



## Research article

## Drawing development of identical and non-identical twins: A case study of triplets



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## ABSTRACT

Differences in drawing development are conditioned by genetics, environment and individuality of children. Therefore, it is exciting to observe the drawing development in children, who are raised in the same environment and have a similar genetic basis, that is in twins, triplets, and so forth. In the study, we were interested in the similarities and differences in the drawing development of the triplets, two of which were identical twins (B1 and B2) and one was non-identical (A), and whether the characteristics of the drawing appear more congruently between B1 and B2 than with A. We proposed two hypotheses: H1: There are more similarities in drawings between identical twins (B1 vs B2) than between identical and non-identical one (A vs B1 and A vs B2); H2: The differences between non-identical and identical triplets are less pronounced at the beginning of the drawing development (in doodle phase) and become more distinctive in later development, in drawing of figure and space. We analysed 123 drawings that the triplets (41 drawings of each triplet) drew from 1 to 12 years of age at the same time and on the same topic. The results of our research have shown that both hypotheses can be confirmed. On the general level, there are more similarities in drawing between identical twins compared to non-identical ones; and the differences and similarities become more distinctive throughout the development, especially in figure drawing and in the depiction of space.

## 1. Introduction

## 1.1. The developmental theory of children drawing

Visual arts have occupied the human mind for thousands of years; therefore, it is not surprising that drawing, besides music, is also one of the first artistic activities children take part in.

There are different theories of children's drawings, one of them being developmental theory, dating back to 19<sup>th</sup> Century when children's drawings were started to be seen as insights into their mind and cognitive development (Quaglia et al., 2015). At the same time, visual arts were recognised as fundamental to education, in line with the need for design skills in the context of the industrial revolution (Milbrath et al., 2015).

Developmental theories are based on the presupposition that drawing development follows the processes that propel universal development in cognition and is characterised by features common to all children (Milbrath et al., 2015). However, it is also largely environmentally (socially and culturally) and individually conditioned (Matthews, 2003; Antoniou and Hickman, 2012). Even though all children spontaneously start to make marks on surfaces, this only progresses to representational

picture-making through interaction with others in some society and culture. Therefore, the cultural influence must be considered when reviewing drawing development, since children drawings mirror the values in some culture. Social and family rites and rituals, gender values, popular culture, mass media (stereotyping and marketing of toys, clothes etc.) are the crucial factors that children perceive as the "norms", which reflect in their drawings (Anning and Ring, 2004). The research on different cultures shows that children draw human figures in various ways, what challenges assumptions that there is a universal pattern in drawing development (Milbrath et al., 2015). For instance, in western cultures, where an individual is highly valued, the human figure is one of the key representations in children drawings. However, in cultures that give more emphasis on collectiveness, the individual figure is not a natural choice of children to draw but is only represented as a part of group activities.

The important part of modern western culture and society is also digital media. The interest in the influence of media on cognitive development first arose in the 1970s when researchers became interested in the influence of television imaginary. Studies show that the age at which children start using media (television, games, tablets,

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smartphones) has drastically fallen, from four years of age in 1971, and is now between three and five months (Valkenburg and Piotrowski, 2017).

Foundation of all developmental theories of children drawing is Luquet's (1913) study of his daughter drawings. The key characteristic of Luquet's theory, still holding in contemporary accounts, is the progression towards visual realism (Milbrath et al., 2015). According to Luquet, children first start making marks with no intention to make an image, and through socialisation gradually progress towards realism in four phases: casual realism (when children begin to notice analogy between traces on the paper and the shape of real objects), missed realism (when children start to show clear intent of drawing identifiable object), intellectual realism (representing an object as "it is" in canonical views) and visual realism (representing object as "it is seen" in view-specific depictions) (Quaglia et al., 2015). Even though linear perspective cannot be acknowledged as the only endpoint of drawing development, children drawings nevertheless do orientate towards realism as they mature (Milbrath et al., 2015). However, two annotations should be added to properly understand such developmental progression towards realism. First, that the fallacy of assuming that children desire for realism is inborn, which is a relic of Western aesthetics (Quaglia et al., 2015). The mind-set has changed in contemporary developmental theories from the realistic to aesthetic perspective, emphasising that a preference for abstract art in some children does not imply a developmental shortcoming of the child but is an expression of child's own aesthetic sense. A second important aspect which must be stressed is that drawing development shouldn't be misinterpreted as a fixed progression. The stages of drawing development are not mutually exclusive but are choices a child makes according to the task, stimulation and instruction provided to them. Drawing is a problem-solving activity, and drawing "errors" are solutions with which children solve the dilemma of representing three-dimensional reality on a two-dimensional surface (Quaglia et al., 2015). Therefore, Louis (2005) emphasises that instead of *phases*, we should talk of developmental *stages*. Children should be regarded as cognitive agents, who use acquired cognitive repertoire variably with the changes in their intentions and the task they are faced with. Properly stimulated, children may use cognitive strategies earlier than predicted with the developmental stages or, vice-versa, use lower-level abilities still after they have presumably overgrown them. Therefore, the question is not merely when children acquire certain cognitive skill, but how they use the skills they possess. On the one hand, children often do not recognise when they should use the cognitive strategies available to them, or, on the other hand, simply choose not to use them (Louis, 2005).

## 1.2. Overview of drawing development in children

Milbrath et al. (2015) divide contemporary developmental approaches on conceptual (focusing on conceptual development), perceptual (emphasising perceptual development), production (emphasising production strategies) and syntactic (analysing syntax rules) approach, and integrate them.

According to Milbrath et al. (2015), the crucial challenge for children is integrating the two primary processing routes in cognition: top-down or operative and bottom-up or figurative. These are reflected in object-centred (view-point independent description of objects in long-term memory) and viewer-centred (description of objects from particular view-point) perception. A top-down process uses a semantic or symbolic code accentuating the meaning of what is represented, and a bottom-up process reveals the perceptual strategies of how space is drawn. In younger children, the semantic code prevails over the bottom-up sensorimotor route, resulting in object-centred canonical representations, especially when a model has a strong semantic content (also, adults draw less realistically when semantic content is very strong). Therefore, over the course of development, children drawing advance from object-centred representations based on the top-down processes towards view-specific representations based on bottom-up processes (Milbrath et al., 2015).

Around age one children discover delight in making marks (Golomb, 1992; Piaget and Inhelder, 1967). Drawing first starts as a sensory-motor action – a scribble – but soon comes under the guidance of figurative and operative thinking and object-centred and viewer-centred perception. Mathews (2003, 2009) categorises three types of first marks children make: vertical arc (up-and-down movement); horizontal arc (left-right movement); and push-pull (back-and-forth movement). When these basic actions (scribbles) are synthesised, second-generation actions (doodles) are produced, (lines, points, waves, zigzags, rotations, etc.). Third-generation actions evolve when children discover resemblances between an object and their drawing, reflecting the likeness – when drawings become intentionally representational.

