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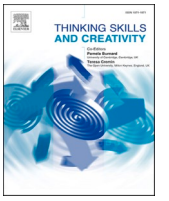

Creative potential in flux: The leading role of originality during early adolescent development

Ross C. Anderson [a,*], Matthew Graham [b]

[a] Inflexion, 360 10th Ave, Eugene, OR 97401, United States
[b] The University of Oregon, United States

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ABSTRACT

Divergent thinking can approximate creative potential of individuals and provide a valid way to understand the creative thinking process and creative development. Still, little is known about how the primary factors that make up divergent thinking—*fluency, flexibility,* and *originality*—develop during the early stages of adolescence. The dual pathway model suggests that creativity can emerge from both persistence and cognitive flexibility pathways. This study addresses current gaps about this theory, and tests the dual pathway model at the level of both creative ideation tasks and developmental change across time using the random intercepts cross-lagged panel model. That model controls for the autoregression effect of prior level on subsequent score as well as the effect of one factor on change in another. The results suggest that originality and fluency remain relatively stable from Grades 6–8, while flexibility increases from Grade 7–8. Within each wave, fluency showed the only positive relation with originality, suggesting the persistence pathway may be primary during early adolescence. Neither pathway explained developmental change. Originality influenced increase in flexibility and fluency, and that increase flexibility influenced further increase in fluency. Originality contributed to higher levels of creative illustration, creative self-efficacy, and creative self-concept. Fluency led to higher levels of creative metacognition. Developing ideas that are high in originality requires effort, time, practice, and strategy across different contexts. Formal learning opportunities to develop affect and skills for originality in ideas may converge with developmental advantages for creative potential in early adolescence, supporting students' self-beliefs, metacognition, and cognition related to creativity.

1. Introduction

Since Guilford's theorizing decades ago (Guilford, 1950, 1968), divergent thinking, or creative ideation, has been studied in the creativity field as a measure of creative potential and has provided researchers from diverse disciplines—from psychology to neuroscience—one efficient and valid way to understand creative production and development (Barbot, 2018; Runco, 1991; Runco & Acar, 2012). Conceptually, divergent thinking contrasts with convergent thinking as a cognitive process that should, theoretically, produce original ideas and possibilities as opposed to conventional or typical solutions. Though divergent thinking is not the same as creative production and achievement in a specific discipline, researchers have produced substantial evidence that the domain-general

* Corresponding author.
E-mail address: ross.anderson@inflexion.org (R.C. Anderson).

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creative ideation process represents capacities that contribute to actual creative achievement (Runco & Acar, 2012). Moreover, the study of creative ideation can help clarify important processes (Barbot, 2018). However, the longitudinal development of the central processes underlying divergent thinking—fluency, flexibility, and originality—and how they influence one another during the pivotal developmental period of early adolescence has been understudied. Clarity on patterns of change and influence can provide the fields of education and creativity a better understanding of how these creative resources become available to young people and how they play distinct roles in creative outcomes.

The creative potential of young people is important to consider when understanding healthy adolescent development. The capacity to think flexibly undergirds resilience and adaptability to face changes encountered in life (Cohen, 1989). In fact, recent research demonstrates links between teachers' creative attitudes, beliefs, and environmental supports and well-being and resilience during times of crisis, such as the COVID-19 pandemic (Anderson, Katz-Buonincontro, Bousselot, & Todd, 2021). The ability to think of original and surprising ideas and uses for common objects or figural patterns is an important step to remaining open to divergent possibilities, identifying opportunities that others might not, or making new connections across disparate categories (Anderson, 2015). The development of that creative potential is important for personal growth as well as progress of communities. For instance, creative ideation contributes to healthier identity exploration and commitment in adolescence (Barbot & Heuser, 2017; Sica, Ragozini, Di Palma, & Aleni Sestito, 2017). However, during the period of rapid growth that accelerates in early adolescence during middle school—the second most important period of human development (Dahl, Allen, Wilbrecht, & Suleiman, 2018)—research and theories are mixed about how creative ideational fluency, flexibility, and originality interact and change across time.

For instance, the fast-developing body of knowledge gained during adolescence could produce heightened potential for associative and exploratory thinking that should link to divergent thinking flexibility (Kleibeuker, De Dreu, & Crone, 2013; Kleibeuker, De Dreu, & Crone, 2016), which could ultimately lead to greater originality of ideas. Empirical research suggests that for students in socioeconomically marginalized U.S. schools, creative ideational originality, fluency, and flexibility decreases for most students during Grade 6–8 (Anderson, 2019). Research has clarified that creative ideational factors of fluency and originality are distinct, and that the relationship between them will likely vary depending on the scoring method (Dumas & Dunbar, 2014). Still, decades of research and the development of many different scoring techniques illustrates a fluency contamination effect, where the quantity of ideas generated (fluency) is highly related to the quality of ideas (originality), especially if scoring of originality in divergent thinking tasks is additive across items (Forthmann, Szardenings, & Holling, 2020). The most effective approach to dealing with the fluency contamination effect appears to be using an average score of originality; yet how much fluency will determine others scores remains unclear. To further understand how these factors change across early adolescence requires careful consideration of these methodological challenges. This current study aimed to provide new understanding about how three primary factors of creative ideation—fluency, flexibility, and originality—change and influence one another during early adolescence for a diverse sample of middle-level students using rigorous methods. This study also aimed to understand how those factors contributed to the outcomes of creative production, metacognition, and self-beliefs.

