children” [13] (p. 148). Some of these children’s differences in intelligence are caused by differences in DNA sequence [13]. Single-nucleotide polymorphisms (SNPs) are the most common form of human genetic variation. SNPs involve variation at a single base pair and occur normally throughout a person’s DNA [14]. In just the last couple years, GWAS (Genome-Wide Association Studies, which identify variants in the DNA code—SNPs—that are statistically associated with important traits, such as intelligence) have identified hundreds of SNPs, which together explain around 11% of the variance in IQ [15]. So, there is a strong genetic component in the stable parts of IQ [16,17]. However, the high heritability of intelligence—indeed, intelligence is one of the most heritable traits [18]—should not obscure the fact that is considerably less than 100%. It is important to recall that, although all complex traits are heritable, none is 100% heritable, i.e., all complex traits also show environmental influence [13,18]. Consequently, it is also applicable to intelligence. More importantly, given IQ is not all heritable, IQ is also subject to change. Thereby, intelligence has a substantial malleability coexisting with its high heritability [13,19]. Intelligence is malleable especially in children—in coherence to its lower heritability in this early stage of life than in adulthood [16]—through major systematic interventions, such as education [13]. However, the complex interplay between genetic and environmental factors must be taken into account. One type of gene-environment interplay is gene-environment interaction. It is when the effect of a variable (gene) with another variable (an environmental factor) has multiplicative consequences, with the result (variation in a trait) being more than the sum of its parts. So, “it describes genetic or environmental effects that are conditional upon each other—for example, the effects of genetic variation that become apparent only in the presence of specific environmental conditions, or the effects of social contexts that are more or less potent depending on the underlying genotype of the individual who experiences them” [20] (p. 65). It means that there is a difference in the effect of a given relevant environment on individuals depending on their genotypes for that trait [19,21]. “This is because during gene-environment interactions, genetically different individuals have different experiences (i.e., pay attention to, absorb, or respond differently) to the same environmental stimulation” [19] (p. 9). In the educational framework, it involves that the same education program does not necessarily produce the same effects in all students given their genetic differences for intelligence [21]. Therefore, establishing effective environments and experiences

that facilitate infant abilities requires deep knowledge about the characteristics of each child in each moment of their development and knowledge about the formative dynamics that come with this. This results in the need for pedagogical work founded on an accurate assessment process [22].

Both the literature [23] and the educational legislation in many states [24,25] outline that the assessment of children in early childhood education must reflect the children's daily activities and the situations that mirror the child's current performance in a natural way, without altering the child's behavior or the teaching-learning process. Hence, a systematic observation (characterized by the study of spontaneous behavior that occurs naturally in everyday contexts) is an ideal methodology, or even the only one possible, when the aim is to evaluate early childhood development and learning. Systematic observation brings together the inherent objectivity and rigor necessary in educational evaluation and science, with the flexibility needed to capture the many and often complex changes that occur in a child's behavior in real-life settings [26–29].

Among the daily activities performed by children in early childhood education—which is to be considered in their evaluation through systematic observation—the act of playing stands out. Play is an inherent activity of childhood but is also much more: it is a necessity of life as children learn through play [30]. This results in children's learning being visible through play. Therefore, the observation of children's play is an essential tool in obtaining the relevant information about children's learning. From this knowledge, professionals can design more playful activities that are appropriate to the child's level of development in order to promote their motor, cognitive, affective, and social skills [23]. As such, early childhood education is considered to be a protective factor for the integral development of children, especially for those most disadvantaged and who are at biological and/or social risk [31], such as twin children. The biological conditions to which twin children are exposed during the prenatal period can negatively affect all dimensions of their development and wellbeing. These effects can be maintained in the short, medium, and long term [32–35]. Therefore, prenatal conditions of twins may entail many further effects. However, early childhood education is an opportunity to preventing and ameliorating the impact of their prenatal conditions by promoting their optimal development and well-being [22,23].

1.2. Twin Babies in Early Childhood Education

Recent years have seen a considerable increase in twins in early childhood education classrooms. The rate of twins being born has increased to over 50% in the last decade globally [32]. Factors which have contributed to this are (1) childbearing in older ages, since the hormonal changes that women undergo with age make the probability of twin pregnancy greater; and (2) the increased use of subfertility treatments, particularly the use of agents that induce controlled ovarian hyperstimulation and in vitro fertilization, in which the transferring of multiple embryos back into the uterus is common practice [32]. Some authors consider the increased rate of twin births to be an 'epidemic' given the unacceptably high number of incidences of maternal, perinatal, and childhood morbidity and mortality associated with these types of births [33]. Being a twin is therefore a risk factor for child development, which subsequently results in the children needing greater and different attention than those born from single births. As such, attending to the unique characteristics of these children is a current phenomenon that demands a response in all its dimensions and is present all over the world, but is especially notable in high-income countries. However, the attention being given to these children is mainly medical, as reflected in the scientific literature. We know of very few scientific works that address the cognitive skills, learning processes, and educational needs of twin children at any age, let alone during the first three years of life; these are essential elements for all later learning [34]. Further research is needed on this topic since some of the few existing works on the matter have highlighted that there are more cognitive, linguistic, motor, social, and emotional defects in twin children than in children from a single birth. Some of these difficulties may persist into adolescence or even adulthood [35].

The cases of twins with birth weight discordance (BWD) are particularly concerning. A discordance in birth weight asserts a weight difference between the two siblings of at least 15%, calculated as follows $((\text{heavier twin weight} - \text{lighter twin weight}) / \text{heavier twin weight}) (\%)$. This discordance may result in a risk factor or in the children suffering from any complication which is typical of multiple pregnancies [36]. Birth weight discordance (BWD) may result from a combination of intrinsic variations between the twins themselves due to the fetuses' potential unequal accessibility to nutrients (placenta sharing, cord insertion abnormalities) or from extrinsic factors (maternal complications, such as pregnancy-induced hypertension, diabetes, and pre-eclampsia) [36]. Approximately 25% of twin pregnancies have this risk factor, which often is associated with adverse short, medium, and even long-term outcomes, especially in the lighter discordant birth weight twin. This twin is usually the most affected since they have a less optimal intra-uterine environment than their heavier birth weight twin, which ultimately affects both their birth weight and brain development [36–39]. Among other disadvantages the lighter twins face, the literature on the subject has shown that they have lower IQ; perform significantly worse in cognition, language, and motor skills compared to the heavier twins; and are usually at major risk for later behavior problems [37–40]. However, many aspects of these children's development are still unknown because, if we consider that the research on psychoeducational issues in twin children is scarce, even scarcer is the research focused on twin children with BWD. Of all the difficulties that twins with BWD may present—and which must be addressed in early schooling—, this study focuses on some that relate to cognitive development. These issues are addressed in the following sections.

1.3. Early Cognitive Development

Cognitive development is a crucial part of development. It involves the construction of highly diverse yet interdependent skills, which involve processes linked to the acquisition, organization, retention, and use of information and knowledge that allow a person to adapt to a continuously changing environment [41]. The years between 0 and 3 is a critical period of time in which a child is primed to develop specific cognitive skills which are essential for later learning, such as logic skills and executive functions. Logic skills and interference suppression (a component of executive functions) are the cognitive aspects on which this study focuses.

1.3.1. Logic Skills

Logic skills involve the ability to understand, develop, organize, and internalize information. It is centered on the intentional and structured behaviors that young children display with the objects they find within their reach from their first days of life [42]. In these interactions, children explore and experiment with objects and their own actions; discovering the characteristics and properties of objects and the associations that can be established between them. This is their way of building knowledge. Children are able to spontaneously engage in a variety of logic activities during their play [43].

Initially (0–12 months), these interactions are very primitive. They are carried out in isolation and without considering the characteristics of the objects. Due to this, for example, it is common for infants to suck or throw objects. In the second year of life (13–24 months), there are many significant advances that make this stage especially important. The interactions become more flexible and encompass the objects' characteristics more. In addition, the different interactions are coordinated and combined to obtain more information. Due to this, the toddler begins to put together different objects (grouping), then objects with equal characteristics (collection), and, later, thanks to increasingly organized and complex interactions, they establish an association between objects that belong to different sets of characteristics (distributions and later, one-to-one correspondence). Among the types of associations that can be established between the objects from different sets, the one-to-one correspondence stands out. It consists of the sequential matching of each object in a set with a different object in another set. The result is an equivalence association between the two sets. Since one-to-one correspondence is a building block to mathematics skills [44,45], the other logic-based actions (grouping, collection,

and distributions) are in turn necessary to achieve said mathematics skills. Many authors refer to these logic skills as logic mathematic skills [44]. Early childhood education curriculums recognize logic skills as skills that need to be developed at this educational stage [24,46].

However, despite logic skills being highly relevant for later development and learning outcomes, they are a scarcely researched aspect of a child's development and learning, especially at ages below 3 [46]. The study of these skills has been even less addressed in populations with risk factors, such as BWD. Thus, most studies on one-to-one correspondence are focused on acquisition in children in primary education—specifically, on acquisition within the mathematics in compulsory education—and have been carried out using samples of children who present typical development. Research has, therefore, seemed to forget that: (1) the origins and development of one-to-one correspondence precede the ages corresponding to primary education and are the basis for development and later learning; and (2) children who present risk factors at birth can present difficulties in such development. With this in consideration, this work aimed to contribute to filling this research gap and providing greater knowledge on this subject.