Machón (2013) distinguish the following five characteristics of doodles in the period from one to 4 years of age:

- *Back and forth movement* occurs around one year and six months when disjointed and jerky movements turn into more permanent, continuous movements back and forth;
- The circular movement resulting in *cyclic circular shapes* is possible when the child successfully passes three stages: control of impulses, neuro-motor development, and the steady prevalence of the visual function over the action.
- *Dots and commas* are no longer associated with aggressive, impulsive movements of the hand, but with a relaxing game.
- *Units and combinations of units* are characteristic from 3 years on. The child begins to produce a small number of shapes, which represent the symbol of the concept of unity and individuality, the selection of which gradually increases in diversity and complexity. By naming the shapes, the child describes similarities between the shapes and the phenomenon depicted.

Young children are first dominated by bottom-up figurative thought, but their drawings are paradoxically top-down object-centred representations (Milbrath et al., 2015). Since the object-centred perception is the primary function of the visual system, an observer ordinarily sees an object as the whole, not just its appearance from a specific point of view. Subsequently, young children are unable to systematically visually analyse the world and draw representationally by reflecting general views of objects, leading to object-centred drawings in the phase of intellectual realism, even when drawing from the model. Such representations have only a few variants, and one type of drawing can symbolise different things: the round shape (circle) is for regions, like for head or body; lines are for extended shapes, like arms and legs (Milbrath et al., 2015).

The rotary arm movement naturally results in a circle, which is the first representational shape a child can draw and copy (Golomb, 1992). The circle can convey the surface and the volume of objects. It is thus not surprising that the first recognisable form of the human figure is represented by a circle with attached arms and legs – a tadpole man. The head-body can include basic facial features (eyes, mouth, nose, hair), and the palms and feet can appear on the extremities. The eyes are usually the first facial feature to appear since they represent one of the most recognisable parts of the face. They are soon followed by the mouth and nose. Other facial features (ears, hair, beard, eyebrows) usually occur later with the conventional human figure and are often associated with the indication of the gender of the drawn figure (Cox, 1993). In Taylor and Bacharach's study (1981), 42% of three-year-old and 45% of four-year-old children made a tadpole figure. In Cox's (1993) study, the average age of children drawing a tadpole is four years and one month. A transitive shape represents an intermediate phase between a tadpole and the conventional human figure. The child draws a human figure by drawing the long lower extremities and adding the upper extremities. Intermediate space is the body, sometimes supplemented with a belly button or with a line connecting the legs (Cox and Parkin, 1986). At around the age of 5, children start to draw a conventional figure, which differs from the tadpole and the transitional form in separating the torso

and the head. The characteristics of the conventional human figure can be divided into two groups. The ones that are essential (eyes, legs, hands, mouth, gender, neck), and others that are included arbitrarily (nose, ears, shoulders, gender indicators, drawing from the back and back, movement figure). Children gradually add details, thus complementing the depiction of parts of the body (Cox, 1993). Despite showing some sensitivity to proportions in the conventional figure, children often draw head too large, possibly also resulting from the fact that children start mostly drawing the figure with the head, therefore unproportioned figure results from planning failures. Research shows that when children start with the trunk, they made proportions more accurately (Milbrath et al., 2015). The head-to-body ratio becomes more visually accurate after preadolescence.

According to Milbrath et al. (2015), the crucial dilemmas regarding the tadpole figure and conventional human figure are: Is the tadpole most economical solution or the result of planning problems? In addition, does conventional figure derive directly from the tadpole? Since the studies show that representation of human figure can be manipulated when children are motivated to copy a model figure segment by segment, this suggests that children have more schemas for the human figure and the tadpole is perhaps the simplest and most economical form, which they use, when they are asked to draw a figure spontaneously. However, children can use a more complex schema when a more differentiated version is required. This suggests that tadpole and conventional figure are not necessarily interrelated but coexist as two different graphic schemas.

In young children, sensory-motor procedures are accommodated to top-down operative thought but remain inconsistently coordinated with bottom-up figurative thought (Milbrath et al., 2015). In productional theories, the inability of children to overcome internal object-centred generic representations or canonical views of the visual model is called “canonical bias”. Typically, animals are drawn from the side, and humans are portrayed from the front; the figure is facing the observer, the legs are drawn apart, and the arms grow from the trunk. In this way, the child shows the most important parts of the human figure and avoids overlapping of the body parts. Drawing a figure from behind and from the side is usually not present until the age of five or six (Cox, 1993). However, when asked to depict the human figure in motion, children switch to profile. Younger children illustrate the movement of a figure with parted legs, while older children illustrate it with a changed position, a disproportionate extension or fold of the extremities; at the latest, a change in the inclination of the body occurs (Goodnow, 1977). Three-quarter rotation views are rare, however, can be characteristic to talented children.

Important advancement comes when children give more complex meaning to the marks. Lines start to denote edges, not just boundaries of regions or volumes; enclosed regions, like a circle, which first stand for volume in general, start to denote shapes by similarity (a circle is for roundness and not just for “thingness”). This is a necessary condition for overcoming canonical bias and the development towards viewer-centred representation (Willats, 2005).

Children from five to 7 years of age dramatically improve cognitive-processing abilities (Valkenburg and Piotrowski, 2017). They can concentrate longer and start to show more interest in complex humour like riddles, word games, etc., instead of innocent and clownish humour. Educational media, like Sesame Street and Dora, start to bore them. They express more preference for action, violence and action-packed media content that fit their cognitive needs, what is characteristic especially for boys (Mamur, 2012). This confirms Golomb's findings (1992) that spontaneous drawings of boys show interest in warfare, violence, destruction, sports, while girls rather draw calm scenes, like romance, family life and play.

Children also start to enjoy binary media characters, like extremely evil or good, masculine or feminine etc. At this age also the gender differences (gender segregation) become quite rigid, with boys avoiding slightest hint of femininity and vice versa (Valkenburg and Piotrowski,

2017). While boy and girl infants scarcely differ in their toys, television shows, games and picture books preferences, after three years of age gender differences become more apparent. Subsequently, children drawings and media preferences become more gender-stereotyped. Human figure drawings are important expressions of children gender identity (Lamm et al., 2019). With a conventional figure, children begin to add gender-specific details (Cox, 1993), like the style and length of hair, the shape of the torso and style of clothes (Sitton and Light, 1992).

One of the key cognitive changes in preadolescents (eight-to twelve-year-olds) is more interest in real-world phenomena, which is also reflected in the advanced ability of “decentering” (Valkenburg and Piotrowski, 2017). If younger children can focus only on the most striking aspect of an object or phenomenon, preadolescents can scrutinise the world in more detail. They look for realism in toys, books and entertainment (like in preteen drama series). Children at this age can also pay much more attention to the interesting story than on the physical appearance of a character. They are also able to divide attention between different media simultaneously, watching television and scroll tablet at the same time. One of the consequences of “decentering” ability is the enjoyment of collecting or saving. When children develop an eye for the detail, they become fascinated by different items of the same categorisation, like cards, stamps etc. They develop an ability to group phenomena by more than one criterion at the same time (shape, colour, length, etc.).