1.1. The role of creative potential in learning and life

Creative potential appears to play a role in academic success beyond just creative endeavors. In a recent meta-analysis, researchers found, on average, a small-to-medium effect for the association between creative potential and academic achievement—the largest effect was for the middle school period (Gajda, Karwowski, & Beghetto, 2016). From a socio-cognitive perspective, creative potential contributes to students' motivation and self-beliefs in school (Dai et al., 2012; Hennessey & Amabile, 2010; Peng, Cherng, Chen, & Lin, 2013; Putwain, Kearsley, & Symes, 2012), which can shape students' engagement and persistence through K-12 education (Anderson, Graham et al., 2019). From the student perspective, space to think divergently during learning increases the quality of the learning experience and contributes to their holistic development as agentic actors in their school experience (Anderson, Haney, Pitts, Porter, & Bousselot, 2020). Though it is clear that creative potential can be adaptive and productive for adolescents during middle school, it is unclear how the cognitive divergent thinking factors that traditionally compose students' creative potential play a role in their creative development.

1.1.1. Divergent thinking as creative potential

Though conceptualized by Guilford (1950) with a variety of factors, creative ideation most often focuses on three dimensions, fluency, flexibility, and originality, each scored to approximate different components to divergent thinking capacity (Barbot, 2018; Reiter-Palmon, Forthmann, & Barbot, 2019; Runco, 1991). Divergent thinking tasks can be verbal, figurative, illustrative, and even numerical (Preckel, Wermer, & Spinath, 2011). One of the most common divergent thinking tasks is the Alternate Uses Task, which asks participants to produce as many ideas as possible for a common object—most famously, the brick. *Fluency* represents the number of different ideas or solutions produced by an individual in response to the prompt. *Flexibility* represents the associative or categorical difference between ideas produced, often calculated as the number of distinct categories that ideas produced fit into. *Originality* represents the novelty and uniqueness of an idea, most often evaluated as being conceptually distinct from all other ideas produced by a sample (Beketayev & Runco, 2016). Importantly, when the originality or flexibility score of individual ideas (e.g., 0 = not original and 1 = original) are aggregated into person scores, an average score across the ideas generated per task is key to addressing fluency contamination (Reiter-Palmon et al., 2019).

Though the field has some understanding of the development of divergent thinking during adolescence (see Kleibeuker et al., 2016), little is known about how these dimensions change during the critical period of cognitive and social-emotional growth in early adolescence and how each factor may or may not influence change in one another across that period. For instance, whereas the work by Kleibeuker et al. (2016) mapped development in different cognitive abilities across many years in adolescence, this current study focuses in on the onset of early adolescence—a period of rapid development—and investigates factors beyond just cognitive abilities. When zooming in from the macro-level of development across three years of early adolescence to the micro-level of creative ideation in a task, the dual pathway model theorizes inter-relationships between fluency, flexibility, and originality (Nijstad, De Dreu, Rietzschel, & Baas, 2010). Operationalized within divergent thinking scoring, average originality across tasks is either a function of flexibility in the number of distinct categories generated per task (flexibility pathway) or the average fluency of ideas produced within each category within a task (persistence pathway). The dual pathway model posits two qualitatively distinct processes that may result in creative ideas—the cognitive flexibility pathway and the persistence pathway. Importantly, the model also assumes that other situational or dispositional variables (e.g., creative self-beliefs and metacognition) that relate to creative performance will play different roles within each pathway.

The flexibility pathway focuses on achieving more creative ideas, insights, or solutions through flexibly switching between categories assisted by a variety of potential factors, such as overcoming "functional fixedness," availability of dopamine in certain brain areas, flattened hierarchy of ideas, and reduced latent inhibition, or filtering out previously irrelevant stimuli (see Nijstad et al., 2010). The persistence pathway focuses on achieving more creative ideas, insights, or solutions through systematic, thorough, and diligent exploration of possibilities within a few categories or a single problem space, assisted by blocking out of irrelevant thoughts and a focus on the target at hand, which is supported by strong evidence of relation between the quantity and quality of ideas. This study tests the dual pathway model at two different levels. First, this study tests which pathway appears to play the strongest role within divergent thinking task completion at each time point across three years of early adolescence. Second, this study will test if and how the persistence pathway (e.g., fluency) and the flexibility pathway influence the development of average originality from one time point to another, over and above the common role they share. One limitation to testing the dual pathway model at both levels in this study is that fluency scores did not take into account persistence *within a single category*, rather fluency accounts for persistence in developing many ideas in response to a single stimuli. By regressing originality on flexibility and fluency together at each wave and across waves, the number of categories produced by an individual is controlled for, to some degree, which should ensure that fluency represents the persistence pathway, accurately.