1.3.2. Executive Functions: Interference Suppression

Executive functions are another set of cognitive skills that are developed in early life and may be affected in twins with BWD. That is why they are also of interest in our study. Executive functions are a set of high-level cognitive processes that allow for the conscious and goal-directed control of thoughts and actions. They allow for us to solve problems effectively and efficiently. They are especially needed in tasks or situations that are new, complex, or conflict-inducing. Executive functions are of great interest in research given their relevance and involvement in learning and academic success, as well as in other areas of life. They are therefore associated both with adjustment and success in academia, work, social, and personal settings, in addition to health and quality of life [47,48].

From the many processes that make up executive functions, this study focuses on inhibition. Inhibition is understood as the ability to control one's behavior, thoughts, and/or attention in order to override a strong internal predisposition or external lure [47,49]. Inhibition has been considered to play a central role in cognitive development because it precedes the development of more complex cognitive functions. Therefore, inhibition is a general resource for other executive functions [49] and, as such, is also essential for enhancing children's learning and academic success.

Among the different types of inhibition that exist [49], we focus on interference suppression, that is, the ability to control one's attention. Interference suppression constitutes the ability to resist interference or distraction generated by external information or stimulus that is irrelevant to solving the task at hand and that can produce a decrease in the execution of such task. It requires a person to control their attention and to focus on the appropriate information or stimulus needed to solve a task, since all distracting stimuli should be ignored [47,49]. Children show inhibitory behaviors as early as 6–12 months of age. From 12 months onwards, inhibition continues to progress, showing a rapid and significant improvement during toddler and preschool years (2–6 years). During preschool years, the ability to focus one's attention and ignore distractions is especially relevant since it facilitates learning [50]. During school years, it continues to develop but at a slower and more constant pace until it reaches adult levels of performance towards the end of childhood or early adolescence (around age 15) [51].

Despite the important implications of the early development of interference suppression, and as is generally the same with executive functions, interference suppression from 0 to 3 years has hardly been studied [52]. The studies that analyze children's executive functions do so mainly using children between 3–6 years of age, with very few works studying earlier ages. Moreover, studies on executive functions rarely adopt a longitudinal perspective [53]. Likewise, we are unaware of any studies by other authors that analyze the emergence of executive functions—and specifically of suppressive interference—in twin children with BWD, a central aspect in this study. These gaps in research will also be addressed in this study.

In summary, we find that we are unaware of empirical studies by other authors that have jointly addressed the following: (1) the logic and interference suppression in children, which are essential for cognitive development and adjustment to schooling and learning; (2) the increase in twin children with BWD and their greater probability of being disadvantaged in cognitive skills; and (3) the importance of carrying out early evaluations that allow for educational interventions which respond to children's needs, and which have the purpose of strengthening their short-, medium-, and long-term development (and, consequently, their future academic success). Thus, we consider that there is a gap in the study of early logic and executive development in body weight discordant twin children in early childhood education. This may be due to (1) the difficulty of working with such young children; (2) the complicated access to differential populations; and (3) the rigidity and time demands involved in observation during the evaluation process. In spite of these difficulties, and given the relevance of the subject, this research intends to aid in the elimination of this gap in the field and aims to obtain greater knowledge about the subject matter.

1.4. Aims

The aims of this study were to: (1) analyze the development of cognitive skills in each type of twins with BWD (both the heavier and lighter twin) at 18, 21, and 24 months; and (2) discover whether there were differences between the twins in their cognitive skills.

The results obtained will be useful for professionals in early childhood education and will aid in the design of an early intervention plan which is tailored to the characteristics and needs of each group of children, with the goal of enhancing their development and learning. Early experiences and early learning environments that adults provide in the first three years of a child's life affect all domains of their later development. This is in such a way that they become an essential component in contributing to a person's health, well-being, and future. In addition, it must not be forgotten that children today are our future leaders. So, investment in the early years implies not only personal and individual benefits but also social benefits. Furthermore, early intervention has been shown to be more effective than later remediation [54].

2. Materials and Methods

2.1. Design

We used systematic observation because, as previously mentioned, it is a methodology that allows for the study of the spontaneous behavior that occurs naturally in everyday contexts (like at school). It is the ideal methodology, or even the only one possible, when early childhood development and learning are being assessed. It is a mixed methodology that integrates qualitative and quantitative elements to extend and deepen our understanding of the reality observed. This integration is carried out through a succession of stages. The first stage prioritizes the qualitative perspective in data collection. In the second stage, this information is quantitatively analyzed. In the third and final stage, the results are interpreted by returning to a qualitative framework [26–29].

According to the observational designs described by Anguera et al. [26], the observational design we employed was nomothetic, follow-up, and multi-dimensional (N/F/M). It was nomothetic because we observed various different toddler twins (32 children), which were subsequently analyzed in two groups (the heavier and the lighter twins); it was follow-up because we performed both inter-sessional analyses (corresponding to the age of 18, 21, and 24 months of the participants) and intra-sessional analyses (sequential recording of all behaviors from start to finish in each session); and it was multi-dimensional given that various dimensions of the participants' actions were taken into account (logic skills and interference suppression) when shaping the observation instrument. It should be noted that this type of observational design (N/F/M) is considered to be the most complete and optimal [26].

We carried out non-participatory and direct observations [26] with toddler behavior in the context of a classroom, while they were playing.

2.2. Participants

The sample consisted of 32 Spanish twin toddlers with BWD of, minimum, 15% and a maximum of 55%. Twenty-four twins (75% of participants) had mild BWD ($BWD < 25\%$), and 8 children (the remaining 25% of participants) had severe BWD ($BWD \geq 25\%$). Eighty-seven and a half percent of the twins were dizygotic, and the rest, 12.5%, were monozygotic. Among the participants, 13 (40.6%) were male, and 19 (59.4%) were female. Their distribution in terms of whether they were the heavier or lighter sibling was as follows: the siblings with greater weight were 7 males (43.8% of all the siblings with greater weight) and 9 females (remaining 56.2%). The lighter weight siblings were 6 males (37.5% of the lower weight siblings) and 10 females (62.5%).

All children were in the first stage of early childhood education (it corresponds to level 01 of the International Standard Classification of Education –ISCED– approved by the United Nations Educational, Scientific and Cultural Organization –UNESCO– in 2011). In Spain, this is a paid-for and non-compulsory stage of education and involves children from birth to 3 years of age. It has a participation rate of 36.4%, which is very similar to the Organisation for Economic Co-operation and Development –OECD– (36.3%) and European Union –EU– (35.6%) averages [55]. The participants were studied longitudinally by providing conditions that were repeated as three stages: 18, 21, and 24 months. All participants were from a medium socio-economic background.

The criteria for inclusion in the sample were: (a) to be a twin; (b) to have a $BWD \geq 15\%$; (c) to have BWD as the only risk factor present in both twin siblings; (d) for there not to be an associated pathology present in either of the two siblings; (e) to have a level of cognitive development that is appropriate for chronological age (18 months); and (f) to have the authorized consent of the parents/guardians who authorized the participation of their children in the study.

The information regarding the children's fulfillment of the inclusion criteria (a–d), and (f) was provided by the parents (who, in turn, obtained the information from their children's pediatricians). To obtain the information required for inclusion criteria (e), the participants were evaluated through the 'Scales of Systematic Observation from 0 to 3 years' [56].

Participants were treated according to the rules of the Declaration of Helsinki of 1975—revised in 2013—and Spanish Organic Law 15/1999 of December on Protection of Personal Data (Spanish Government, 1999), published in the Official State Gazette n_ 298, December 14. The research protocol was endorsed by Psychology and Sociology Department, University of Zaragoza, and by the management teams at the schools attended to by the participants. As it was mentioned earlier, written informed consent was obtained from the parents of all the participants.

2.3. Instruments

2.3.1. Observation Instrument

We used an original ad hoc observation instrument previously created and validated [57] to measure toddlers' cognitive skills. Some details were specified to facilitate understanding of the elements that composed it: (a) more specific names for 4 dimensions were provided; (b) definitions of all dimensions were included; (c) more detailed definitions for all the categories were elaborated; (d) examples of all the categories were offered; and (e) a more internationally user-friendly code system was determined.

From the different typologies of existing observation instruments [26], and in accordance with our study objectives and the type of observational design used, the instrument employed was a combination of field format and category systems. Therefore, dimensions formed the field format and each of these dimensions was broken down into a system of exhaustive and mutually exclusive categories. This structure—typical of this type of observational instrument—allows for each behavior

of interest to be codified simultaneously into several dimensions, but, for each dimension, only one category of the system can be assigned. Therefore, the categories that form the same dimension cannot co-occur or be registered simultaneously, but those belonging to different dimensions can. The most important dimensions for this study were Logic content and Adaptation, given that they cover infant behaviors which are directly referred to as logic skills and interference suppression, respectively. The other dimensions offered complimentary, but also necessary, information for the understanding of toddler behavior. Supplementary Material includes the observation instrument.

2.3.2. Recording Instruments

To record the playful activity of each of the participants, a Sony (Tokyo, Japan) video camera was used.

To carry out the codification of the behaviors which were indicative of logical skills and interference suppression in toddlers, the free software Match Vision Studio v3.0 (Vitoria, Spain) was used (<http://www.observesport.com>) [58,59]. It is a free and user-friendly tool initially designed to codify sport behaviors but which also enables us to codify the behaviors which spontaneously occur in any natural or habitual context. In fact, it has also been used in other observational studies in the educational field [60]. It requires the introduction of the codes which correspond to each of the categories in the observation instrument and the video recordings. Each time that behaviors of interest are observed in the video according to the objectives of the study (i.e., when behaviors included in the categories of the observation instrument are observed), they are coded on the screen [59].