It is not that preadolescents do not enjoy fantasy anymore, what they are looking is a realistic fantasy following rules of logic, a possible realistic scenario in a fantasy setting. The Harry Potter is such an example of s. c. “magical realism”; it is a fantastic world, but characters reflect the real world of preadolescents, their true-to-life emotions and dilemmas (Valkenburg and Piotrowski, 2017).

The cognitive turn towards real-world phenomena makes children aware of their point of view, which enables them to develop better strategies for visual observation and subsequently orientates their drawings towards view-specific visual realism. In addition, drawing activity itself helps children to overcome natural object-centred tendency in perception and call their attention to spatial relation, thus help them to become aware of visual appearances – elements and relationships between them (Milbrath et al., 2015). When children are confronted with familiar models, they only look at it as long as they try to categorise it and instantly refer to their internal object-centred graphic schema in canonical view. However, they can be stimulated into using more view-specific drawings by inducing more careful visual observation and analysis. That is why children, when confronted with unfamiliar models or when their attention is focused (by an adult, e.g. teacher) to the interrelation between lines and corresponding visual model, can drastically improve and advance their realistic ability in comparison to their spontaneous drawings. Such “looking strategies” are something that western artistic training is practising for many centuries (Milbrath et al., 2015).

With a better ability for visual analysis, children begin to notice a mismatch between their drawings and the reality they are representing. Subsequently, canonical schemas are broken apart, and new strategies that consider view-specific aspects emerge. In line with that goes the syntax development, establishing the relationship between shapes and between shapes and the drawing surface. Children progress from arranging individual elements to an integration of the parts with the whole in the drawing. The syntax development is two-sided: spatial and compositional.

From spatial point of view there is a developmental progression towards the usage of projective drawing systems (between age 9 and 11), resulting in perspective (by age 13 or 14). Mixed view-point drawings are characteristic of this struggle – a combination of view-points relating individuals forms in preferred canonical orientations. One of the first spatial principles defining the relations between shapes is separation (Golomb, 1992): a division of a shape on inwards and outwards. Divisions on inwards are initiation of the figure features (facial and body features), and on the outside, a beginning of relationship between

separate figures. Relations between shapes and the drawing format evolves gradually. First, shapes are dispersed throughout the field, and then they gradually rearrange one next to another. The figures are laid on the lower edge establishing the floor line (Golomb, 1992). The appearance of a horizontal line is the first sign of relating figures to space and of awareness of the relation between the paper surface and the representation of space (top and bottom differentiate between far and near, constructing a ground plane). Children between seven and nine years, often display space with inclination and placing shapes from the lower edge upwards, suggesting the least distant on the lower edge to the furthest ones on the top of the format. Occlusion as an indication of depth consistently appears after ages of 9 or 10 (Milbrath et al., 2015). Children gradually advance towards using oblique projection, since the understanding of diagonals is more demanding than orthogonality. Eventually spatial cues as gradation, overlapping and inclination develop culminating in the ability to use perspective. Systematic coordination of a single view-point and convergence of oblique lines in perspective does not appear until age of 13 or 14 and is mostly only achieved by talented children and through education (Milbrath et al., 2015). Spontaneous usage of perspective is typically naïve with planes converging above eye level. When trying to approach perspective, children experiment with a number of ways to achieve this goal, such as size gradation, overlapping of shapes, foreshortening, modelling, shading, the use of colour texture and colour gradient (Golomb, 2002). Studies show that in spontaneous drawings, only half of adolescents between 13 and 14 attempts to use these indicators (Milbrath et al., 2015).

Besides the development of visual space towards perspective and realism, there is also the development of visual composition from simple alignments approaches to symmetrical balancing culminating, although rarely, in asymmetrical and dynamic balancing (Milbrath et al., 2015). Younger children typically arrange elements on a horizontal or vertical axis in a grid-like manner and in a somewhat disorganised manner. Older children achieve visual balance by making symmetry around a centre or arrange elements asymmetrically on diagonal axis. Arranging composition in an asymmetrically and dynamically balanced way is rare. The representational skill also significantly influences composition. Grid-like alignments are typical of object-centred schematic drawings, and more complex compositions are characteristic of more view-specific realistic representations.

### 1.3. Drawing development in twins

Although the drawing development of children was intensively studied in the last Century, the review of the literature reveals that the studies in the drawing development of siblings, especially those of multi-fertile pregnancies, like twins, triplets etc. are very rare, which could be mainly contributed to the difficult access to the research sample.

Twins, triplets etc. belong to the group of multi-fertile pregnancies. When one fertilised egg is divided into two or more identical parts, this results in identical (monozygotic) twins, but when two or more separate eggs are fertilised, the result are non-identical (dizygotic) twins (Buckler, 1999). In the case of triplets, two eggs may be separately fertilised, and one of them is then divided, leading to two identical twins and one non-identical. The identical twins share the same genetic code, while the non-identical twins have on average a 50% match in the DNA sequence (Fierro, 2005).

Greater monozygotic than dizygotic resemblance in twins suggests greater genetic influence on behaviour (Velázquez et al., 2015). Therefore, the studies of twins can help us to understand which personality traits are more likely to have a genetic background and which are more environmentally influenced. The properties that match in identical twins are being attributed more closely to genes than the properties that match both identical and non-identical twins (Tan et al., 2015). Thus, identical and non-identical twins enable scientists to understand the influence of genes and the environment on the personality and developmental characteristics of the individual (Matthews et al., 2010), for example on the

nature of learning needs (Clay, 1989; Preedy, 1999), development of mental, verbal and non-verbal skills (Asbury et al., 2005; Thorpe, 2006), social skills (Cherro 1992), exercising abilities (Stubbe et al., 2006), identity (Ainslie, 1997; Klein, 2012), creativity (Velázquez et al., 2015) and individuality (Nobel et al., 2017).

The genetic inheritance influences individual personality traits as “relatively enduring patterns of thoughts, feelings, and behaviours that distinguish individuals from one another” (Roberts et al., 2008, p. 375). Twin studies have shown mixed findings regarding genetic and environmental contributions on behavioural characteristics (Velázquez et al., 2015). Some studies propose that identical twins share more personality traits than non-identical twins. For example, Nichols' study (1978), summarizing ten studies on creativity, showed greater correlations for monozygotic twins (0.61) than dizygotic twins (0.50), which suggests modest heritability (Velázquez et al., 2015). Other studies stress that the environment also has a significant influence on that (Haider and Hussain, 2009). As emphasised by Hay and Preedy (2006), despite sharing the same genes, the different environment, parents rearing practices, and education bring changes in twins' personalities.