Currently, it remains unclear whether fluency or flexibility relates strongest to average originality of ideas during this developmental period. And, of those three dimensions, it is unclear which relates strongest to other creative outcomes, such as creative production in a domain, creative metacognition, and creative self-beliefs. As Dumas and Dunbar (2014) note, fluency has been studied by many researchers as the most consistent and practical way to approximate divergent thinking; however originality is more closely linked to creative potential, conceptually (Zeng, Proctor, & Salvendy, 2011). With greater clarity about which pathway is most influential in developing original ideas, the field can understand the development of creative ideation during this pivotal developmental period. Additionally, with more understanding about how these dimensions change and influence one another during this early adolescent phase, explanatory models to describe creative ideation, such as the dual pathway model, can be expanded, integrated, or proposed anew. Moreover, this understanding can help educators and parents leverage the creative strengths of young people in early adolescence through conditions, routines, and practices that develop those ideational processes as a means to sustain or boost natural growth and development.

1.1.2. Other issues about how divergent thinking factors relate

The creativity literature has discussed at length some of the issues in studying divergent thinking factors, longitudinally. For instance, the within-person correlations between different divergent thinking task forms (i.e., many uses for a "brick" versus a "tire" or "newspaper") has demonstrated inconsistent levels, often falling below what would be acceptable by most psychometric standards (Barbot, 2018). Additionally, fluency plays a role in shaping the quality, distinctness, and novelty of ideas produced—the more ideas produced the higher the likelihood that one will be original—and this relationship between quantity and quality produces the fluency contamination effect mentioned previously. As such, it is critically important to use average originality rather than additive originality scores in analyses.

Research does suggest that greater time spent thinking about ideas predicts higher originality of ideas produced (Acar, Abdulla Alabbasi, Runco, & Beketayev, 2019), and more uncommon and original ideas require more effort and time (Barbot, 2018). However, Forthmann et al. (2020) show that when prompted to "be creative" on ideational tasks, research evidence suggests a trade-off model where average originality of ideas is negatively correlated, in fact, with fluency of ideas. Though predictions in that model rely on a *be creative* prompt, they fully contrast with the dual pathway model. Still, Nijstad et al.'s (2010) work suggests the relation between flexibility and originality is stronger than the relation between fluency within a specific category and originality, unless people generate ideas within a narrow rather than broad topic. At the task level there are multiple, competing models to explain how average original ideas take shape for an early adolescent population. This study aims to provide clarity about how these models fit consistently at each measurement occasion, and the inter-relationships between these factors across a pivotal three years of development in early adolescence.

1.2. Creative potential, self-beliefs, and production

In an educational context, creative ideation becomes the interaction between aptitude, process, and environment of an individual or group (Plucker, Beghetto, & Dow, 2004), so self-beliefs matter as both an antecedent of creative behaviors and as an outcome of creative development in a learning environment. Creative self-beliefs represent an individuals' views and convictions about their creative potential and self-efficacy in specific tasks or domains and regarding their self-concept in context, such as school (Anderson & Haney, 2020; Karwowski & Barbot, 2016). Past research indicates that creative self-beliefs are fairly malleable and responsive to environmental conditions, training experiences, the influence of others, and certain personality traits (Karwowski & Lebuda, 2016). Some conceptualize creative metacognition as a component of creative self-beliefs (Beghetto & Karwowski, 2017), but creative metacognition should be thought as the metacognitive experiences, knowledge, monitoring, and adjusting necessary for individuals to understand the context, be self-aware, and know and apply strategies to be effective in their creative process (Anderson & Haney, 2020; Jia, Li, & Cao, 2019). Given that definition, creative metacognition is related to creative self-beliefs, such as creative self-efficacy and self-concept; however, empirical research identifies it as distinct (Anderson & Haney, 2020). Generally, results have been mixed in the investigation of metacognitive components and creative thinking, with some aspects, such as processing fluency, showing consistent relationships, and other aspects, such as metacognitive knowledge, showing inconsistent relationships, due, in part, to potential measurement issues (Jia et al., 2019). Specifically, incongruency appears between a self-report approach to measuring some aspects of creative metacognition and actual creative thinking and production. This current study uses a written reflective approach that should align more closely to creative thinking and action taken.

Recently, the conceptual model of creative behavior as agentic action (Karwowski & Beghetto, 2018) illustrates one way that divergent thinking fluency, flexibility, and originality could predict creative metacognition, self-concept, and self-efficacy during this early adolescent period. Divergent thinking serves as a measure of individuals' creative potential, which will only be operationalized as creative behavior through aspects of personal agency, as theorized by social cognitive theory (Bandura, 2018), such as self-efficacy, self-concept, and metacognition. Karwowski and Beghetto (2018) provided early support for this model with three empirical studies with early adolescent samples. More recent work (Anderson & Haney, 2020) demonstrated the mediational qualities of creative metacognition and self-beliefs; however, no study goes further to understand the unique contribution of each divergent thinking in this model.