2.3.3. Data Analysis Instruments

Statistical Analysis System –SAS– 9.1.3 (Cary, NC, USA) [61,62] and EduG 6.1 (Neuchâtel, Switzerland) [63] were used to analyze observational data quality (intra- and inter-observational reliability).

Thème 5.0 [64] was used for the temporal pattern (T-pattern) detection and analysis, i.e., to analyze the sequential and temporal structure of the toddler behavior which is indicative of their cognitive skills. (More information about the type of analysis that this software carries out is in the Data Analysis: Temporal pattern (T-pattern) Detection and Analysis section.)

2.4. Procedure

To access the sample, we worked in collaboration with different children's schools and pediatric teams that allowed us to disseminate information about the research among the families of potential participants. Subsequently, the research staff held meetings with interested families. The purpose of these meetings was to inform more widely about the goals and nature of the research, to check the criteria for inclusion/exclusion in the sample, and to request the informed consent that authorized their children's participation in the research, as well as their being recorded on video while playing.

Each participant was observed for a total of 9 sessions: 3 sessions at 18 months, 3 sessions at 21 months, and 3 sessions at 24 months. Thus, a total of 288 sessions were conducted. Sessions took place in the usual school context of each participant. Specifically, a room from the educational center which was known to the child was used. However, this room had no distracting stimuli, and only the participant and a specialized adult (same adult in all sessions) were present. This adult did not know which was the heavier and lighter sibling.

For each participant, the 3 sessions all corresponding to the same age took place on the same day, with a 2-min break between them. In each of these 3 sessions, the child was presented with a non-verbal play task that facilitated the toddler's logical activity (specifically, the construction of one-to-one correspondence). For the design of these tasks [57], how the characteristics and number of materials may have affected the one-to-one correspondence was considered [42–45]. Therefore, with regard to this, and with the age of the participants in mind, each task consisted of 4 balls of different sizes and 4 round storage boxes—without tape—which were the same size as the balls since: (1) according to the literature [43,45], these objects facilitated one-to-one correspondence by allowing for an insertion

or container-content association to be made between them (the notion that inside is easier: the balls could be put in the box); (2) also according to the literature [42], the number of objects (4 objects) in each set was adequate enough to be able to assess the development processes taking place with a child as they age to 2 years old. These processes, in theory, leads the child to reaching the one-to-one correspondence, which usually happens at around 24 months. Successfully performing one-to-one correspondence between the objects from the two sets according to their size (that is, introducing each ball into its corresponding box and doing it sequentially) implied the successful resolution of the task. However, to vary the difficulty of the 3 tasks done at each age, and also to be able to evaluate the interference suppression, the color of the object was varied in each task as follows: (1) in task 1—presented in session 1 for each age: 18, 21, and 24 months—the objects with the same size (box and ball of the same size) had the same color. This correspondence between the objects' size and color facilitated the resolution of the task. This is because, from an early age, color is a characteristic that is processed with more primacy than any other characteristic (such as size; therefore, children are naturally oriented towards it [65]). Therefore, to solve the task, it was enough for the children to pay attention to the color of the objects (as it was consistent with their size). (2) In task 2—presented in session 2 for each age—all objects were white. Therefore, the only information the children could use to solve the task was the size of the objects. This made task 2 more difficult than task 1. (3) In task 3—presented in session 3 for each age—the objects that had to be associated based on their same size had different colors. These objects, instead, had the same color as other objects of a different size (for example, the smallest ball was green and the smallest box, red; but the largest box was green and a medium size ball, red). Therefore, to successfully solve the task, the child had to make an effort to focus their attention on the size of the objects and not on the color; that is, they had to suppress the interference generated by color, which was processed faster than size but which did not allow them to solve the task. This made task 3 the most difficult.

Before the beginning of each observation session, the adult placed the material for each task on the floor. The location and distribution on the floor was random (as it was after the bag was emptied). Only when: (1) a box was left with the opening facing downward; (2) an item (either a ball or a box) was left inside a box; or (3) an item was not accessible to the participant's hands (for example, a ball rolled away) did the adult touch the material and change the situation. During the observation sessions, the participant was on the floor next to the material for each task and the adult. The adult did not instruct the child, so the child was free to start and develop their own play. This was to respect toddler behavior and avoid directing play. Therefore, the adult's role was to support the children without disturbing the flow of play. Consistent with this, the adult only participated if the child requested it or if the child stopped the flow of play; encouraging the child to continue, but respecting the child's desire not to play if indicated by their verbal and/or body language. The participants had a maximum of 15 min to resolve each task. If the child solved the task before that time, the session would end (that is, when the child established the one-to-one correspondence between the objects in both sets according to their size). The session also ended in the case that the child stopped the flow of their play for more than three minutes in a row.

All the sessions were video recorded. The video recordings were imported into the software Match Vision Studio and were coded using the observation instrument. An observer (observer 1, who was an expert in observational methodology and in the development of logical and executive functions in children) coded all sessions, without knowing which recording belonged to the heavier and lighter twin. The data obtained included information on the frequency, order, and time of behaviors. In accordance with the type of data proposed by Bakeman [66], the data was type IV, i.e., data was concurrent (as we considered various dimensions and each behavior was coded using one specific code for each dimension, according to the multi-dimensional nature of the observational design and the observation instrument built) and time-based (as the behaviors were coded as they occurred, thereby providing information through order, sequence, and time, essential factors for our study).

2.5. Data Quality Analysis

Observational data quality was assured in two ways [26,27]. First, it was assured qualitatively through consensual concordance: 18 sessions were chosen (one for every task, age, and type of twin = 3 tasks \times 3 ages \times 2 types of twin). They were jointly coded by the 2 observers who applied the consensual concordance. Secondly, it was assured quantitatively by calculating the intra- and inter-observer reliability. Thirty-six sessions were selected at random (assuring the representation of the 3 tasks, the 3 ages of study, and the 2 types of twin siblings) and were coded for a second time by observer 1 to calculate the intra-observer reliability. Another 18 different sessions were also chosen at random (assuring also that they represented the 3 tasks, the 3 ages, and the 2 types of twins) and were coded by observer 2 to calculate the inter-observer reliability. Intra- and inter-observer reliability were calculated through the intraclass correlation coefficient (ICC) using Generalizability Theory (GT) [67]. Generalizability Theory explicitly recognizes the multiple sources of measurement error (participants, contexts, observations, sessions, time of measurement...) that can affect measuring behavior. Each of these sources of error (called facets in the theory itself), as well as the interactions between them, can be calculated. The measurement error is the result of fluctuations due to the random choice of participants, contexts, observations, sessions, time of measurement..., that is, the sampling of particular subgroups in each of the facets from a universe of possible observations. Therefore, GT directly identifies the source or sources that contribute most to measurement error. Since in this case, we were interested in calculating intra- and inter-observer reliability, we were therefore also interested in calculating the measurement error associated with the time of measurement and observer facets, respectively. These facets should show low measurement error or low variability to ensure good intra- and inter-observer reliability and high intraclass correlation coefficient (ICC). As such, the real observations could be generalized to any time of measurement (in the case of intra-observer reliability) or any observer (in the case of inter-observer reliability) [68–70].

SAS 9.1.3 and EduG 6.1 softwares were used for the calculation. Regarding intra-observer reliability, a three-faceted DA/M (Dimension, Category/Moment) design was used. The analysis showed that the variability percentage for the Moment facet was nil (0%) in all sessions and the ICC was ≥ 0.98 in all sessions, showing an excellent high intra-rater reliability. In terms of the inter-observer reliability, using a three-faceted DA/O (Dimension, Category/Observer) design, the analysis showed that the Observed facet showed no variability. The ICC was ≥ 0.96 and as such, the inter-rater reliability was high, too. In conclusion, rigidity in the interpretation of the coding process was guaranteed.

2.6. Data Analysis: Temporal Pattern (T-Pattern) Detection and Analysis

Temporal pattern (T-pattern) detection is a relevant data analysis technique in systematic observation [60,71–74]. It assumes that flows of human behavior are characterized by incidental and sequential structures that are impossible to detect with the naked eye. Therefore, to detect them, it is essential to use standard statistical and behavior analysis methods. Consistent with this, T-pattern detection and analysis consist of exploring recorded behavioral data, with the goal of detecting strong connections in successive recorded behaviors that would otherwise have been assumed to have happened by chance. The aim of this analysis technique is to reveal a combination of events that occur in the same order with temporal distances between each other remaining relative invariant (regardless of the occurrence of any unrelated event in between them). This is done with reference to the null hypothesis that each component is independent and is randomly distributed over time [75]. This combination of events occurring in the same order and separated by a relatively invariant time is called T-pattern.

Thème software is a powerful algorithm-based research tool for obtaining T-patterns [72,73,76]. Its algorithm is based on probability theory and, more specifically, on binomial distribution. As Magnusson [72,75,76] explains, data sets in Thème are considered as a collection of n (>1) T-series (point series representing the occurrence of event types (categories)) within an observation period $[1, T]$ (T being the duration of the observation period corresponding to the number of data points in the

data set). The number of occurrences of an event type is divided by T and gives the average probability of this event type occurring in a given time unit, which is later used as the baseline probability for the detection algorithms. Thème searches for critical intervals $[d1, d2]$ ($d2 \geq d1 \geq d0$) that contain an occurrence of A followed by B that is higher than what would be expected to happen by chance, according to a pre-established level of significance by the researcher.