Some limitations regarding the research on influences of genes and environment on personality traits of twins can be overcome using adult identical twins that were reared and live apart – share the same genes but live in different (nonshared) environment (Velázquez et al., 2015). The reason for that is that adults have greater control over their environments than children, allowing genes to become more clearly expressed. Therefore, some studies suggest that genetic influence (heritability) on many personal traits increases with age when individuals gain greater control over their environments (McClearn et al., 1997).

The studies of twin siblings that include drawing activity investigate different cognitive characteristics of children (e. g. intelligence, behaviour, creativity etc.) by analysing how genes and environment influence the drawing development (Velázquez et al., 2015). With regards to drawing development, the studies of twins can help to determine which drawing features are more likely to have a genetic background and to which features the environment has a greater impact.

One of the rare studies of drawing development in twins was carried out in 1991 by Gedda (1991). The study aimed to determine the influence of genes and environment on children's drawing, based on 44 pairs of twins (31 pairs of identical and 13 pairs of non-identical twins) of different ages who grew up in the same environment. In the study, children draw in separate rooms and with the same materials on the same motif (a family having a meal). In their drawings, ten parameters were analysed: first impression, choice of colours, choice of perspective, seating order of the members, emphasis on the twin (author of drawings), table design, plate placement and food, furniture, drawing of the building and of the landscape. The analysis of concordance and discordance between the drawings within the groups of identical and non-identical twins showed that concordance within the group of identical twins was higher in comparison to the group of non-identical twins where there was no concordance (0%). This suggested the more expressed influence of the genetic component in the group of identical twins. However, despite the presence of the concordance in the group of the identical twins, the concordance was small (6.45%) and the discordance in both groups was dominant (in the group of identical twins it was 93.55%, in the group of non-identical twins it was 100%). Therefore, the individuality prevailed in both groups, which was attributed by the author to the effects of epigenetic component (of extragenetic, environmental origin) which is superimposed on the genetic component and individualizes each of the twins and his or her creativity (Gedda, 1991).

Another major study of influence of genes and environment on drawing development was done by Arden et al. (2014) within a sample of twins TEDS. TEDS or Twins early development study is a large longitudinal study of twins born in England and Wales between 1994 and 1996, within which investigations of different behavioural and cognitive characteristics of twins are taking place (Haworth et al., 2012). One of the aims of Arden, Trzaskowski, Garfield and Plomin's research (2014)



was to discover the extent to which genes influence individual differences in children's drawings of human figures. Their research included 7752 pairs of four year old TEDS twins, who were tested by a Draw-a-Child test. The findings of the research which are particularly relevant for our study are the following: firstly, the drawings done by identical twins were significantly more similar than those done by non-identical twins, which suggested a genetic influence on the children drawing at the age of four. Secondly, heritability increased over ten years, between ages four and 14 (measured by the correlation with intelligence between ages four and 14), which confirms other findings that suggest that genetic influence becomes more obvious when individuals have more control over environment. And thirdly, the results on the other hand also showed that scores for individual drawings revealed individual-specific environmental influence on the drawing at age four, which, similarly to [Gedda \(1991\)](#), suggested that epigenetic, environmental component in children drawing is strong and should be taken into account. For that reason, [Arden et al. \(2014\)](#) hypothesised that despite significant genetic influence, the similarities between twins drawings could also be contributed to environment and they would not be surprised if the data would show that any siblings' drawings were alike, irrespective of zygosity, because it seems plausible that any siblings from the same environment would copy each other or be guided by parents.

[Velázquez, Segal and Horwitz's \(2015\)](#) study also researched on influences of genetics and environment on drawing ability. To give more direct estimations of how genetics effects twins' behaviour (creativity in drawings) their study was done with adult twin pairs that were reared apart and lived apart most of their lives (69 identical adult twin pairs and 53 non-identical adult twin pairs). Twins were given two drawing assignments: Draw-A-House and Draw-A-Person in which three creative dimensions were rated (esthetically pleasing, well-drawn and creatively done). The authors hypothesis was that that identical adult twins would have greater creative similarity and receive more similar creativity scores (intraclass correlations) than non-identical adult twin pairs, what would indicate greater genetic effects. Their result were somehow contradictory. Namely, greater intraclass correlations were confirmed in Draw-A-Person task, but not in Draw-A-House task, where intraclass correlations were similar across both twin types, suggesting a lack of genetic effects and more pronounced nonshared environmental influences. The authors speculated why Draw-A-Person task showed more genetic influences and Draw-A-House task greater environmental influences. According to them, the drawing of a person enables greater variability across features (face, hair, gender, clothing etc.) whereas the drawing of a house results in more uniform drawings features (chimney, door, windows etc.). Therefore, people can draw a person in a more individual way than a house, having more decision-making freedom, which results in more individual and creative expression which could give rise to more expressed heritability. The somewhat contradictory results between the two tasks lead the authors to acknowledge the significant genetic influence one one hand, but also to stress the importance of the nonshared environmental influences, like the differences in art instructions, parental encouragement and available opportunities.

## 2. Methods

### 2.1. Research problem

Despite some of the research on drawing development of twins being made (as reported above), the drawing development in identical and non-identical twins is still poorly studied. The [Arden et al. \(2014\)](#) study focused only on one age group of twins (four years old) and one type of drawing (figure drawing) and the [Velázquez, Segal and Horwitz's \(2015\)](#) research was focused on creativity of adult twins expressed in two types of drawing, of a person and of a house. The limitations of both these two studies is that they focus on one age group and on one type of drawing. However, we could find no research studying longer period of twins' drawing development and encompassing analyses of drawings from more

complex developmental perspective, not just from a figure point of view, but also including doodle and space. This was the intention of our research in which we wanted to study drawings of identical and non-identical twins made over a longer period of time and from three developmental categories: doodle, figure, space. We report findings from the longitudinal case study of triplet sisters, two of which are identical and one is non-identical. The purpose of our study was to analyse the similarities and differences between identical and non-identical twins over the course of drawing development from age 1 to 12. We were especially interested in which characteristics of drawing development appear more similar between the identical twins compared to the non-identical one. Based on the previous studies reported above we proposed two hypothesis: H1: There are more similarities in drawings between identical twins (B1 vs B2) than between identical and non-identical one (A vs B1 and A vs B2); H2: The differences between non-identical and identical triplets are less pronounced at the beginning of the drawing development (in doodle phase) and become more distinctive in later development, in drawing of figure and space.

### 2.2. Research sample

In the research, a sample of 123 drawings of triplet sisters, two of which are identical, and one is non-identical, were analysed (41 drawings of each triplet). The triplets are marked with A (non-identical triplet), B1 and B2 (identical triplets). We sorted 123 drawings chronologically into groups (three drawings per group that were made at the same time and on the same subject) and numbered them from one to 41.