The production of creative stories, images, inventions, or other types of products naturally builds on some of the same processes of fluency and flexibility as proposed by the dual pathway model (Nijstad et al., 2010) that go into domain-general creative ideation. One major difference is that creative products are judged within a sociocultural context and domain to be appropriate and effective and to be novel, unique, and surprising (Baer & McKool, 2016). In exercises of divergent thinking, a learner can pursue wild ideas disconnected from the confines of reality and conformity of norms; however, in completing a domain-specific task that will be judged by semi-experts in an educational context, those wild ideas must be constrained for the result to fit the general criteria for creativity to be recognized by others—novelty and effectiveness (Runco & Jaeger, 2012). In that process, conformity and conventions play a role in balancing out the use of novelty, uniqueness, and surprise in a learner's response. Conformity and convention play an important role in other contexts for creativity as well (Beghetto, 2017); yet, those two constraints do not exist in domain-general divergent thinking exercises, unless the learner's affect or approach consciously or unconsciously imposes them.

As recent research found (Anderson & Haney, 2020), it is possible that when accounting for the potential role of fluency and flexibility through the dual pathway model, originality in creative ideation could contribute uniquely to creative production and stronger creative metacognition and self-beliefs in a specific domain. Insights about students' creative metacognition in early adolescence during a task to invent a mythological creature revealed the two most common forms of creative metacognition—strategy selection (e.g., thinking about putting two different animals together or making the creature scary or strange) and self-regulation (e.g., slowing down, thinking through multiple ideas before choosing one, or letting go of expectations). Additionally, the ability to produce many ideas (fluency) and different categories of ideas (flexibility) should relate to students' creative metacognition. It is possible that the effort to persist in generating lots of ideas or different types of ideas would relate to an individual's general creative self-concept. Because creative self-efficacy should be conceptualized to be more task-specific in line with social cognitive theory (Beghetto & Karwowski, 2017), the relationship of divergent thinking processes to creative self-efficacy in a domain-specific task may likely be weak.

1.3. Context of study

The context of this study provides an opportunity to understand (a) how the creative ideation factors of fluency, flexibility, and originality develop across three years of middle-level education during adolescence for a sample of U.S. students, (b) how they influence change in one another, and (c) how they influence the development of creative production, metacognition, and self-beliefs prior to entering high school. This study uses data gathered as part of a federally-funded development and evaluation project, focused on integrating the arts into middle school curriculum in underserved schools for socioeconomically marginalized students (Anderson & Pitts, 2017). This study investigates relationships between divergent thinking factors through the dual pathway model at two different time scales—the task level and across three years of early adolescent development—and does not attend to the nature of the arts integration condition experienced by some students. Prior to testing all three divergent thinking factors together in one model,

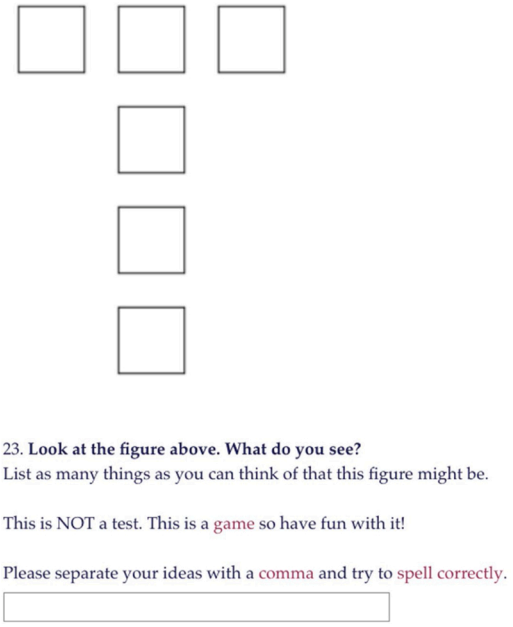

Fig. 1. This example illustrates the figural divergent thinking tasks used in this study.

we tested three models that analyzed each pair of factors on their own. However, our research questions focus on results from the complete trivariate model. Specifically, in this study, we pursued the following research questions in a sequential format.

1 Within each wave, does originality consistently regress onto both flexibility and fluency, as suggested by the dual pathway model?
2 Does within-subject change for each factor show a carryover effect into subsequent waves during Grades 6–8 (e.g., if a student is above their within-subject mean at one time point a positive carryover effect indicates they are likely to remain above their within-person expected mean in subsequent waves)?
3 Across waves, do fluency and flexibility illustrate cross-lagged influence on the carryover effect for originality during Grades 6–8, as suggested by the dual pathway model?
4 Are these patterns of within-subject change and factor-to-factor influence consistent across Grades 6–8 in middle school?
5 When controlling for shared influence of the three factors of creative ideation—fluency, flexibility, and originality—does originality demonstrate the strongest contribution to creative production, creative metacognition, and creative self-beliefs?

