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# One-Year-Olds Think Creatively, Just like their Parents

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One-Year-Olds Think Creatively, Just like their Parents

Creativity is a defining feature of human thinking (Kirton, 1989). It is at the heart of successful human adaptation, both on a large scale (e.g., finding solutions to climate change, or collapsing economies) and small scale (e.g., 3D printers). Divergent thinking (DT) is a measure of creative potential, based on the generation of several ideas within one problem space (Torrance, 1974). Children's DT aptitude at 7 years predicts their future creative achievements and careers (Cramond, Matthews-Morgan, Bandalos, & Zuo, 2005; Runco, Millar, Acar, & Cramond, 2010). Thus the capacity to think divergently early in life may be essential for adults to later contribute important, influential ideas to society (Kaufman & Beghetto, 2009). However, given the importance of early DT, it is surprising how little research exists to determine the factors related to its emergence in the first place. The current study will determine whether (1) 1-year-olds can thinking divergently, and (2) toddlers' DT is linked to parents' at its emergence. While past research found toddlers can think divergently from 2 years (Bijvoet-van den Berg & Hoicka, 2014), it is important to determine whether this ability emerges earlier to better understand when this cognitive ability comes online. This in turn can help us better understand which factors affect the initial emergence of DT, which might be difficult or impossible to establish when some cognitive and social processes are already well established in older children.

DT is a cognitive ability related to, but distinct from, IQ, executive function, and convergent thinking (the ability to combine pieces of information into a solution) (Kim, 2008; Zabelina & Robinson, 2010). It has been measured in children since the 1960s, through tasks such as the Torrance Test for Creative Thinking (Torrance, 1974), the Wallach and Kogan tests (1965), and a pattern task (Moran, Milgram, Sawyers, & Fu, 1983), which askquestions such as, "Name all the things you can think of that are round." However, due to verbal limitations with younger children, these tests cannot be used with toddlers. Recently a new test was developed to measure DT in 2-year-olds. The Unusual Box Test (UBT) involves children playing with a colorful box with strings, hoops, stairs, ledges, etc., alongside 5 novel objects (see Figure 1) (Bijvoet-van den Berg & Hoicka, 2014). DT is determined by the number of different action/box area combinations children generate (see Methods). This test shows good test-retest reliability in 2-year-olds, and good validity in 3- and 4-year-olds when compared to the Wallach and Kogan test (1965), and the Thinking Creatively in Action and Movement (Torrance, 1981), another DT test that cannot be used with children under 3 years.

**Fig. 1.** The Unusual Box, and the Five Novel Objects

The first goal of this study was to determine whether DT is measurable in 1-year-olds. To do this, we will determine whether the test shows a range of scores, suggesting individual differences across 1-year-olds, and good test-retest reliability to determine whether individual differences are consistent over time.

The second goal of this study was to determine whether parents' and 1-year-olds' DT positively correlate, to give us the first clue as to how DT emerges. There are two reasons positive correlations were expected between parents' and toddlers' DT. First, recent research demonstrates DT is related to gene variants active in the dopaminergic pathways (de Manzano, Cervenka, Karabanov, Farde, & Ullen, 2010; Reuter, Roth, Holve, & Hennig, 2006; Runco et al., 2011; Volf, Kulikov, Bortsov, & Popova, 2009). Therefore parents and children may show similar DT levels due to genetic inheritance. Indeed, parents' and adolescents' DT correlated at moderate to high levels (Runco & Albert, 1986; Zenasni, Besancon, & Lubart, 2008).

Second, 1-year-olds are very good imitators (Carpenter, Akhtar, & Tomasello, 1998; Hilbrink, Sakkalou, Ellis-Davies, Fowler, & Gattis, 2013; Sakkalou & Gattis, 2012), and parents are one group of people they may have a good chance to imitate in day to day life. While most imitation research focuses on imitating specific actions, some research shows 2- and 3-year-olds imitate how people interact with the world more generally. In particular, 2-year-olds who watch an experimenter model a high level of DT produce higher levels of DT themselves, compared to children who watch no demonstration (Hoicka, Perry, Knight, & Norwood, 2015). In contrast, when an experimenter models only one action per object, and hence, as a bi-product, models a low level of DT, 1-year-olds produce lower levels of DT, compared to children who watch no demonstration (Bonawitz et al., 2011). Toddlers create their own novel jokes of a similar type after copying an experimenter's jokes (Hoicka & Akhtar, 2011), and both extend and create new pretend actions after watching an experimenter pretend (Nielsen & Christie, 2008; Rakoczy, Tomasello, & Striano, 2004). Therefore, if toddlers have parents who interact with the world in a divergent way, e.g., coming up with many different uses for things around the house, such as using towels not only to dry themselves, but also to bunch up as a pillow, use as a blanket, or even wear as a cape, then toddlers might imitate this style and also interact with the world in a divergent way. In contrast, if toddlers have parents who interact with the world in a non-divergent way, e.g., using towels only to dry their bodies, then toddlers may be less keen to try out new ideas, leading to low DT.