### 2.3. Data collection

The triplets made the drawings during the kindergarten and primary school classes between ages 1–12 years (from 2005 to 2016). Triplets were not intended to be included in research in advance, and we did not control the production of the drawings. We found the opportunity for research analysis when we came across the triplet's family and discovered that parents were carefully, systematically and chronologically collecting drawings of triplets throughout the periods of pre-school and primary school. The overall number of drawings that was delivered to us by triplets' parents was 159 and we selected 123 of them that fitted two criteria: drawings that were made by all triplets at the same time and on the same subject. In that respect, it is important to assert that the results of our research should be regarded as influenced by various external conditions, which we did not control, like the influence of other children in a class, teachers, parents, media images etc. However, we tried to control the research sample by selecting only those drawings that were made at the same time and on the same subject, which enabled us to make chronological and thematic classification of drawings. The study was approved by Ethical committee of Faculty of Education University of Ljubljana and complied with regulations of responsible conduct of research at University of Ljubljana. The informed consent was obtained from triplets' parents, who also provided the drawings for the research.

### 2.4. Data analysis

Since there are several issues regarding the reliability of using the drawings in research and the interpretation of features in drawings (e. g. exaggeration or minimisation of a given drawing feature that could support different interpretations, depending on the person interpreting the drawing; [Merriman and Guerin, 2006](#)), we tried to minimise these issues by providing a well structured coding system, by maintaining inter-rater agreement comparable to other studies (stated above) and by combining the benefits of qualitative and quantitative (statistical) analysis.

We devised a unique coding frame for analysis of drawings based on previous research (see the Introduction section) and on the drawings themselves.

First, we set the three categories in drawing development (doodle, figure and space) and associated them with the features that we identified in theory (see the Introduction section). These categories and features were then observed in 41 groups of drawings. After overall examination of drawing groups, we decided to include into the analysis of doodle 13 drawing groups, of figure 23 groups and of space 19 groups.

Then we rated the drawings in the drawing groups according to the devised coding system, marking whether a particular drawing included some feature or not. The (three) authors themselves did the rating of drawings. Each of us first rated the drawings separately, which enabled us to check the inter-rater reliability. The raters agreement was to follow the defined coding system for analysis strictly. The reliability between raters was 73%, which is not very strong, but is between 60% and 79% which is suggested as a moderate inter-rater agreement (McHugh, 2012). We attribute the differences in ratings to the complexity of the designed coding system and to the qualitative nature of some of the drawing features that were rated. In comparison, Arden et al. (2014) achieved 79% interrater agreement on the Draw-a-Child test, which is 14 % below the published interrater reliability for this test (93%; Naglieri and Maxwell, 1981)). However, the scoring of the Draw-a-Child test is simple, straightforward and quantitative, only counting a few body parts and intentionally ignoring more complex and qualitative features like size, proportion, expressed emotions, enclosure of shapes etc. Since our coding system tried to address more features in drawing development, some of them being also more qualitative in nature, it is not surprising that subjective differences in ratings were more expressed, resulting in moderate interrater agreement. Interrater agreement in Velázquez, Segal and Horwitz's (2015) study was also varying a lot, ranging from 63% to 77%, which could also attributed to the fact that raters qualitatively evaluated creative features and not merely counted body and house parts in the drawing.

Knowing these setbacks, we reviewed the differences in our ratings and come to an agreement over them, based on which combined ratings were made.

Next, we compared the ratings of drawings of each drawing group and identified how the analysed features match between the triplets. Based on the comparisons, we made tables for the three categories (doodle, figure and space), where we marked how some feature appeared in drawings of triplets (Tables 1, 4, 7, and 8). We used the mark »●« when a certain feature appeared in drawings of all the triplets (A, B1 and B2); the mark »■« when a certain feature appeared in drawings of triplets B1 and B2, the mark »◆« when a certain feature appeared in drawings of triplets A and B1, the mark »□« when a certain feature appeared in drawings of triplets A and B2, and marks »A«, »B1« or »B2« when a feature appeared only in one of the triplets. We counted the number of occurrences of each matching feature (Tables 2, 5, 9, and 11).

In the last step, and to give more relevance to our observations, we tested the hypothesis regarding the differences and similarities between triplets using a chi-square ( $\chi^2$ ) statistics (Tables 3, 6, 10, and 12). Degrees of freedom is 1. To statistically compare A versus B1 and B2 together, we calculated the chi-square of A versus average of B1 and B2 ((B1 + B2)/2). We used an alpha level of .05 and interpreted effect size (w) from 0.00 to 0.29 as small, from 0.30 to 0.49 as medium, and from 0.50 to 1.00 as

large. In the tables, we marked with bold when  $p < .05$  and when  $w > 0.3$ .

### 3. Results and discussion

#### 3.1. Doodle in the drawing

We analysed doodles in triplets' drawings according to the features defined by Machón (2013) (Table 1). The movements of the hands back and forth appear first in the triplets A and B1 at the age of 1 year and nine months in Drawing group 1. By the age of 1 year and ten months, the back and forth movement appear in the drawings of all three girls (Drawing group 2). Cyclic circular shapes appear significantly less often than the back and forth movements, only twice in the triplets B1 and B2, and once in the triplet A. Dots and commas are also rare and appear in all triplets at the same time. Units and combinations of units first appear in triplet A (Drawing group 2), however become regular in all three triplets simultaneously in Drawing group 7.

Despite minor differences, there is a prevailing similarity between drawings and the concurrent occurrence of the individual properties between all triplets in the doodle phase (Figure 1). By this, also our study confirms universal principles that are common to all children in the doodle phase. The chi-square ( $\chi^2$ ) statistics also confirms that no significant relevance is found in differences between triplets and also effect size of all the compared differences is small (Tables 2 and 3).

#### 3.2. Figure in the drawing

In the figure drawings similarities and differences between triplets start to appear more distinctively (Table 4), especially in comparison between triplet A to B1 and B2.

A tadpole and a transitional shape appears only in triplets B1 and B2 (Drawing group 10), but not in triplet A. Triplets B1 and B2 also depict a conventional human figure four months before triplet A (Drawing group 8), however, the movement of the figure is first introduced by the triplet A (Drawing group 15). Even the triplets B1 and B2 hardly ever draw a tadpole and a transitive shape, but made an almost direct transition to the conventional human figure (at the age of 3 years). That could indicate that the tadpole and transitive shape are not a necessary foundation for developing a conventional human figure and can exist as separate graphic schemas as suggested by Milbrath et al. (2015).

A significant milestone in representing human figure is the Drawing group 11 (Figure 2), which was created on the theme "My Mommy" when the triplets were three years and four months old. In that drawing, all three girls draw a conventional human figure. From then on, all the human figure drawings of triplets contain a conventional human figure.

It is characteristic that triplets differ in how they incorporate different parts of the conventional human figure. All the triplets include essential parts of the conventional human figure (eyes, legs, hands, mouth, hair, neck; Figure 2), however, they differ in how they include nonessential characteristics. The difference is distinctive especially in comparison between the triplet A versus B1 and B2. For instance, neck and shoulders more often are included in the drawings by the triplet A (Figure 3). There are also differences regarding the representation of gender signs, which

Table 1. Doodle.