In order to achieve this, Thème compares the null hypothesis that A and B are independently distributed and that B has a fixed probability of occurrence per unit of time ($=NB/T$) during the observation period (N is the number of occurrences of B and T, as already explained, and is the duration of the observation period). If Thème detects an occurrence of A followed by B within a critical interval, it generates a simple T-pattern (AB). Occurrences of simple T-patterns become events. After, these events subsequently constitute focal event types for the next level of detection. Thème repeats this process, moving up, level by level (from 1 to n) searching for critical interval associations which feature the patterns detected in previous levels with the goal of detecting increasingly complex T-patterns.

In order to select the T-patterns that are most relevant to the research question being investigated, Thème allows for the establishment of some search parameters (both quantitative and qualitative) on the basis of which the software searches and detects T-patterns. In addition, Thème allows for the detection of T-patterns for data from a single individual record and for data from different individual records.

In our study, as we were interested in establishing the T-patterns of each type of twin sibling (heavier and lighter siblings) in each of the 3 tasks and ages studied (18, 21, and 24 months), the records of the different observation sessions were compiled according to these criteria. The compilation of records allowed by Thème is useful when wishing to jointly analyze data from different individual records, as was our case.

In order to detect T-patterns according to our aims and to guarantee that any T-patterns detected were not due to random events, we established quantitative and qualitative search parameters. The quantitative search parameters established were (for more information, see the reference manual): (a) frequency of occurrence of ≥ 3 (i.e., detection of patterns that had a minimum occurrence of 3); (b) significance level of 0.005 (0.5% probability of the critical interval being due to chance); and (c) redundancy reduction setting of 90% (exclusion of T-patterns when $>90\%$ in occurrences of a new pattern start and finish with the same critical interval relationships of patterns already detected). As already mentioned, these quantitative search parameters were established according to the aims of this study. However, we also consider it necessary to inform that they were often found to be the most beneficial parameters [75,76]. The qualitative search parameters established were: (1) occurrence of patterns that referred to information relating to logic skills, that is, that the pattern contained one of the categories included in the Logic content dimension of the observation instrument: grouping (g); collection (cl); container-content composition of a set (cc1); container-content composition of two sets (cc2); one-to-various distribution (1vd); one-to-one distribution (11d) or one-to-one correspondence (c); (2) occurrence of information patterns which refer to interference suppression, that is, that the pattern contained any one of the following categories that makes up the Adaptation dimension: adaptation to size but not color (asnc); adaptation to color but not size (acns), or no adaptation to either size or color (nsnc); and (3) validation of results through randomization of data on ten occasions (that is, the statistical validation of the patterns obtained by comparing them with patterns that would be obtained using the same filters but with the data having been randomized 10 times), with acceptance only of patterns for which the probability of the randomized data coinciding with the real data is 0.

3. Results

3.1. T-Patterns of Each Group of Twins as 18, 21, and 24 Months

Tables 1–6 present the results obtained which allowed us to respond to objective 1 of our study: to analyze the development of cognitive skills (specifically, logic skills and interference suppression) in each type of birth weight discordant twins (heavier and lighter siblings) at 18, 21, and 24 months. More exactly, Tables 1–3 show the T-patterns obtained in the group of heavier twins in tasks 1, 2, and 3, respectively. Tables 4–6 do the same but in relation to the behavior of the lighter twins. Each table presents the T-patterns obtained in that task for each of the 3 ages studied (18, 21, and 24 months). In this way, each table shows the evolutionary T-patterns obtained in each task and group of twins. Within each task and age, the T-patterns are organized according to their frequency of appearance (from highest to lowest frequency).

Given the objectives of the study, when explaining the behaviors relating to the T-patterns obtained, we focus especially on those which refer to the logic skills and interference suppression.

3.1.1. Heavier Weight Twin Group

Table 1 shows that, in task 1, the most complex patterns in terms of logic skills are detected at 24 months because, as the children age and progress, so does the logic content of their patterns. Specifically, the following can be observed. At 18 months, a pattern appears that consists solely of gathering objects which are not similar (grouping (g)), which is the least complex logic skill of those which can be performed with the material. This pattern is the most frequent at this age (occurrence = 7). At 18 months, other patterns with more complex logical content also appear, but less frequently, since they involve associations between the two sets of objects (cc2 and/or 1vd). In one pattern, these are incidental associations (not sequential), where only one object of each set is matched (only one ball is matched to one box: cc2). In another pattern, these incidental associations appear combined with others of greater complexity in which one object of a set is successively matched to several of the other sets (one ball is successively matched to several boxes: 1vd). In another pattern, only this latter type of sequential association appears (1vd). Both types of associations (cc2 and 1vd) appear incorrectly executed at the beginning of the patterns, that is, without considering the size of the objects (and therefore, given the characteristics of the objects in this task 1, without attending to their color either (nsnc)). The children only seem to detect this error on one occasion, producing a temporary or momentary result, that is, that it is an unstable result (ur). However, it is worth noting that, although these incorrect associations are generally not detected by the children (producing stable results over time (sr)), they are always followed by other correct associations, that is, associations based on the size and color of the objects (asac). It is also worth mentioning that, although adult intervention (a,prb) appears in a pattern, it is not effective for the child (the adult's proposal is not followed by child's activity). At 21 months, some progress is detected when comparing with the previous age: (1) There are no longer patterns composed only of elementary actions that involve the gathering of objects, but now the children are able to establish associations between objects from the two sets. (2) When elementary actions referring to the gathering of objects appear, it is no longer a matter of gathering different objects (case of grouping (g) at 18 months); now it is a question of matching objects according to their similarity (collection: cl). That is, the grouping (g) that appeared at 18 months is taken over by collection (cl). It is important to remember that, in addition, as has just been mentioned, these collections always appear in the patterns which are combined with other more complex actions which involve associations between the objects of the two sets (cc2 and, especially, 1vd). (3) Although incorrect associations between the objects still appear, that is, without considering the size or color of the objects (nsnc) (and this in reference to both incidental (cc2) and sequential (1vd) associations), children autodetect this error in most cases, and so they do not let these incorrect results last long and so, generally, they are temporary unstable results (ur). On the other hand, correct results, that is, those originated by associations established according to the size and color of

the corresponding objects (asac), are always stable results (sr). (4) There is an important advance in terms of the type of associations established between the objects: the one-to-one distribution (11d) appears, that is, more than 1 ball (2 or 3, but not all) are individually and sequentially matched to a different box, which constitutes a more complex logical action than those previously seen in the previous age. However, this one-to-one distribution (11d) is done without considering the size or color (nsnc) of the objects. On this occasion, this incorrect result does last some time and is stable (sr). This would all indicate that the greater complexity of the associations established between the objects (i.e., the greater logical complexity of the action (11d)) makes it difficult for children to consider the physical qualities (size and color) of the corresponding objects. At 24 months, this error is overcome because the one-to-one distribution happens according to the size and color of the objects (11d, asac). At 24 months, it also is recognized that all the associations established between the objects from the two sets, no matter what type they are (incidental (cc2) or sequential (1vd, 11d)), are always correct, that is, correctly done according to the size and color of the objects (asac). This implies stable results (sr). This would indicate that, at this age, color always acts as a facilitating variable when establishing associations between objects (not in previous ages where objects were matched with no regard to their size or color (nsnc)). Despite the progress achieved at 24 months, the participants do not adequately solve the task: they do not perform the logical operation of one-to-one correspondence according to the size of the elements. That is, they do not manage to sequentially match each of the balls to the box of their same size (and, therefore, in this case, also for their color; we must remember that size and color coincide in this task 1).

Table 1. T-patterns: Heavier twins in task 1. All codes are explained in Supplementary Material.

Age	T-Patterns	Occurrence
18 months	(ch,p,g,sr, ch,p,g,ur)	7
	(ch,p,cc2,sr,nsnc (ch,p,cc2,sr,asac a,prb))	3
	(ch,p,1vd,sr,nsnc (ch,p,cc2,sr,asac a,rf))	3
	(ch,p,1vd,ur,nsnc (ch,p,1vd,sr,asac a,rf))	3
21 months	(ch,p,cc2,sr,nsnc ch,p,11d,sr,nsnc)	4
	((ch,p,cc2,ur,nsnc (ch,p,cc2,sr,asac a,rf)) ch,st) ch,ig)	3
	((ch,p,cc2,sr,asac a,rf)(ch,p,cl,sr ch,p,1vd,ur,nsnc))	3
	((ch,p,cl,sr, ch,p,1vd,ur,nsnc)(ch,p,1vd,sr,asac a,rf))	3
24 months	(ch,p,1vd,sr,asac ch,p,cc2,sr,asac)	3
	(ch,p,cc2,sr,asac (a,rf ch,if,sr,asac))	4
	((ch,p,11d,sr,asac a,rf) ch,p,cl,ur)	3
	((ch,p,1vd,sr,asac ch,p,11d,sr,asac) a,rf)	3

Table 2 shows the patterns of interest detected during the completion of task 2 at 18, 21, and 24 months by the heavier twins. As the children age, certain advances are detected in the content of the patterns. Thus, at 18 months, no pattern of interest for the objective of this study is detected—reflecting fragmented and unstructured behavior—but is detected in later ages. At 21 months, a single pattern of interest is detected, and it is not very complex in content. It is a pattern composed by an incidental association between a ball and a box, without considering its size (cc2, ns), followed by a collection (cl: gathering of objects by similarity). At 24 months, 3 patterns are detected. Among them, the occurrence of distributions is notable, that is, the establishment of sequential associations between several objects from the two sets (1vd and 11d). This would mean that associating more balls and/or more boxes in a sequential way communicates an advance with respect to the incidental associations established at 21 months between

a single ball and a single box (cc2). Additionally, in one of the patterns, different types of sequential distributions are combined (1vd and 11d), emphasizing that all of them are correct, that is, considering the size of the corresponding objects (as). This pattern is the most complex pattern detected in this task. Even though, in another pattern, incorrect (1vd) distributions appear (i.e., without attending to the size of the elements (ns)), sometimes they suppose an unstable result (ur) and other times a stable result (sr). This implies that sometimes children detect their error; therefore, the incorrect association they have established between the objects is only momentary (ur). However, other times, they do not detect their error, and, consequently, the incorrect relationship lasts long and is stable (sr). Therefore, despite the progress made at 24 months, a child's action can still develop and improve. In fact, the participants still do not adequately solve the task: they do not perform the one-to-one correspondence according to the size of the objects.