In this study, we measured 1-year-olds' DT on the UBT twice, two weeks apart. We also measured parents' DT on the Thinking Creatively in Pictures (TCP) test (Torrance, 1966). If children's scores on the UBT correlate with parents' scores on the TCP, this suggests children's DT is already linked to parents' when DT first emerges, perhaps due to genetic and/or social learning factors. Additionally, if children's scores on the UBT at both time points correlate, this suggests good test-retest reliability, revealing consistency in individual differences in 1-year-olds' DT.

## Methods

### Participants

A G-Power analysis found that 29 participants were needed for a large effect size (0.50) with a power at 0.80 and alpha at 0.05 (Faul, Erdfelder, Lang, & Buchner, 2007). Twenty-nine 1-year-olds (*M* = 19 months; 0 days; *SD* = 3;6; *Range* = 12;22-23;6; 14 boys) and parents (*M* = 34 years; *SD* = 4 years; *Range* = 27-44 years; 7 parents did not report their age; 4 fathers) participated. All participants were Caucasian and lived in the United Kingdom, and most were middle class. Additional children were not included due to not returning at Time 2 (2), not completing the test (1), or the parent instructing the child (2).

### Materials

The UBT (Bijvoet-van den Berg & Hoicka, 2014) is a colorful wooden box designed to measure DT (see Figure 1). It contains several features: blocks/ledges attached to one of the external walls, strings attached to a wire hung over one of the short sides of the box, rings attached to another external wall, a round hole cut into the final (short) external wall, a small room (reachable from the hole or top of the box) and stairs inside the box. The UBT also involves five objects novel to the participants: a metal spiral-shaped egg holder, a plastic unusually-shaped spatula, a rubber toy, a plastic hook and a shaker (see Figure 1).

The TCP, Booklet B (Torrance, 1966), measured parents' DT. The first task involved completing incomplete pictures (simple abstract line drawings). The second task involved filling in up to 24 circles with pictures. We chose to use a figural rather than verbal test because the UBT is non-verbal in nature, and so a non-verbal test would be a better comparison.

Since the UBT requires motor skills, we also measured motor development as a control. The Infant Development Inventory (IDI) (Ireton, 1992) is a motor skills questionnaire for children from birth to 18 months. This was used for children who were 12-18 months in our sample. There are 20 questions for gross motor skills, ranging in order from those typical from birth to 21 months, e.g., "Stands alone, steady" (12 months). There are 16 questions for fine motor skills with the same age range, e.g., "Scribbles with crayon or pencil" (15 months).

The Child Development Review (CDR) (Ireton, 1992) is a motor skills questionnaire for children from 19 months to five years with statements relating to fine and gross motor skills. This was used for children who were 19 to 23 months in our sample, and has stage overlaps with the IDI. There are 20 questions for gross motor skills, ranging in order from those typical from birth to 5 years, e.g., "Walks up and down stairs alone" (23 months). There are 18 questions for fine motor skills, with the same age range, e.g., "Picks up object with thumb and finger grasp" (8 months). Parents respond with either a tick if their child performs the action, or a cross if not.

**Design**

A within-participants design was used. The main variables included children's DT at times 1 and 2 (2 weeks apart), and parents' DT. Potential covariates included children's chronological age, and fine and gross motor ages.

**Procedure**

During the first testing session, the parent completed the IDI or CDR away from the child, but without being occluded. Parents were instructed not to show or tell their child what to do. The experimenter (E) sat next to the child. Children were presented with the box which had been placed on a turntable to ensure all features of the box were accessible by the child. All features of the box were individually highlighted by E, e.g., "On this side there are blocks of different sizes" while pointing our the blocks, and the child was given the opportunity to turn the box around using the turntable. E spoke while showing the parts of the box to make the interaction more naturalistic. However, the verbal script was not necessary for children to look at the different features of the box. Then E handed an object to the child and a ninety second trial period commenced where the child played freely with the object and box. After 90 seconds, E stopped the child playing, praised them, removed the object and gave them a new object. This was repeated for all 5 objects. If the child asked what the object was or how to use it, E used standardized responses, such as, "Just play a little while longer." Otherwise E looked to the child once in a while and smiled, but otherwise did not engage with the child. During the second testing session (*M* = 13.8 days later, *SD* = 5.34, *Range* = 7-28), the parent filled out the TCP behind an occluder while E ran the UBT again.