2. Method

We studied a sample of middle school students ($N = 1{,}299$) across Grades 6–8 using common divergent thinking tasks to measure creative ideational fluency, flexibility, and originality. Though the years that span Grades 6–8 represent a small piece of adolescence, these years demonstrate a period of accelerated growth and change, rivaled only by the first couple years of life (Dahl et al., 2018). We used the random intercepts cross-lagged panel model (Hamaker, Kuiper, & Grasman, 2015) and predictive path models in a structural equation modeling framework described below to respond to the research questions.

2.1. Participants

This study included a sample of middle-school students from the Pacific Northwest, who began 6th grade in 2015 and completed 8th grade in 2018. As 6th graders, this sample was approximately $n = 1299$ students, where 77 % are White, 5.5 % are Multiracial, 3.1 % are Black, 3 % are American Indian/Alaska Native, 1.3 % are Asian, 1.1 % are Native Hawaiian/Pacific Islander, and 12.5 % are Hispanic and another race and 9 % are Hispanic only (Anderson, 2019). Additionally, 52 % of the sample were male and 48 % were female; 2.7 % had been identified as English language learners and 13.7 % were identified for special education services. Students attended schools with high proportions of students historically furthest from opportunity (e.g., as high as 95 % of students eligible for free- and reduced-meals). As such, student attrition from the study was about 30 % missing per wave. We report more findings about missingness in the results section. We conducted modeling using full information maximum likelihood estimation (Graham, 2009), allowing data from all students with at least one complete wave to be included in the analyses (van Buuren & Groothuis-Oudshoorn, 2011).

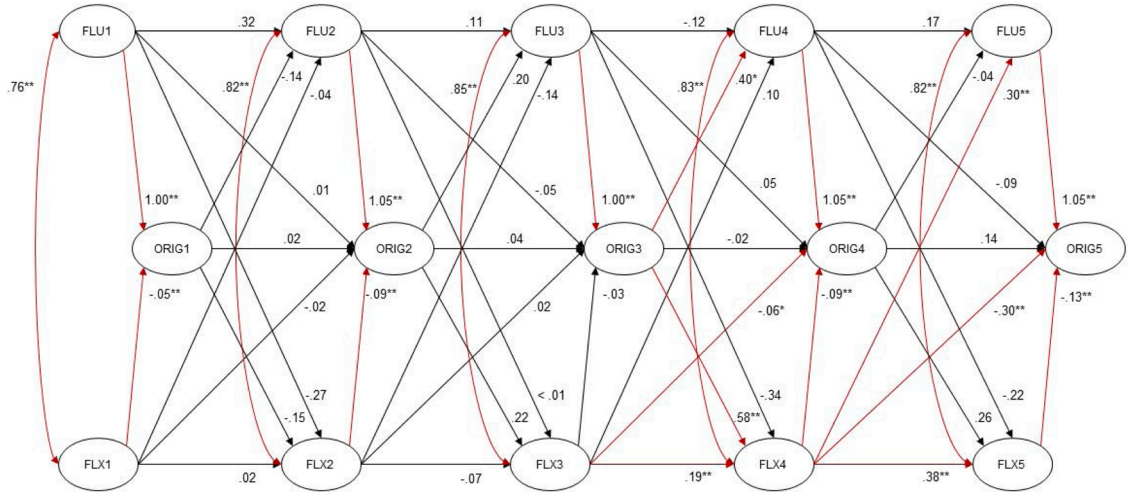

Fig. 2. Trivariate RI-CLPM for Fluency, Flexibility, and Originality, Statistically Significant Parameters in Red (Standardized Estimates). Paths include regressions of originality on fluency and flexibility within each wave and cross-lagged parameters of each factor on the other two factors at subsequent waves (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).

2.2. Measures and variables

Divergent thinking (DT) was measured at each wave using two sets of divergent thinking tasks—one verbal and one figural-verbal—with three stimuli in each set (Runco, 2011, 2012). Four forms of verbal and figural tasks were used, where the first tasks that students responded to at the beginning of Grade 6 (Wave 1) were used again 2.5 years later in the middle of Grade 8 (Wave 5). Fig. 1 provides an example of a figural-verbal divergent thinking task—the stimuli is figural and the response is in a verbal (written) format. The verbal tasks followed the *Many Uses Games* or *Alternate Uses Task* protocol that has decades of use in creativity research (Barbot, 2018; Snyder, Hammond, Grohman, & Katz-Buonincontro, 2019). As Wallach and Kogan (1965) suggested these types of figural and verbal prompts contrast by requiring different types of pattern finding but relate by requiring a similar verbal response to express and put meaning to those patterns, explicitly. Verbal task prompts were nearly identical to the figural task depicted in Fig. 2, except that students were given an object prompt in writing, such as *shoelace* or *tire*, and asked to generate as many ideas as possible for how to use that object.