Table 2. T-patterns: Heavier twins in task 2. All codes are explained in Supplementary Material.

Age	T-Patterns	Occurrence
18 months		
21 months	(ch,p,cc2,sr,ns ch,p,cl,sr)	4
	(ch,p,cl,ur ch,p,cl,sr)	4
24 months	(ch,i (ch,p,1vd,sr,as (ch,p,11d,sr,as a,rf)))	3
	(ch,p,1vd,sr,ns ch,p,1vd,ur,ns)	3

Table 3 shows the patterns detected during the performance of task 3 by the heavier siblings at 18, 21, and 24 months. At 18 months, only one pattern of interest is detected. It is a simple pattern in terms of its logical content: it consists only of incidental associations of an object from one set and another object from the other set (cc2), that is, incidental associations between a single ball and a single box. It should be noted that these associations between objects are established according to their color and not their size (acns), that is, without suppressing the interference generated by the color of the elements. At 21 months, a single pattern of interest is also detected. However, it includes advances when compared to the previous pattern: (1) its logical content is more elaborate when sequential associations occur between objects of the two sets (1vd); (2) a certain capacity to suppress the interference generated by the color of the objects is detected (corresponding objects appear according to their size and not their color (asnc)); and (3) although sometimes this suppression capacity still fails (since objects continue to be matched according to their color (acns)), children seem to detect their error since these incorrect results are momentary and not stable (ur). At 24 months, 3 patterns of interest are detected. One of them stands out for being the most frequent pattern at this age ($n = 4$), as well as being the most complex in content. The following aspects stand out: (1) the one-to-one distribution (11d) appears for the first time, which means an advancement compared to 21 months. (2) In addition, this logic skill is performed according to the size of the objects, i.e., (asnc), suppressing color interference. (3) The other action displayed by the child, that is included in the pattern, is a 1 to various distribution in which the color interference was also suppressed (1vd, asnc). Despite these advances, in another pattern, associations between objects were still being established according to color (acns), which denotes that the interference suppression is not fully consolidated. Nevertheless, the child could have detected the error since the result is unstable (ur) but does not show capacity to correct it (in the following action that makes up the pattern, the child does not relate the objects adequately but rather matches them at random, considering neither size nor color (nsnc)). Despite the progress made at 24 months, the participants do not solve the task correctly: they do not make the one-to-one correspondence according to the size of the objects (and therefore suppressing the interference generated by the color).

Table 3. T-patterns: Heavier twins in task 3. All codes are explained in Supplementary Material.

Age	T-Patterns	Occurrence
18 months	(ch,p,cc2,sr,acns,csd ch,p,cc2,sr,acns)	3
21 months	((ch,i (ch,p,cc2,sr,asnc (ch,p,1vd,sr,asnc a,rf))) ch,p,cc2,ur,acns)	3
24 months	(ch,p,1vd,sr,asnc (ch,p,11d,sr,asnc a,rf))	4
	(ch,p,1vd,ur,acns ch,p,1vd,sr,nsnc)	3
	(ch,p,cl,ur ch,p,cc2,sr,nsnc)	3

3.1.2. Lighter Weight Twin Group

As for the patterns detected in the lighter twins' activity, the following was obtained (Tables 4–6).

Table 4 shows there are advances in the logical content of the actions that make up the patterns detected in the lighter twin group for task 1. At 18 months, there are patterns consisting of very elementary actions that do not involve associations between the two sets of objects (grouping (g) and container-content composition of a single set (cc1)). However, there are other patterns in which associations between the 2 sets appear (container-content composition of two sets (cc2) and 1 to various distribution (1vd)). Among these associations, the most complex (1vd) are carried out without regard to size or color (nsnc), which indicates that, in these cases, color does not facilitate the matching of objects. In addition, children do not detect this error, since their erroneous results last over some time and are stable (sr). At 21 months, some progress can be seen: (1) despite the fact that the 1 to various distributions (1vd) that continue to be carried out are fundamentally incorrect (that is, without considering the size or color of the objects (nsnc)). On some occasions, children detect this error, and, as such, these actions do not bring stable results but rather unstable ones (ur); (2) the one-to-one distribution (11d) occurs, a logical action of greater complexity than those that appeared in the previous age. Although occurrence is still not very frequent, the action is fundamentally carried out incorrectly (without considering the size or color (nsnc)) and without error recognition (sr). Nevertheless: on one occasion, children do detect this error and generate an unstable result (ur); and, on another occasion, they even perform the one-to-one distribution (11d) correctly (according to size and color (asac)). At 24 months, improvements in the child's logical activity continue to appear: (1) the sequential associations between the objects from the two sets (1vd) and (11d) increase; (2) the number of correctly established associations increases, that is, those established according to the size and color of the objects (asac); and (3) the one-to-one distribution (11d), although still rare, is already done correctly (i.e., according to the size and color of the elements (asac)). Moreover, it is true that, although elementary actions that do not involve associations between the two sets of objects (grouping (g) and collection (cl)) are again frequent, and that, at 21 months, were already almost non-existent, now they are always (except in one pattern) associated with more complex actions that do consist of associations between the two sets of objects (cc2, 11d, and, mainly, 1vd). This combination of lesser and more complex actions in the same patterns, reflecting advances compared to previous ages, also informs about the possibility of improvement and development in child activity still existing at 24 months. As such, the more complex actions should be consolidated and sequenced more, without the need for elementary actions. This is necessary to advance and to be able to solve the task.

Table 4. T-patterns: Lighter twins in task 1. All codes are explained in Supplementary Material.

Age	T-Patterns	Occurrence
18 months	(ch,p,g,sr ch,p,cc1,sr)	4
	(ch,p,cc1,ur ch,p,cc1,sr)	4
	((ch,p,1vd,sr,asac a,rf) ch,p,1vd,sr,nsnc)	3
	(ch,p,cc2,ur,asac ch,p,1vd,sr,nsnc)	3
21 months	(ch,p,cl,sr ch,p,cl,ur)	5
	((ch,p,cc2,sr,asac a,rf) ch,p,1vd,sr,nsnc)	4
	((ch,p,1vd,sr,asac a,rf) ch,p,cc2,sr,asac)	4
	(ch,p,1vd,sr,asac (ch,p,11d,sr,asac a,rf))	4
	(ch,p,cc2,ur,nsnc ch,p,cc2,sr,nsnc)	4
	(ch,p,cc2,ur,nsnc ((ch,st ch,r,cc2,sr,asac,csd) a,prb))	3
	(ch,p,1vd,sr,nsnc ((ch,st ch,r,cc2,sr,asac,csd) a,prb))	3
	((ch,p,g,ur ch,p,g,sr) ch,p,cc2,ur,nsnc)	3
	((ch,p,cc2,ur,asac a,rf) ch,p,11d,ur,nsnc)	3
	(ch,p,cc1,ur ch,p,cc1,sr)	3
	(ch,p,1vd,sr,nsnc ch,p,1vd,ur,nsnc)	3
	(ch,p,11d,sr,nsnc ch,p,1vd,sr,nsnc)	3
	(ch,p,1vd,sr,nsnc ch,p,1vd,sr,asac)	3
	(ch,p,1vd,sr,asac ch,p,11d,sr,nsnc)	3
	(ch,p,cc2,sr,asac (a,prb ((ch,ig ch,p,cc2,sr,asac,csd)(a,rf ch,if,sr,asac))))	3
	((ch,i ch,p,1vd,sr,asac)(ch,p,cc2,sr,nsnc (ch,p,1vd,sr,nsnc (ch,p,cc2,sr,asac a,rf))))	3
((ch,i ch,p,cl,sr)((ch,p,g,ur ch,p,g,sr)(ch,p,11d,sr,asac a,rf)))	3	
(ch,p,cl,sr (ch,p,1vd,sr,nsnc (ch,p,cc2,sr,asac (a,rf ch,p,cc2,sr,nsnc))))	3	
(ch,i ((ch,p,cl,ur ch,p,cl,sr)(ch,p,g,ur ch,p,g,sr)))	3	
((ch,i ch,p,cl,sr) ch,p,cl,ur)(ch,p,1vd,sr,nsnc a,rf))	3	
((ch,p,cc2,sr,asac a,rf)(ch,p,cc2,sr,nsnc (ch,p,g,sr ch,p,g,ur)))	3	
((ch,i a,rf)(ch,p,g,sr ch,p,1vd,sr,asac)) ch,p,cl,ur	3	
(ch,i ((ch,p,g,sr ch,p,1vd,sr,asac)(a,rf ch,p,1vd,sr,nsnc)))	3	
((ch,i ch,p,cl,sr)(ch,p,1vd,sr,nsnc (ch,p,1vd,sr,asac a,rf)))	3	
((ch,i ch,p,cc2,sr,asac)(ch,p,1vd,sr,asac a,rf) ch,p,cl,ur)	3	
(ch,p,cl,sr (ch,p,1vd,sr,nsnc (ch,p,g,ur ch,p,g,sr)))	3	
(ch,p,cc2,sr,asac ((a,rf ch,p,g,sr) ch,p,1vd,sr,nsnc))	3	
((ch,p,cc2,sr,asac a,rf)(ch,p,1vd,ur,nsnc ch,p,1vd,sr,nsnc))	3	
((ch,i ch,p,11d,sr,asac)(a,rf ch,p,1vd,sr,asac))	3	
(ch,p,cl,sr (ch,p,11d,sr,nsnc ch,st))	3	
(ch,p,g,sr (ch,p,1vd,sr,asac ch,p,g,ur))	3	
24 months		