**Coding**

The UBT was coded by observing the number of different actions a child performed using the box and the objects in the five 90 second free-play sessions. Actions were coded from video, covering two angles, based on the type of action performed (e.g., hit, place, squeeze) and where on the box the action was performed (e.g., rings, edge of box; for full coding scheme, see Bijvoet-van den Berg & Hoicka, 2014). For an action to count as a different action, it needed to either take place on a different box area, be a different action type, or both. If the child performed the same action in the same place, it was not coded again. Coding was assessed for inter-rater agreement. Examined was whether each action-area combination was counted by both raters, neither rater, or one rater. Ten randomly chosen videos (17%) were coded for agreement. The inter-rater agreement was good, *Cohen's kappa* = 0.69. Where there was disagreement, we used the original coder's coding. The coders were not blind to the hypotheses of the study, but they also did not have access to the TCP scores when coding the UBT, and vice versa.

The TCP was coded according to the manual. DT was the number of different pictures completed, that relevantly used the shapes provided. Agreement for 5 (17%) of the tests was $r = 0.99$, $p < .001$. Toddler's gross and fine motor ages were calculated using the IDI or CDR (Ireton, 1992). This was defined as the age corresponding to the most advanced motor skill the parent reported, for which at least one of the three previous stages of motor development was also reported.

## Results

Table 1 shows means, confidence intervals, and ranges for all measures. Children's fine and gross motor ages were normalized by square root transformations (Osborne, 2010). The square root transformations for fine and gross motor ages were nearly collinear, *Pearson's* $r = .88$, $p < .001$. Therefore these were collapsed into a general square root motor age by adding both scores together and dividing them by two. Table 2 shows raw correlations for children's DT at Times 1 and 2, parents' DT, children's chronological age, and children's transformed motor age. The square root of motor age correlated with children's DT at Time 1, better than chronological age. Therefore all further correlations partialled out the square root of motor age. Chronological age did not correlate with any DT measures once the square root of children's motor age was accounted for.

Figure 1 shows the scatterplot of the raw correlation between children's DT at Time 1 and parents' DT. Figure 2 shows the scatterplot of the raw correlation between children's DT at Times 1 and 2. Partial correlations, with the square root of motor age as a covariate, found children's DT at Time 1 correlated with parents' DT: $r' = .44$, $p = .021$; and children's DT at Time 2, $r' = .59$, $p = .004$, though children's DT at Time 2 showed only a trend with parents' DT: $r' = .33$, $p = .083$.

**Table 1.** Means, Confidence Intervals (CI; 95%), and Ranges for all measures

| | Mean | CI | Range |
|---|---|---|---|
| **Children** | | | |
| Divergent Thinking Time 1 | 15.97 | 2.02 | 6-28 |
| Divergent Thinking Time 2 | 16.76 | 1.68 | 6-23 |
| Distinct Actions Time 1 | 9.86 | 1.64 | 3-24 |
| Distinct Actions Time 2 | 10.66 | 1.55 | 2-21 |
| Same Actions Times 1 and 2 | 6.03 | 1.30 | 0-13 |
| Children's Motor Age | 24 months; 4 days | 2;29 | 13;0-49;0 |
| **Parents** | | | |
| Divergent Thinking | 20.59 | 2.42 | 7-33 |

**Table 2.** Raw Correlations for Children's DT at Times 1 and 2, Parents' DT, Children's Age, and Children's Motor Age (Square roots of fine and gross motor ages collapsed).

| | Child DT T2 | Parent DT | Child Age | Motor Age (square root) |
|---|---|---|---|---|
| **Child DT T1** | .656*** | .423* | .326$^{t}$ | .475** |
| **Child DT T2** | | .333$^{t}$ | .447* | .490** |
| **Parent DT** | | | .013 | .089 |
| **Child Age** | | | | .762*** |