Features	Drawing group												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Hand movement back and forth	◆	●	●	B2		■	●	●	●	B2		●	●
Cyclic circular shapes			■	A	B1	B2							
Dots and commas				●					A				
Units and Combinations of units		A					●	●	●	●	●	●	●
Age	1-3									3-4			



Figure 1. Drawing Group 2 (1 year ten months). Drawings order: A, B1, B2. Source: Authors own.

Table 2. Frequency of matching features in drawings.

	Mark	Frequency	Percent
A + B1 + B2	●	15	62
B1 + B2	■	2	8
A + B1	◆	0	0
A + B2	□	0	0
A	A	3	12
B1	B1	2	8
B2	B2	2	8
Total		24	100

are more frequently found in the drawings of the triplet A (16 times), and less often with triplets B1 (13 times) and B2 (12 times). The difference between the triplet A versus B1 and B2 are particularly evident in Drawing groups 14 (Figure 3), 15 (Figure 4), 17 (Figure 5) and 19 (Figure 6), where the triplet A draws a human figure with other attributes than B1 and B2.

Additionally, besides human figure (Figures 3, 4, 5, and 6) greater similarity in drawings between triplets B1 and B2 in comparison to triplet A can also be observed regarding other motifs, like by the choice of shapes, colours etc (Figures 7 and 8).

We tested the differences between the triplets regarding the figure drawings with the chi-square ( $\chi^2$ ) statistics, that also confirms that there are significant differences between triplet A versus B1 and B2. The effect size is medium too large regarding the differences (Tables 5 and 6).

### 3.3. Space in the drawing

Similarities and differences between the triplets can be further observed regarding the representation of the space.

In Table 7, we analyse the space in the drawing from the relationship between the shapes and the relationship between the shapes and the drawing format. In Table 8, we analyse the space in the drawing regarding overlapping, inclination and size gradation of shapes.

In the drawings of the triplets, *relations between shapes* (a division of shape inwards and outwards) appear simultaneously in all three at the age of 3 in Drawing group 7 (Figure 9).

However, it is characteristic that relations between shapes and drawing format is most frequently found in the triplets B1 and B2, while the triplet A uses it less frequently (Figures 4, 7, and 8). The sequence of shapes one next to the other or on the lower edge of the format also very distinctively occur first in triplets B1 and B2 in the period between 3-4 years, while the triplet A catches up with her sisters between 4 and 5 years of age.

Inclination and size gradation occurred in the drawings of all triplets and in very different combinations. Overlapping appears for the first time in triplet A in drawing group 27 in the detail of hands overlapping a centre line of a basketball field (Figure 10).

Size gradation appears less frequently in our study but appears simultaneously in the drawing of all triplets. The layering of plains one

Table 3. Test of differences.

Comparison	$\chi^2$	p	w
B1 + B2 vs. A + B1	/	/	/
B1 + B2 vs. A + B2	/	/	/
A + B1 vs. A + B2	/	/	/
A vs. B1	0.20	.328	.20
A vs. B2	0.20	.328	.20
B1 vs. B2	0.00	.50	.00
A vs. (B1 + B2)/2	0.20	.328	.20

/ - calculation is not possible, since one of frequencies is 0.

**Table 4.** Figure (developmental stages, body parts, figure layout).

Features	Drawing group																					
	7	8	10	11	14	15	17	18	19	21	22	23	25	26	27	29	31	33	36	37	38	41
Tadpole																						
Transitive shape																						
Conventional figure	B2	■	●	●	●	A	●	●	●	◆	●	●	●	●	●	●	●	●	●	●	●	●
Mouth		B2	●	●	A		A	■	●	A	◆	●	●	●	●	●	●	●	●	●	●	●
Ears		B2	●	◆					A										□		B2	A
Neck			●	A		A	A	B2	A		B1		◆	□	●	●	A	●	□	■	●	
Shoulders											B1		A	□	A	●	A	●	A	B2	●	
Arms		B2	●	●	A		◆	●	●	◆	●	●	●	●	●	●	●	●	●	●	B2	●
Eyes	B2	■	●	●	●	A	□	■	●	◆	●	●	●	●	●	●	●	●	●	●	●	●
Nose				●	A		B2	■	□	◆		B1	B2	□	■	B2		●	□	■	●	
Legs	B2	B2	●	●	■	A	●	●	●	◆	●	●	●	●	●	●	A	●	●	●	B2	●
From side						A			B2	◆	●	B1	A	●		●	A	◆	■	B2	●	
From back					A																	
Gender indicators			●	◆		A	●	■	A	B1	□	◆	●	●	●	□	A	●	●	●	●	●
Movement					A		□		□						●	B1	■	●	◆		●	●
Age	1-3		3-4		4-5				5-7					7-8				8-9	9-10			10-12

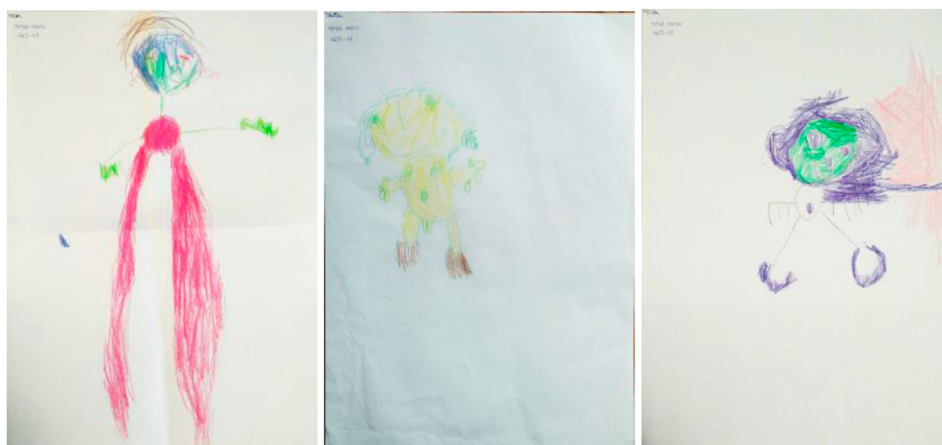


**Figure 2.** Drawing Group 11, My Mommy (3 years 4 months). Drawings order: A, B1, B2. Source: Authors own.

above the other occurs in all three triples simultaneously. All principles of spatial cues (overlapping, inclination and gradation) are adopted and become consistently present after the age of nine in all triplets. The milestone in this respect is Drawing group 33 (Figure 11), where layering

of plains one above the other is upgraded with the principles of overlapping and inclination.

We tested the differences between the triplets regarding space in the drawings with the chi-square ( $\chi^2$ ) statistics, that confirms that there are



**Figure 3.** Drawing Group 14, My Mommy (4 years three months). Drawings order: A, B1, B2. Source: Authors own.





Figure 4. Drawing Group 15, *Visiting Little Red Riding Hood* (4 years 5 months). Drawings order: A, B1, B2. Source: Authors own.