Table 5 shows that, in task 2, the logic content of patterns detected in lighter twin group progresses as the children get older. Specifically, the following advances are detected. At 18 months, the patterns detected are formed only by the actions that imply a simpler logical content: children only gather objects, either by non-similarity (grouping (g)) or by similarity (collection (cl)), but they do not establish associations between objects from the two sets. At 21 months, there are two main advances: (1) the associations between the objects from the two sets (cc2 and 1vd) begin to appear. Sometimes they are done correctly (according to the size of corresponding objects (as)) and other times, incorrectly (without considering the size (ns)). (2) Although the most elementary actions (grouping (g) and collection (cl))

are still present, they now tend to appear combined with slightly more complex actions which consist of associations between the objects from the two sets (they are combined with incidental associations being made between a ball and a box: container-content composition of two sets (cc2)). At 24 months, many advances are detected: (1) the most elementary actions (grouping (g) and collection (cl)) are, proportionally, less frequent; (2) moreover, when they do appear, they are combined with more complex actions than in previous ages (mainly, 1 to various distribution (1vd), that is, sequential relations between an object from a set and various from the other set); (3) the association between objects from the two sets that appeared for the first time in the previous age (cc2 and 1vd) have increased frequency and appear together to form part of common patterns; (4) although the children continue associating objects incorrectly (without considering the size of the corresponding objects (ns)), sometimes, they detect this error, and their results are unstable (ur) and not lasting. Sometimes, they even correct this error; after detecting their error, they continue with their action until being able to associate objects properly, i.e., according to their size (as); and (5) the one-to-one distribution (11d) appears for the first time in this task, being almost as frequently well executed (the objects are matched according to their size (as)) as incorrectly executed (the size of the objects is not taken into account (ns)). However, in spite of these many progressions, children do not manage to solve the task correctly.

Table 5. T-patterns: Lighter twins in task 2. All codes are explained in Supplementary Material.

Age	T-Patterns	Occurrence
18 months	(ch,p,g,ur ch,p,g,sr)	4
	(ch,p,cl,ur ch,p,cl,sr)	3
	(ch,p,cl,sr ch,p,g,sr)	4
21 months	(ch,p,g,ur (ch,p,cc2,sr,as a,rf))	3
	(ch,p,g,sr ch,p,cc2,sr,ns)	3
	(ch,p,1vd,ur,as ch,p,1vd,sr,ns)	3
	((ch,i (ch,p,cc2,ur,ns ch,p,1vd,ur,ns))(ch,p,cc2,sr,as (a,rf (ch,p,1vd,sr,as ch,if,sr,as))))	3
	((ch,i ch,p,11d,sr,ns)(ch,p,cl,sr (a,prb (ch,p,cc2,sr,as,csd a,rf))))	3
	((ch,i ch,p,11d,sr,ns)((ch,p,cc2,sr,ns ch,st)(a,prb a,rf)))	3
	(ch,i (ch,p,1vd,sr,as (ch,p,11d,sr,as a,rf)))	3
	(ch,p,11d,sr,ns ((ch,p,1vd,sr,ns ch,p,cl,sr)(a,rf ch,if,sr,as)))	3
	(ch,i (ch,p,cc2,ur,ns ch,p,cc2,sr,ns))	3
	((ch,i ch,p,cc2,ur,ns)(ch,p,11d,sr,as a,rf))	3
24 months	((ch,i ch,p,11d,sr,ns)(ch,p,11d,sr,as a,rf))	3
	((ch,p,cl,sr ch,p,g,sr)(ch,p,cc2,sr,as a,rf))	3
	((ch,i ch,p,cc2,sr,ns)(ch,p,cl,ur ch,p,g,sr))	3
	(ch,p,cc2,sr,ns ((ch,p,1vd,sr,ns ch,p,cl,sr)(ch,p,1vd,sr,as a,rf)))	3
	(ch,p,1vd,sr,ns ((ch,p,cl,sr ch,p,g,sr)(ch,p,1vd,sr,as a,rf)))	3
	(ch,p,1vd,sr,ns (ch,p,g,sr (ch,p,cc2,sr,as (a,rf ch,p,1vd,sr,as))))	3
	(ch,p,g,ur ch,p,g,sr)	3
	(ch,p,cc2,sr,ns ((ch,p,1vd,sr,ns ch,p,g,sr)(ch,p,1vd,sr,as a,rf)))	3

Table 6 shows that, in the lighter sibling group, in task 3, more complex content patterns are detected at 24 months than in previous ages. The following stands out. At 18 months, the patterns are mainly formed by elementary actions that do not involve associations between the objects from the two sets (grouping (g), collection (cl), container-content of a single set (cc1)). When associations between the objects of the two sets appear (container-content composition of 2 sets (cc2) and 1 to various distribution (1vd)), they are never correct: the objects are not matched according to their size, but to their color (acns). This shows the lack of interference suppression in children at this age. At 21 months,

this lack of interference suppression is still evident: all associations continue to be according to color and not size (acns). At 24 months, there is significant progress in interference suppression. The children begin to match objects from the two sets according to their size and not to their color (asnc). However, interference suppression still needs to be improved since (1) the suppression of the interference generated by color only occurs in the types of associations between objects that were made at 18 months (container-content composition of two sets (cc2) and 1 to various distribution (1vd)) but never in those that appeared for the first time at 21 months (one-to-one distribution (11d)), which are more complex; (2) the errors regarding interference suppression are still frequent and not well detected (they produce mostly stable results (sr)); and (3) in the few occasions in which these errors are detected, they are incidental associations between 1 object from each set (cc2, ur). That is, if the action implies a greater number of objects associated, the children do not detect their suppression error (the greater logical complexity of the action diminishes their suppression capacity). Therefore, the lighter siblings do not manage to solve this task either: they do not carry out the one-to-one correspondence according to the size of the objects (thus suppressing the interference generated by the color).

Table 6. T-patterns: Lighter twins in task 3. All codes are explained in Supplementary Material.

Age	T-Patterns	Occurrence
18 months	((ch,i ch,p,cc2,sr,nsnc)(ch,p,cl,sr ch,p,g,ur))	3
	(ch,p,cl,sr ch,p,cc1,sr)	3
	(ch,p,1vd,sr,acns ch,p,cc2,ur,acns)	3
21 months	(ch,p,11d,sr,acns ch,p,g,sr)	4
	(ch,p,1vd,sr,acns ch,p,11d,sr,acns)	3
24 months	((ch,p,cc2,sr,acns ch,p,1vd,sr,asnc) ch,p,g,ur)	4
	(ch,p,1vd,sr,nsnc ((ch,p,1vd,sr,asnc a,rf)(ch,p,cc2,sr,acns ch,p,cc2,sr,asnc)))	3
	((ch,p,1vd,sr,asnc (a,rf ch,p,cc2,sr,nsnc)) ch,p,g,ur)	3
	((ch,p,11d,sr,acns a,rf)(ch,p,1vd,sr,acns ch,if,sr,acns))	3
	((ch,p,cc2,sr,nsnc ch,p,1vd,sr,asnc)(ch,p,cc2,sr,asnc a,rf))	3
	((ch,p,1vd,sr,acns ch,p,cc2,sr,acns)(ch,p,1vd,sr,asnc ch,p,cc2,sr,asnc))	3
	((ch,p,cc2,sr,nsnc a,rf)(ch,p,cc2,sr,acns ch,p,cc2,sr,asnc))	3
	((ch,p,cc2,sr,nsnc ch,p,cc2,sr,asnc)(a,rf ch,p,1vd,sr,acns))	3
	(ch,p,cc2,ur,acns (ch,p,g,ur ch,p,cl,ur))	3
	(ch,p,cc2,sr,nsnc (ch,p,g,sr ch,p,cc2,sr,asnc))	3
24 months	((ch,p,cc2,sr,acns ch,p,cc2,sr,asnc) ch,p,g,ur)	3
	((ch,p,g,sr ch,p,g,ur) ch,p,1vd,sr,asnc)	3
	(ch,p,g,sr (ch,p,cc2,sr,asnc ch,p,1vd,sr,asnc))	3
	(ch,p,cc2,ur,acns (ch,p,cc2,sr,acns ch,p,cc2,sr,asnc))	3
	(ch,p,1vd,sr,acns (ch,p,1vd,sr,nsnc ch,p,cc2,sr,asnc))	3
	(ch,p,cc2,sr,asnc (a,prb ch,p,11d,sr,acns))	3
	(ch,p,cc2,sr,acns (ch,p,g,ur ch,p,g,sr))	3
	(ch,p,cl,ur ch,p,cl,sr)	3
	(ch,p,cl,sr ch,p,1vd,sr,asnc)	3

3.2. T-patterns: Differences between the Groups of Twins

Comparing the T-patterns of the two groups of siblings in each task and age (objective 2 of the study), the following was detected.

In task 1 (Tables 1 and 4), it can be seen that, at 18 months, both groups of siblings manage to put the objects from the two sets together (cc2 and 1vd), but the heavier siblings do it more frequently.