*p<.05, **p<.01, ***p<.001, $^{t}$<.1

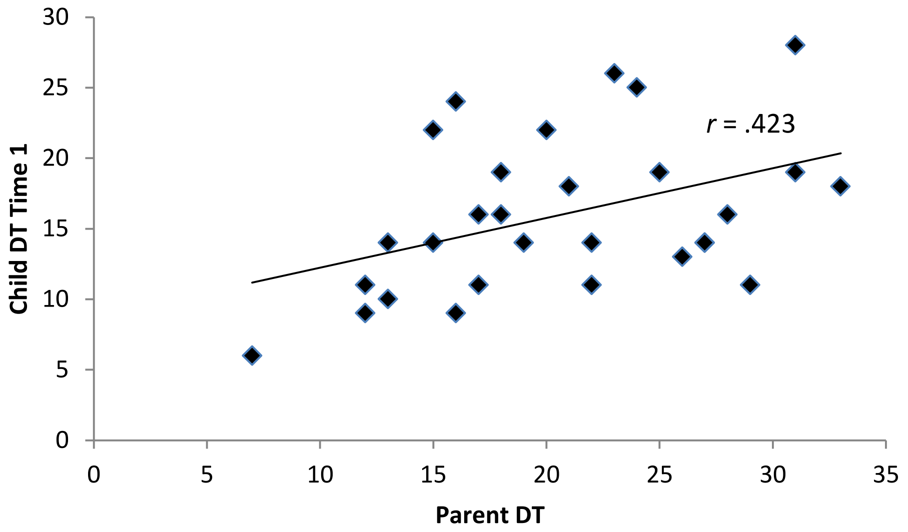


**Fig. 2.** Scatterplot showing the raw correlation between children's DT at Time 1 and parents' DT.

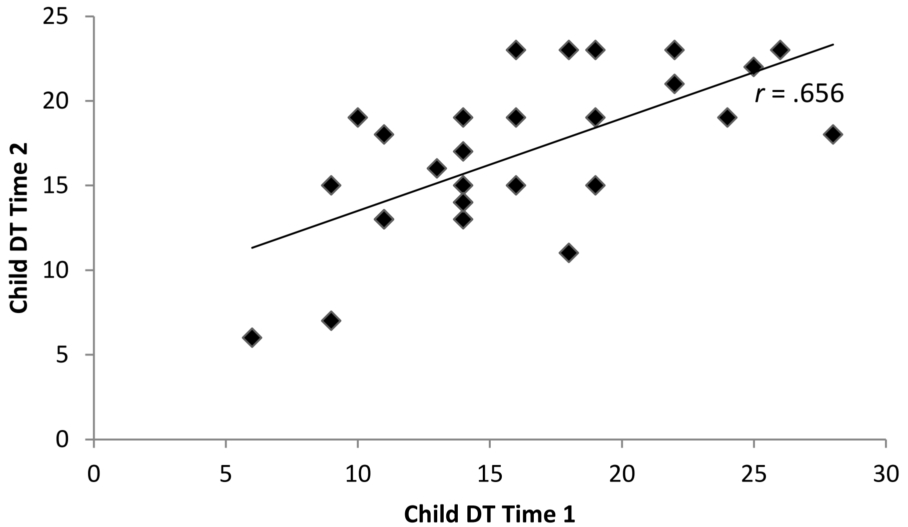


**Fig. 3.** Scatterplot showing the raw correlation between children's DT at Times 1 and 2.

To determine whether children's DT was consistent over time due to repeating the same actions, we considered distinct and same actions at Times 1 and 2, where distinct actions were done only at one of the time points, and same actions were done at both time points. Neither chronological nor motor age correlated with distinct or same actions, so neither was partialled out for the following analyses. The total number of distinct actions at

Times 1 and 2 were strongly correlated, $r = .52$, $p = .004$, suggesting children have similar DT over time, which is not reliant on repeating the same actions. A paired-samples t-test found children produced more distinct than same actions at Time 2, $t(28) = 3.87$, $p = .001$, *Cohen's d* = 1.46, therefore, again, children were not simply remembering what they did during Time 1, and were instead coming up with more new ideas. A paired samples t-test found no difference in children's distinct actions at Times 1 and 2, $t(28) = 0.99$, $p = .330$, reinforcing the idea that children's DT was consistent over time.

## Discussion

This study suggests the UBT is a good measure of DT in 1-year-olds. The test shows high test-retest reliability, suggesting it captures individual differences in DT, with scores ranging from 6-28. Therefore it is a reliable test of DT in 1-year-olds. The correlation between scores is not due to children remembering previous actions and repeating them – most actions were new on the second testing. Additionally, not only did total DT scores correlate across time points, but so did children's number of distinct actions at both time points.