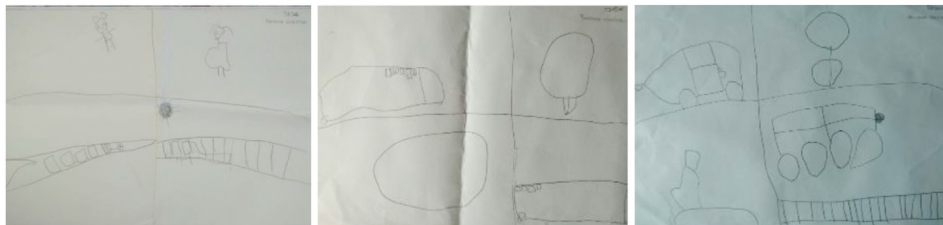


Figure 5. Drawing Group 17, *Transport vehicles*. Drawings order: A, B1, B2. Source: Authors own.



Figure 6. Drawing Group 19, *Me* (5 years). Drawings order: A, B1, B2. Source: Authors own.

medium too large effect sizes regarding the differences between triplet A versus B1 and B2 (Tables 9 and 10).

The overall analysis of the drawings shows that all three triplets simultaneously depict equal elements 144 times (sign “●” in doodle, figure and space). Beside doodle, this is most evident in the depiction of the key elements (extremities, facial features) of conventional figure. On the other hand, we found that the drawings express the individuality of the triplets 72 times (signs “A”, “B1” or “B2”). This is most often (38

times) found in triplet A, with triplet B2 it appears 22 times, and with the triplet B1 12 times (the individuality is dispersed through all ages in all three triplets). This suggests that the drawing development of non-identical triplet A differs more distinctively from B1 and B2, whereas the development of the identical triplets B1 and B2 are more similar. This is also revealed by the fact that a certain feature in drawing of B1 and B2 often appears simultaneously (sign “■” appears 21 times; most often between 4 and 7 years of age), while the coincidence between the triplet



Figure 7. Drawing Group 12, *Breakfast is healthy* (3–4 years). Drawings order: A, B1, B2. Source: Authors own.





Figure 9. Drawing Group 7 (3 years). Drawings order: A, B1, B2. Source: Authors own.



Figure 10. Drawing Group 27 (7 years). Drawings order: A, B1, B2. Source: Authors own.

Table 9. Frequency of matching features in drawings.

	Mark	Frequency	Percent
A + B1 + B2	●	28	57
B1 + B2	■	7	14
A + B1	◆	1	2
A + B2	□	2	4
A	A	7	14
B1	B1	2	4
B2	B2	2	4
Total		49	100

of the drawing development (in doodle phase) and become more distinctive in later development, in drawing of figure and space. This is confirmed by comparing of chi-square ( $\chi^2$ ) statistical analysis of particular drawing groups (doodle, figure and space). When comparing Tables 3, 6, and 10, we can see that the chi-square ( $\chi^2$ ) statistics shows no significant statistical relevance of difference A vs. (B1 + B2)/2 in doodle phase (Table 3). However, the difference becomes statistically significant in figure (Table 6) and especially in space (Table 10).

Since this is a case study, the study has a limited range of generalisation, but nevertheless reveals important findings when related to the findings of studies discussed above. Relating our findings to previous

studies enables us to make assumptions of the possible causes of why (H1) there are more similarities in drawings between identical twins and why (H2) the differences between identical and non-identical twins are less pronounced at the beginning of the drawing development.

As discussed above, Gedda (1991), Arden et al. (2014) and Velázquez, Segal and Horwitz's (2015) studies encountered similar results in their research of the twin drawings, in which they found that the drawings of identical twins are more similar than the drawings of non-identical twins. According to them, the statistically important differences between drawings of identical twins vs. non-identical ones suggest that such differences are genetically influenced, since identical twins share more

Table 10. Test of differences.

Comparison	$\chi^2$	P	w
B1 + B2 vs. A + B1	4.50	<b>.017</b>	<b>.75</b>
B1 + B2 vs. A + B2	2.78	<b>.048</b>	<b>.56</b>
A + B1 vs. A + B2	0.33	.282	<b>.33</b>
A vs. B1	2.78	<b>.048</b>	<b>.56</b>
A vs. B2	2.78	<b>.048</b>	<b>.56</b>
B1 vs. B2	0.00	.50	.00
A vs. (B1 + B2)/2	2.78	<b>.048</b>	<b>.56</b>

Marked with bold when  $p < .05$  and when  $w > 0.3$ .