Both groups of siblings associate objects correctly (according to the size and color of the corresponding objects (asac)) and incorrectly (without considering the size and color of the corresponding objects (nsnc)). However, the heavier siblings sometimes detect this error (nsnc), so their results are momentary and unstable (ur). Lighter siblings never detect their errors. Thus, it can be said that the heavier siblings show a slightly higher level of logical development than the lighter siblings. This situation seems to be reversed at 21 months. Although the most complex logical action carried out by the two groups of twins is the same (one-to-one distribution (11d)), differences appear in favor of the lighter siblings in that (1) they perform it more frequently; (2) although it is only on one occasion, they perform it correctly, that is, taking into account the size and color of the objects (asac); this is not the case for the heavier siblings, who never perform it correctly; (3) the lighter siblings combine the one-to-one distribution (11d) with more complex logical actions (1vd) compared to those from their heavier siblings (cc2). This combination of different types of distribution (1vd and 11d); taking into account the size and color of the objects (asac) is performed by the lighter siblings at 21 months, and in the heavier siblings it appears later, at 24 months. However, at 24 months, again, it is the heavier siblings that show a higher level of logical development. All the associations established between the objects from the two sets are correct (according to the size and color of the corresponding objects (asac)), which indicates that it is at this age when the color of objects acts as a facilitating variable. At this age, lighter siblings continue to match correct and incorrect objects, with incorrect objects being more frequent. Therefore, for them, the color of the objects does not always act as a facilitating variable. Although the more patterns and longer patterns are seen in the lighter twins, these are patterns in which elementary logical actions appear (grouping (g); collection (cl)).

In task 2 (Tables 2 and 5), at 18 months, the lighter siblings show more organized and structured behavior than the heavier siblings because, although their patterns are formed by actions of simple logical content, at least patterns are detected. This is not the case with the heavier twins. At 21 months, the lighter siblings are sometimes able to associate the objects from the two sets according to their size. On the other hand, the heavier twins do it without paying attention to their size (ns), having to wait until 24 months of age to show this capacity (as). However, at 24 months, both groups of siblings execute, as a more elaborate logical content pattern, the same pattern. This is the combination of 1 to various distribution according to the size of the objects (1vd, as) and one-to-one distribution also according to the size (11d, as). Although lighter siblings have other patterns of greater length, they are patterns formed by elementary actions (g and cl) and/or by incorrect associations between objects, regardless of their size (ns). It is precisely this greater quantity of patterns from elementary actions and the establishment of associations between unrelated objects, comparatively with the smaller errors of their heavier siblings, which indicates a lesser cognitive development in the lighter siblings. Therefore, in task 2, at 18 and 21 months, it is the lighter siblings who show more development, and, at 24 months, the difference is inverted in favor of the heavier twins.

The patterns detected in each group in task 3 (Tables 3 and 6) reflect the interference suppression develops earlier in the heavier siblings. At 18 months neither of the two groups is able to implement interference suppression, as the 2 groups of siblings mistakenly associate objects according to their color (acns). However, the type of associations established by the lighter siblings (1vd) implies that they persist more in these incorrect associations and pair more objects incorrectly. At 21 months, significant progress is made in the heavier twins: they already match objects from the two sets (1vd) according to the size and not color (asnc) while their lighter siblings do not achieve this until 24 months of age. In addition, at 24 months, the heavier siblings are able to perform one-to-one distribution (11d) according to size (asnc); that is, even in logical actions of a certain complexity, they can suppress the interference generated by color. On the other hand, lighter siblings never suppress color interference in these 11d actions; they only suppress color interference in simpler logical actions (cc2 and 1vd). However, even at 24 months, both types of siblings do not have fully developed and consolidated interference suppression, as they continue to associate objects according to their color (acns). However, the heavier siblings seem to detect this error, since they do not let

their incorrect results (acns) be stable (ur), while the lighter siblings do not detect the error, and their incorrect results (acns), besides being frequent, are long-standing (sr). This would indicate that they have lesser cognitive development.

In addition, on a general level, it is notable that: (1) The most elementary logical action (grouping (g)) in the patterns from the heavier siblings only appears in task 1 at 18 months, while, in the patterns from lighter siblings, it is maintained in all tasks and ages. (2) Lighter siblings show, especially at 24 months, a great variability in their actions (greater number of patterns), but these actions are of lower logic content than their siblings. (3) Benefiting from the facilitating characteristic of color (task 1) and having the capacity to suppress its interference (task 3) is greater in the heavier siblings than in the lighter. This would imply that the heavier siblings are more sensitive to environmental information and to correctly processing it in accordance with their objective (paying attention to color in task 1 versus not paying attention to it in task 3). (4) None of the siblings correctly solve any of the 3 tasks. That is, they do not make one-to-one correspondence between the objects from the two sets according to their size.

4. Discussion

Systematic observation has proven useful in the collection of data about toddler behavior while they perform playful activities in their usual school environment. This subsequently serves as an indicator of their cognitive skills. The behaviors that occur over a period of time have been subsequently analyzed, allowing for us to obtain a rich and deep knowledge about cognitive skills and their development in twins with BWD.

The T-patterns detected in each group of twins (heavier and lighter twins) show that the cognitive skills of both groups develop in each task (tasks 1, 2, and 3) as the children age. Thus, in each task, there are longitudinal differences in the cognitive skills of each of the twin groups. These advances observed throughout the second year of life (18–24 months) are consistent with the many literature sources that find rapid changes in cognitive development from birth to ~2 years of age, a stage which coincides with an early sensitive period where the brain is highly malleable. According to the developmental epigenesis approach [77], cognitive development is multicausal, resulting from a continuous interaction that occurs between components of different levels (genetic, neuronal, functional, behavioral, environmental), which influence each other. Genetic and epigenetic processes, in interaction with early environmental experiences, shape neuronal connections and give rise to neural circuits that enable increasingly complex mental functions (enhanced cognitive abilities) [9,12].

The T-patterns detected have allowed us to discover that these advances do not occur at a constant nor common rate in the two groups of twins, but, rather, peaks occur in both groups, at different ages and for different tasks. This is why, when contrasting the patterns of the two groups and depending on what age and task are in question, either twin group may show more advanced cognitive skills. Again, this is consistent with the developmental epigenesis approach [77]. Given that the many factors that continuously interact during development, these interactions happen differently and at different moments in time, that is, at different rates and speeds, resulting in different outputs. All this means that there is no single, continuous, and stable pattern of development, but rather there are many possible patterns of development [22]. Students are active agents in their own learning, with multiple different genetic, neural, relational, environmental, and experiential levels or systems that all intersect, bringing about different patterns of development. Thus, variability is the norm in development. Development always consists of multiple interacting components that can be freely combined from moment to moment, depending on the context, task, and developmental history of the organism [78]. These aspects—the task and characteristics of the participants (such as their age and whether they are the heavier or lighter birth weight twin)—are important elements in our study. The results indicate that, indeed, these are elements according to which the children's cognitive skills have shown differences. This cognitive variability demonstrates the need for diverse educational practices and strategies which are personalized to children's specific developmental trajectories and the need to enhance their development and learning [22,28,29]. There is an exceedingly wide range of individual differences in

learning ability and cognitive skills in the school population [79]. Ability differences must be taken into account, not by trying to eliminate variance, but by designing educational programs and practices that can maximize the acquisition of the knowledge and skills most apt to benefit students. Some children learn more quickly than others, each child learns some topics faster and more easily than other topics, and children differ in the topics that, for them, are easier or more difficult to learn. And although not all children achieve the same level or in the same areas, all children can learn, want to learn, and like to learn [79]. Nevertheless, if education program do not respect their characteristics and differences, they may experience continuous failure and their keenness for learning can be “turned off”. This results in the need for pedagogical work more sensitive to the individual differences [21]. Therefore, to be able to offer the education practice more suitable for each children taken into account their differences, including their different genetic propensity to learn, reason and solve problems, is a pending challenge. Furthermore, there are studies that indicate that some children may be especially sensitive to small environmental changes, which may lead to the child having more advanced cognitive skills [80]. This appears to be the case for the heavier twins. They benefited more from the facilitating characteristic of color in task 1 (specifically at 18 and 24 months) and were able to suppress its interference (task 3) at a previous age and to a greater extent than their siblings (in task 3, at all ages, the heavier twins show greater cognitive skills than the lighter twins). Thus, in each task, they have been shown to be more sensitive to the different information that color communicated and were more sensitive to its processing/interference suppression when also regarding the task objective (attending to color in task 1 vs. suppressing its interference in task 3). This allowed them to display behaviors that were more appropriate to the task objective. This means that, on a greater number of occasions throughout the study, it was these heavier twins who showed greater cognitive skills (specifically: in task 1, at 18 and 24 months; in task 2, at 24 months; in task 3, at all the three ages studied). In the lighter twins, it could be that their developmental history—their less optimal intra-uterine environment which affected both their birth weight and brain development [36–39]—was being translated into their lower sensitivity to environmental information. Less complex neural circuits, due to their less optimal intra-uterine environment, would imply less complex mental activities, that is, a lesser capacity to focus their attention on the appropriate information in the task (less capacity to suppress the interference generated by color).