Importantly, the prompt did not ask students to think of *creative* ideas. "Be-fluent" instructions may suppress the originality of ideas produced (Reiter-Palmon et al., 2019); however, the decision to not prompt students to think of *creative* ideas was meant to avoid triggering any negative self-beliefs a student may carry or to inadvertently create an assessment experience that felt high stakes for students. The prompt encouraged students to have fun with the tasks, following a game-like approach promoted by early developers of creative thinking tasks (Wallach & Kogan, 1965). As such, fluency scores are instruction-congruent and flexibility and originality are instruction-incongruent. Tasks were placed at different intervals within a longer survey protocol. Students had a complete 50-min class period to complete the protocol, so tasks were not timed.

Prior to scoring, we corrected misspelled words, removed duplicate responses, and deleted responses that were illegible, incomplete, or inappropriate (e.g., used offensive language). Student responses were scored separately on three dimensions of divergent thinking by comparing responses within the study sample. Scoring procedures used a semantics-based algorithmic (SBA) process (Beketayev & Runco, 2016) that recent research demonstrates is efficient, accurate, and comparable to traditional methods for scoring DT tasks, showing reliability and predictive validity of creative production and accomplishment (Acar & Runco, 2019). The SBA fluency score was computed as the average number of ideas generated by a participant across tasks. The SBA flexibility score was computed as the average number of different categories of ideas produced across tasks. Each response gets analyzed in its entirety within 12 semantic networks but discrete words or phrases within a response are also analyzed to determine association within one category or another. The number of categories produced within a single task is based on the semantic statistic for any pair of ideas in that response, reflecting the semantic similarity between responses. The SBA originality score (SBAIRO) for each response within a task was computed as an average of all semantic association statistics for that idea, adjusted by the idea association frequency rate. The SBAIRO produces a score based on the frequency of occurrence within the sample from which it was drawn. We selected the approach where each idea judged to be unique among less than 10 % of the sample received one point and each idea unique among less than five percent of the sample received two points, following the approach of Milgram and Milgram (1976). Generally, reliability of factors demonstrated adequate reliability ($\propto > .70$ for all waves and factors except Wave 1 for flexibility).

As a measure of creative production in creative thinking and drawing, we used an assessment that used the consensual assessment technique for scoring (Amabile, 1982; Baer & McKool, 2016)—a technique with decades of application to measure creativity from a

Table 1
Correlation, Missingness, Means, and SD for Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. FLX1	1.00														
2. FLX2	.42**	1.00													
3. FLX3	.36**	.40**	1.00												
4. FLX4	.45**	.47**	.56**	1.00											
5. FLX5	.36**	.42**	.50**	.57**	1.00										
6. FLU1	.84**	.46**	.43**	.48**	.46**	1.00									
7. FLU2	.44**	.88**	.45**	.53**	.47**	.51**	1.00								
8. FLU3	.38**	.44**	.90**	.60**	.55**	.48**	.52**	1.00							
9. FLU4	.44**	.48**	.55**	.90**	.58**	.48**	.54**	.62**	1.00						
10. FLU5	.35**	.41**	.52**	.59**	.90**	.48**	.48**	.58**	.62**	1.00					
11. ORIG1	.82**	.46**	.42**	.48**	.47**	.98**	.50**	.47**	.48**	.49**	1.00				
12. ORIG2	.43**	.84**	.45**	.53**	.47**	.51**	.98**	.52**	.53**	.49**	.51**	1.00			
13. ORIG3	.38**	.44**	.87**	.61**	.56**	.48**	.52**	.98**	.62**	.59**	.48**	.53**	1.00		
14. ORIG4	.45**	.48**	.53**	.86**	.60**	.48**	.53**	.61**	.98**	.63**	.49**	.53**	.61**	1.00	
15. ORIG5	.33**	.37**	.39**	.52**	.78**	.44**	.45**	.48**	.57**	.90**	.45**	.47**	.49**	.58**	1.00
Missing	.24	.30	.32	.46	.36	.24	.30	.32	.46	.36	.24	.30	.32	.46	.36
Mean	1.66	1.71	1.62	1.65	1.63	2.50	2.65	2.42	2.39	2.39	3.85	4.30	3.97	3.67	3.28
SD	0.63	0.73	0.72	0.75	0.75	1.43	1.67	1.62	1.54	1.62	2.56	3.07	2.96	2.72	2.74
∝	.60	.72	.75	.70	.71	.83	.86	.88	.86	.88	.79	.86	.87	.84	.86

Notes. * $p < .05$, ** $p < .01$.

socio-psychological perspective. Students were asked to invent, draw, and describe their own mythological creature. We scored the illustration and written description separately and then provided a combined score; we included both creative illustration and creative description scores as outcomes in this study to detect effects on those two distinct forms of creative production. Given that the sample of responses was randomly split in half and rated by two groups of three raters, we report the ICC for each component for both Group 1 (G1) and Group 2 (G2). All ICCs demonstrated strong reliability: (a) creative illustration (G1 ICC = 0.88; G2 ICC = 0.87) and description (G1 ICC = 0.92; G2 ICC = 0.90). Students were then prompted to reflect on their creative process regarding their strengths, their approach, and what they might do differently.