This study shows, for the first time, that DT processes may exist, and appear to be measurable, in the second year. It thus provides the earliest window to date to examine how DT emerges. This study converges with evidence that young children are good explorers in general (Bonawitz et al., 2011; van Schijndel, Franse, & Raijmakers, 2010; van Schijndel, Singer, van der Maas, & Raijmakers, 2010). Additionally, by demonstrating that DT is measurable early on, this opens up the possibility to determine the initial factors which affect DT at its onset. For instance, we could examine whether executive function affects DT in toddlers, as it does in adults (Zabelina & Robinson, 2010).

This study also demonstrates that parents' DT is already linked to toddlers' DT by the second year, as toddler's scores on the UBT show moderate to high correlations with parents'

DT on the TCP. This extends research finding parents' and their adolescents' DT on the same test are moderately to highly correlated (*r* = 0.46-0.55) (Runco & Albert, 1986; Zenasni et al., 2008). We found similarly high correlations, despite children's young age and participation in a different test.

One way in which parents' DT may be linked to toddlers' is through genetics. Recent research suggests variants of specific genes, including Dopamine Transporter (DAT), Catechol-O-Methyltransferase (COMT), Dopamine D2 receptor gene (DRD2); Dopamine Receptor D4 (DRD4), and Serotonergic gene TPH1 affect creativity (de Manzano et al., 2010; Reuter et al., 2006; Runco et al., 2011; Volf et al., 2009). One-year-olds' and parents' DT similarities may suggest gene variants are already at play. However research on twins suggests that while genetics is part of the answer, it may not be the entire answer. Research examining the heritability-indices of various DT tasks found none of the tests showed a significant difference in variance between monozygotic and dizygotic twins (Pezzullo, Thorsen, & Madaus, 1972; Reznikof, Domino, Bridges, & Honeyman, 1973; Vandenberg, 1968). Thus while modern genetic research reveals there are genetic factors at play, each gene may only account for a very small portion of variance, suggesting non-genetic factors are also important.

A second way parents' and toddlers' DT may be linked is through social learning. Past research shows children learn to think divergently from others. Specifically, toddlers improve their DT if they first watch someone else showing high DT (Hoicka et al., 2015), but reduce their DT if shown low DT behaviors (Bonawitz et al., 2011). Toddlers also innovate jokes and pretending after watching multiple exemplars from an experimenter (Hoicka & Akhtar, 2011; Nielsen & Christie, 2008). In the context of the current study, if a toddler's parent, who can be a prominent source of information about the world, explores the world in a divergent way, toddlers may themselves copy this exploration style. If instead parents do not explore the world, but stick to few ways of behaving, toddlers may reduce how much they explore. Thus through exposure to parents' daily DT, toddlers may imitate an overall exploration style – one high, medium, or low on DT. This makes sense because 1-year-olds are keen social learners who copy others with ease (Carpenter et al., 1998; Hilbrink et al., 2013; Sakkalou & Gattis, 2012).

If this is the case, this suggests parents and early years educators may have the opportunity to increase toddlers' DT early on. For instance, if parents or early years educators did exercises to either increase their own DT, or at least simulate a high DT level in front of toddlers (e.g., following a high DT play script), this could theoretically increase toddlers' DT. Given that children's DT at 7 years predicts creative outputs in later life (Cramond et al., 2005; Runco et al., 2010), influencing DT while children's neuro-development is still very plastic (Joseph, 1999) may have the opportunity to lead to greater future creative gains.

Since a correlation was found it, is also theoretically possible that parents socially learn to adapt their DT style from their toddlers rather than, or in addition to, the other way around. Adults' DT is also influenced through observing others. For instance, if adults worked in groups to come up with different uses for a familiar object, they later came up with more uses for a different object on their own, compared to adults who always worked individually (Andre, Schumer, & Whitaker, 1979). Adults who have the opportunity to copy others in a search task come up more of their own creative solutions to the task (Wisdom & Goldstone, 2011). Adults may increase their creativity in these situations because the collective creativity they were exposed to was high on DT. It is thus also possible that if a parent has a child who tends to explore, parents may be influenced by this and also explore more. In contrast, if a parent has a child who tends not to explore, parents may also imitate this style and explore less as a result.

Finally, it is possible that parents' and children's DT are linked, at least in part, due to other indirect reasons. For instance, in adults, DT correlates with working memory (Roskos-Ewoldsen, Black, & McCown, 2008), and research on twins found a genetic component to working memory (Ando, Ono, & Wright, 2001). Therefore genetic links between basic cognitive functions could help support the relationship between DT in parents and 1-year-olds. Future research should examine this possibility.

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