These results provide information that can be useful in the educational field. Many governments have built their educational policies in accordance with the principles of the 2030 Agenda which determines quality education as one of the SDGs. To achieve this SDG, it set a goal to ensure access to quality early childhood education [2]. Fortunately, this public policy trend is aligned with the scientific evidence [81]. Only quality early education can empower children with the essential skills necessary for later learning, thus contributing to their future success. Quality early education increases educational success and adult productivity, allowing for society’s development [6–8]. One of the aspects that defines quality early education is teachers being able to adapt their practices to the needs of children [21,22,82]. As reflected in the T-patterns detected in our study, children have distinct and ever-changing trajectories and needs that require specific instruction and support to enable optimal growth [22,29]. This is especially important for children under age 3. However, the literature indicates that teachers present gaps in their pedagogical training with under three-year-olds. They are not aware of the particular needs of these children, especially in certain areas of their development, and how to adapt their educational practices to them. It is essential to help staff identify and better understand child development and its needs. It is critical that they can use information about children in productive ways in order to facilitate a child’s fuller development [22]. Perhaps the lack of teacher training on these issues is indicative of the scarce research on the subject [28,29,83]. The early education field needs more empirical studies on which to base professional training and practices. The aim is to enhance children’s learning through improved evidence-based teaching about children’s needs [22,46]. It is due to this latter aspect—offering empirical evidence on the development and changing needs of children under 3 years—that this study has tried to have an input. However, policymakers must be

aware that, if they are to obtain evidence-based knowledge about the developmental trajectory and needs of children under 3 years of age, with the ultimate goal of improving their learning, we must study and understand children's behaviors in a natural context (school). As such, we need to conduct observational empirical research. Consequently, it is necessary to facilitate and enhance links between research and early childhood education schools [22].

The literature also indicates that early childhood teachers present gaps in their knowledge about the specific needs of multiple birth children and how to respond to those needs with the goal of enhancing their learning and development [84]. This is a gap that needs to be filled urgently as more and more twin children are becoming present in classrooms. The goal is to give all children a strong start. Again, and in accordance with what has been previously stated, it seems necessary to facilitate bonds between research and early childhood schools also in this regard. There is a lot of research on twin children but little research from an educational perspective. This study has tried to contribute to eliminating this gap. The majority of research focuses on multiple birth children and has been carried out with consideration of the notion of nature versus nurture; trying to explain the influence of genetics versus the influence of the environment on various aspects; or approaching possible pre-, peri-, and postnatal risk factors which may affect development and physical health. However, it must not be forgotten that the needs of twins are not reduced to these aspects, even less so when the basis of their future learning (encompassing their academic, personal, and social success) may be at risk.

We consider these two aspects—being focused on children under 3 years old and being focused on twins with BWD—to be valuable aspects in this study, in addition to its longitudinal perspective (and other aspects that we indicate below). It is acknowledged that scientific evidence on issues concerning children from 0 to 3 years old in the context of early childhood education is very limited when compared to other groups of older children [83]. Even less is known about twins, and even less again is known about twins with BWD [84]. If we consider working with such young children to take time and effort—resulting in high costs—, it takes even more if the work is done longitudinally and using three tasks (as done in this study). The longitudinal perspective, despite its practicality for studying development, is not always used due to the costs involved [85]. However, it allows us to obtain information that is of great interest and value for the field of early childhood education (given the rapid and significant changes that characterize this stage of life). In this study, obtaining this information has also been possible thanks to the use of systematic observation, a complex but optimal methodology for researching child behavior in depth [26–29].

Another relevant aspect of the study is having an analysis of the development of early logic skills (or logic mathematic skills [45]). Researching this development, and detecting possible difficulties in it, is very important. These skills are the basis of some of the most complex mathematical skills which are essential in our daily lives. The literature indicates that toddlers with low logic skills are most likely to experience difficulties with mathematics at school. In addition, these challenges may become more pronounced as courses increase in difficulty, which could even affect their ability to solve certain types of problems in real life [86]. The importance of early logic mathematic skills does not align with the scarcity of empirical studies which focus on them (even fewer are those which have focused on their development in children under 3 years old) [46]. This study has tried to contribute to eliminate this gap. The real importance of early logic mathematic skills also does not align with the little attention they receive in educational practice from early childhood education professionals themselves. Most consider that, at this stage, these cognitive skills are less important than other aspects, such as cooperation with others. Due to this, and which is in accordance with their beliefs, early childhood education teachers offer less learning experiences and use less specific practices to enhance early mathematics skills than those used to enhance other skills [82]. However, these professionals ought to have the raised awareness that the foundations for later logic mathematic skills are already in place in these early years. They should be aware, therefore, that they should allow and encourage children to develop these skills through fun and stimulating play. Furthermore, it must not be forgotten that—at a legislative level—these early mathematics skills are also part of the early childhood education

curriculum; therefore, they should be considered and practiced—through play—to the same extent as other skills.

It is also worth noting that interference suppression, a very important executive function, has been longitudinally addressed in twins with BWD under 3 years of age. Despite the increasing number of investigations into executive functions, studies have been primarily focused on the ‘average’ child during their school years and do not consider this longitudinal approach [52,53]. Interference suppression is the basis for other more complex functions and is closely linked to school adjustment and learning. Children who are able to suppress interference benefit more from education. However, the literature indicates that children with risk factors may present difficulties in their interference suppression skills from very early ages (an assertion corroborated by our results). With the purpose of allowing all children to equally benefit from later education and to equally have further successful learning and improvement of life, strengthening this executive function is another issue that must be addressed in early childhood education.

This study has some limitations. Firstly, the small sample size. It would be valuable to increase its size in order to corroborate the results obtained. However, this would imply a higher cost, given the difficulty and complexity involved in accessing a sample with the specific characteristics (regarding both the young age and the other characteristics) [87]. It is worth noting that the twins used in this study only present BWD as a risk factor. However, twins often present many other complications. Thus, although the number of twin births is increasing, most of them present pathologies and/or associated risk factors, such as prematurity or low weight, which are criteria for exclusion from the sample in this study. Therefore, achieving the participation of a greater number of twin children who meet the criteria for inclusion could be highly costly. In addition, conducting research with children requires the cooperation of different ‘gatekeepers’, such as school and/or pediatric staff and parents, which is not always easy. This is complicated for twin children. These families tend to be more overwhelmed and present higher levels of stress in the face of increased demands when caring for twins infants [88]. This sometimes makes it difficult for them to find time to meet—in addition to the child’s demands—the ‘demands generated by the researchers’. Nevertheless, in relation to the size of the sample and the cost/benefit that increasing its size would imply, it is worth noting that observational methodology is intensive, which involves working with a reduced number of participants but collecting a large amount of data with high accuracy. When studies are carried out within an observational framework—as in this case—the interest is centered on the exhaustive description of the natural behavior of a reduced number of participants and not on how representative it is of a larger universe [26–29,60]. As such, it is essential that observational studies are not unjustly ‘punished’ by being wrongly assessed from the experimental perspective; this, although decreasing in popularity, continues to be predominant in science [89]. This ‘unfair and erroneous assessment’, together with the high costs of an observational methodology—due to the creation of an observation instrument or at least adaptation of an existing one; difficulty and meticulousness of the recording; training of the observers; and calculation of reliability—have meant that it has sometimes been rejected when researching child development and learning [90], despite being the optimal methodology [26,28,29].

Other limitations of the study are the following. In the analysis of the participants’ cognitive skills, the magnitude or severity of their BWD has not been taken into account: Mild BWD = $BWD < 25\%$; Severe BWD = $BWD \geq 25\%$. However, it is possible that, as with their pre-, peri-, and postnatal physical health [36], cognitive skills more or less depend on the severity of BWD. It would be of value to analyze this aspect in future research. The same is true for other factors, such as zygosity, amnionicity, chorionicity, the type of conception (natural or by assisted reproduction techniques), the type of delivery (natural or cesarean), and the birth order of the twins. The literature indicates that these variables affect the probability of presenting pre-, peri-, and postnatal risks in twins [36,38]. As such, in the future, it would be worth checking whether being a monozygotic, monoamniotic, monochorionic twin, having been conceived by assisted reproduction techniques, being born by C-section, and being born second are factors associated with a child having lower cognitive skills. However, gaining access

to this type of information from the educational field is very difficult. Once again, we express the need to establish collaborations across multiple fields and institutions.

Another important limitation was not being able to collect information regarding the family and educational context of the twins. Although all the participants began the study with a mental age of 18 months, it is not known how each of these two contexts could have affected their cognitive skills during the time that this research lasted and when the data was being collected. Although the two twins from each couple share a family and school, this does not mean that, in each context, the two siblings are cared for and stimulated equally, or, even if they are, the effects on their cognitive development could be different [19,88]. As such, it would be worth analyzing the type of interactions that both families and teachers establish with each of the twins and establishing what the effects are on their cognitive skills.

It would be of great interest to be able to carry out a longitudinal study with a greater length of time in order to know if the differences in cognitive development existing in these early ages are maintained later. Here, special attention should be given to the children's start in compulsory education, where academic demands are greater.

At the analysis level, other complementary perspectives could be utilized. Some of these perspectives are experiencing significant growth due to the large quantity and wealth of information that can be extracted from observational data. These methodologies are lag-sequential analysis and polar coordinate analysis [91]. Given the particularity of each of these quantitative approaches, their complementary use will allow for a greater and deeper understanding of children's observed behavior. Having scientific evidence that allows us to understand the different needs of children is a first step in offering educational practices adjusted to them. Only in this way will we be able to offer quality education. Only in this way will we be able to enhance the future of all children.

5. Conclusions

This paper provides information that may be useful for the professionals in early childhood education who are working with toddler twins with birth weight discordance (BWD) to learn about the particular needs of these children and to adjust their educational practices to such needs. It must be taken into account that there are more and more twins being born; therefore, there are more and more twins whose specific needs must be met by early childhood education professionals. Responding to these needs has a lasting impact in later life and constitutes a building block that contributes to all children receiving quality education.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/24/10529/s1>, Figure S1: Observation Instrument.

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