Creative metacognition was measured by coding students' reflection for self-awareness, strategy selection, contextual awareness, and self-regulation (Anderson & Haney, 2020). Ratings of creative metacognition demonstrated strong reliability (G1 ICC = 0.81; G2 ICC = 0.82). In addition to a creativity rating of students' visual and written work, the assessment measured their creative self-efficacy prior to creative production and reflection using five items with a Likert scale response (item example: *I am confident that I can invent a new creature in my imagination*) and their creative self-concept in school using six items with a Likert scale response (item example: *I have been told I am creative in my school work by others*; Beghetto & Karwowski, 2017) after completing the rest of the assessment. The composite reliability scores drawn from structural equation modeling components indicate very good reliability for all factors: (a) *creative self-efficacy* (CR = .91), and (b) *creative self-concept–social* (CR = .82), and (c) *creative self-concept–affective* (CR = .86).

2.3. Analytic strategy

We tested our research questions using Random Intercept Cross-lagged Panel Models (RI-CLPMs; Hamaker et al., 2015). The RI-CLPM builds on previous longitudinal work using the traditional Cross-lagged Panel Models (CLPM). The CLPM allows for the examination of the influence of level of one divergent thinking factor on subsequent change in other factors while controlling for auto-regressive effects such as regression-to-the-mean (Selig & Little, 2012). Importantly, given the likelihood of finding that divergent thinking ability remains mostly stable across time, CLPM, without random intercepts included, can lead to erroneous conclusions for cross-lagged coefficients. The RI-CLPM further separates variance between-subjects from variance within-subjects by extracting an individual's stability score, or carryover effect, across all waves. As a result, auto-regressive parameters within the RI-CLPM evaluate the degree to which deviations from the expected value persist for each participant across measurement occasions. Hamaker et al. provide a clear description of this analytic approach: "If [the autoregression] is positive, it implies that occasions on which a person scored above his or her expected score are likely to be followed by occasions on which he or she still scores above the expected score again, and conversely" (Hamaker et al., 2015, p. 104). The cross-lagged parameters of one factor on subsequent change in a separate factor are the within-subject effect of first factor at one wave on the change in the second factor on the following wave.

For flexibility, fluency, and originality, we fit RI-CLPMs for each unique pair of bivariate factors in addition to the trivariate RI-CLPM. Modeling these three bivariate models allowed us to examine the relation between each pair of factors independent of the third factor (e.g., the relation between fluency and originality without flexibility). By contrast, the trivariate model allowed us to examine the relation between each factor accounting for variance shared with the third factor (e.g., the relation between fluency and originality accounting for the variance shared with flexibility). Comparing differences in the parameter estimates between the bivariate and trivariate models let us examine both the overall strength of the relations between factors and allowed us to parse out the unique relations between factors, when even small amounts of variance remain.

From Wave 2 onwards, we regressed originality on fluency and flexibility within each wave and allowed the residual variance of fluency and flexibility to covary. Within the bivariate models, this allowed us to examine the relation between fluency and flexibility and the relation of each factor on originality within each wave, not accounting for the influence of the third factor. Within the trivariate model, we were able to evaluate the unique relation between fluency and flexibility and originality, accounting for the shared variance, and compare between the two pathways of the dual pathway model.

Due to the unequal spacing between measurement occasions, which ranged from 5 to 7 months, we fit an unconstrained model in which all parameters were freely estimated, which assumed differences between waves. To test the predictive strength of fluency, flexibility, and originality on outcomes of creative production, metacognition, self-efficacy, and self-concept, we conducted a separate predictive structural model in structural equation modeling, using MPlus software, version 1.31 (Muthén & Muthén, 2010), which controlled for the predictive strength of each factor on each outcome to understand the unique contribution of each divergent thinking factor on these creative outcomes. Effect sizes will be interpreted based on standardized path coefficients, using established standards (Cohen, 1992).

3. Results

We present means, standard deviations, correlations, missingness, and Cronbach's alpha reliability for measured factors in Table 1. Given the high correlation between factors within each wave (e.g., fluency and flexibility within Wave 1 was r = .84), we examined within-wave multicollinearity between fluency, flexibility, and originality using the variance inflation factor (VIF; Miles, 2014). We found significant (e.g., VIF > 10) multicollinearity between fluency and originality, but not between either factor and flexibility. Similar to a traditional regression analysis, multicollinearity in an SEM analysis can lead to instability in the parameter estimates (e.g., small changes in the data can lead to changes in size and direction of relations) and increase standard error estimates (increasing the likelihood of type II error; Grewal, Cote, & Baumgartner, 2004).