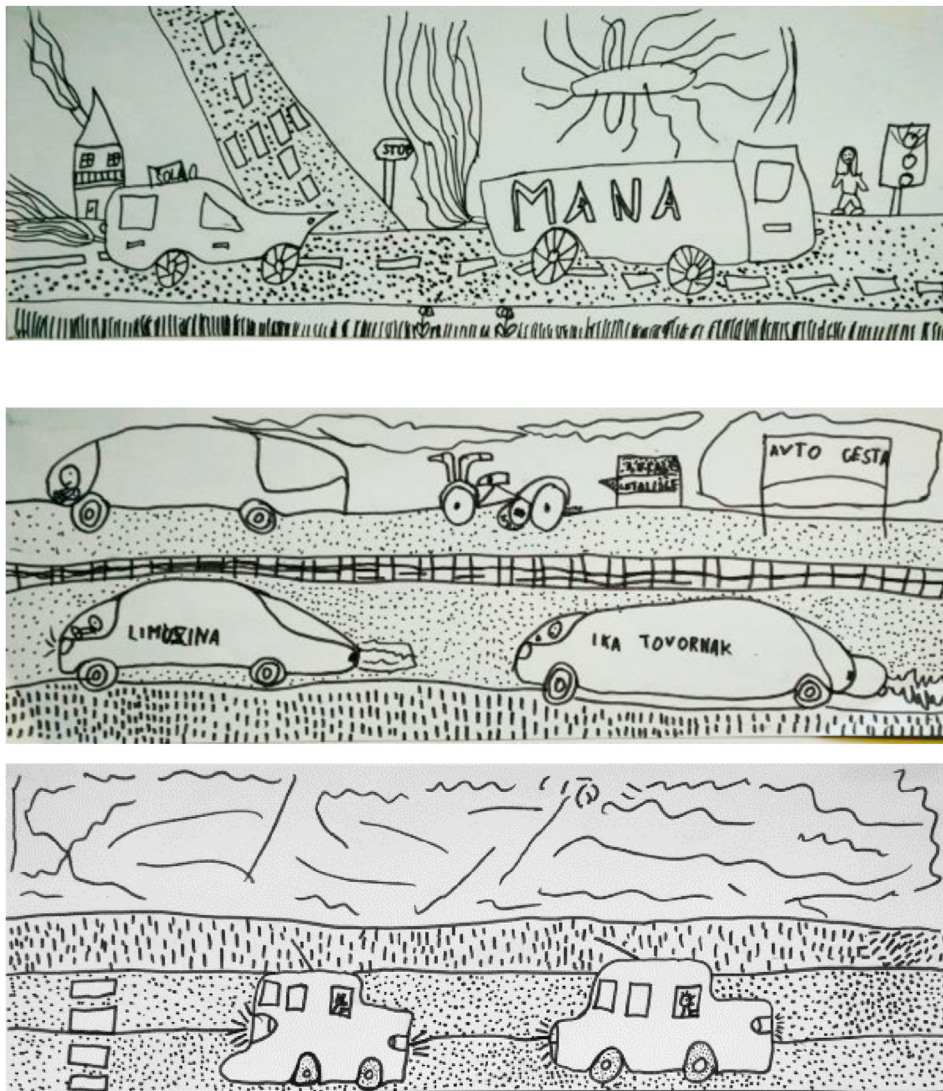


Figure 11. Drawing Group 33, Traffic (9 years). Drawings order: A, B1, B2. Source: Authors own.

genes that non-identical ones. However, in their studies they discovered that the individuality of drawings is also significant, suggesting that the influence of epigenetic, that is environmental component is strong and should not be neglected. Therefore, the important question that arises is what is the relationship between genetic and environmental component and does, in the case of identical twins, genetic component outweighs the environmental one? This dilemma could also be observed in our study. Namely, the individuality of triplets appeared often (72 times; Table 11, signs “A”, “B1” or “B2”) and is dispersed throughout all ages in all three triplets. Although the individuality is more expressed in triplet A

(38 times), and less in triplet B1 (12 times) and B2 (22 times), when comparing differences within all pairs of triplets (A vs. B1, A vs. B2, B1 vs. B2) the chi-square ( $\chi^2$ ) statistics (Table 12) shows that there is also statistically important difference between identical twins (B1 vs. B2), not just between identical and non-identical one (A vs. B1, A vs. B2) and the effect size of this difference is almost medium ( $w = .29$ ). Therefore, our study shows that individuality of identical twins is also important, since the difference between B1 and B2 is significant. That is why, similarly to Arden et al. (2014), we can not exclude the possibility that differences and similarities between identical twins drawings could also be

Table 11. Frequency of matching features in drawings.

	Mark	Frequency	Percent
A + B1 + B2	●	144	53
B1 + B2	■	21	7
A + B1	◆	16	6
A + B2	□	14	5
A	A	38	14
B1	B1	12	4
B2	B2	22	8
Total		267	100



**Table 12.** Test of differences.

Comparison	$\chi^2$	p	w
B1 + B2 vs. A + B1	0.67	.206	.14
B1 + B2 vs. A + B2	1.40	.119	.20
A + B1 vs. A + B2	0.13	.358	.07
A vs. B1	13.52	<b>&lt;.001</b>	<b>.52</b>
A vs. B2	4.27	<b>.02</b>	<b>.27</b>
B1 vs. B2	2.94	<b>.043</b>	<b>.29</b>
A vs. (B1 + B2)/2	8.02	<b>.003</b>	<b>.38</b>

Marked with bold when  $p < .05$  and when  $w > 0.3$ .

influenced by environment, especially since the drawings in our study were not made in controllable circumstances, but in school situation and simultaneously by all triplets (where inter-siblings influences and influences of teachers are possible and cannot be excluded). Being aware of a possibility of such an environmental influence, we must allow the possibility that statistically important differences between identical vs. non-identical twins could be caused by inter-siblings interactions in school environment which are perhaps stronger between identical twins than between non-identical ones, leading to more similar drawings between identical twins.

The result showing that differences between identical and non-identical twins are more pronounced later in the drawing development and become more apparent with age, was already observed by Arden et al. (2014) and Velázquez et al. (2015). Both studies suggested that genetic influence becomes more evident when children have more control over environment, allowing genes to become more clearly expressed. That is also confirmed by other twin studies, researching other personality traits of twins (McCleary et al., 1997). In a similar way, this could also explain why in our study the differences between identical twins vs. non-identical one are more pronounced in figure and space than in doodle phase. However, there is also one possible aspect that has to be stressed here and was also observed by Velázquez et al. (2015). Because they got contradictory results regarding Draw-A-Person and Draw-A-House task, Velázquez, Segal and Horwitz's (2015) hypothesised that different motifs influence how creative potential and individuality is expressed in drawings. Since a motif of figure enables greater variability across features (face, hair, gender, clothing etc.), persons draw a figure in a more individual way than, for example, a house. Being aware of that, we could assume that the motif (of figure) has also some influence on the fact that in our study the differences between identical vs. non-identical twins were more pronounced in relation to figure and space than to doodle.

#### 4. Conclusion

In the study, we were interested in the similarities and differences in the drawing development of the triplets, and whether the characteristics of the drawing appear more congruently between the triplets B1 and B2 who are identical twins than with the triplet A who is a non-identical twin. We proposed two hypotheses: H1: There are more similarities in drawings between identical twins (B1 vs B2) than between identical and non-identical one (A vs B1 and A vs B2); H2: The differences between non-identical and identical triplets are less pronounced at the beginning of the drawing development (in doodle phase) and become more distinctive in later development, in drawing of figure and space.

We confirmed both hypothesis and, in relation to some rare previous studies on twins' drawing development, discussed the reasons for such results.

We see the significance of our study in that it implements the limitations of previous studies in two respects. Firstly, we had a unique

opportunity to study not just the sample of twins, but the sample of triplets, two of which were identical and one of which was non-identical. This means that we could compare pairs of identical and non-identical twins inside the same family environment.

Secondly, we wanted to overcome the limits of studies that analyse differences and similarities between twins based only on one age group of twins and one type of drawing only (Arden et al. (2014) research focused on twins aged 4 years and on figure drawing). Therefore, the crucial significance of our research is in analysing the similarities and differences between identical and non-identical twins over the much longer course of drawing development from age 1 to 12 and on the three types of drawings inside this development, doodle, figure and space, what enabled us to analyse not only differences and similarities at some particular point of development, but also how these differences and similarities vary through the drawings development. Therefore, with the first hypothesis (H1) we addressed the similarities and differences in general that we confirmed with an overall analysis of drawings (Tables 11 and 12), and with the second hypothesis (H2) we explored the dynamics of how these differences and similarities progress over the course of drawing development (Tables 2, 3, 5, 6, 9, and 10).

The apparent limit of our research is that it is a case study, and therefore cannot be generalised. Obviously, our research could be further developed on the larger sample of triplets.

#### Declarations

##### Author contribution statement

Ursula Podobnik and Jurij Selan: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Vilma Peternel: Performed the experiments; Contributed reagents, materials, analysis tools or data.

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##### Data availability statement

Data will be made available on request.

##### Declaration of interests statement

The authors declare no conflict of interest.

##### Additional information

No additional information is available for this paper.

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