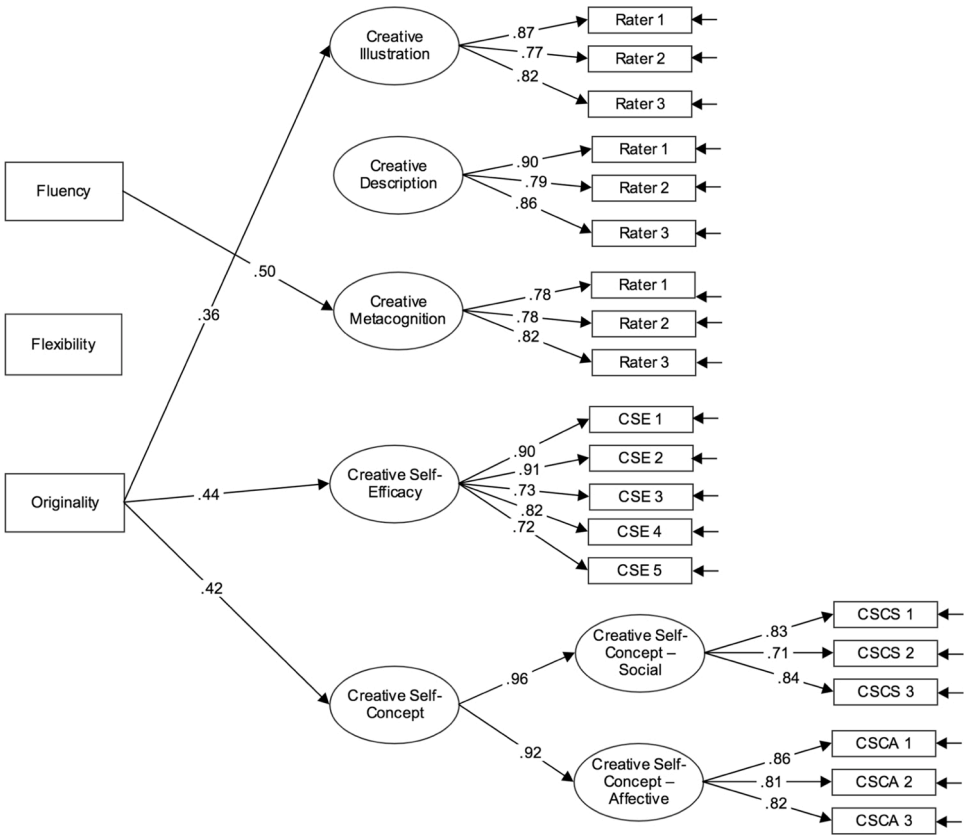

Fig. 3. This diagram illustrates the multivariate outcome path model regressing creative outcomes on divergent thinking fluency, flexibility, and originality with standardized path coefficients included. (Correlations among latent outcome variables are excluded from diagram to ensure visual simplicity. Squares represent observed variables and ovals represent latent variables.).

As a sensitivity analysis to evaluate the degree to which within-wave multicollinearity influenced the relations in our final model, we conducted a split-half reliability analysis (Frey, 2018). Although we were able to establish strict invariance between the two halves, we did find statistically significant differences in the regression and correlation parameters. However, these differences were in the strength of the relations rather than in the pattern and directionality of relations. Parameter estimates for the split-half reliability sensitivity analysis are available in the Appendix A. We analyzed the data for violations of the normality assumptions of SEM (i.e., univariate skewedness +/- 2; univariate kurtosis +/- 7; Finney & DiStefano, 2013). We found only minor violation in the skewedness; towards the last wave of data collection, all three factors were slightly positively skewed. Additionally, we found some violations in kurtosis, particularly in the last several waves of data collection. To adjust for potential bias in standard errors and fit statistics, we used Satorra-Bentler scaled χ^2 and robust standard errors (Savalei, 2014). We report additional information about the distributions in the Figs. A1–A3 in the Appendix A.

Across the five waves of data collection, approximately 27 % of participants were not missing data on any wave, 26 % were missing data from one wave, 20 % were missing from two waves, 14 % from three waves, and 13 % from four waves. Additionally, we observed significant missingness with some waves of data collection (e.g., 36 % missing in wave 5). We used Little's Test of Missing Completely at Random (Li, 2013) to test the assumption that there was no systematic missingness in our data. The test was significant, $\chi 2$ (df) = 1, 092.83 (241), $p < .01$, suggesting that data may be systematically missing and that the assumption of missing completely at random was not tenable. We expected that the wide array of exceptionalities represented by special education identification (SPED) and the special accommodations and pull-out services required by students' Individualized Education Plans would likely increase the odds of not being present for a wave or more. Similarly, students eligible for free-reduced lunch (FRL) would likely face more socioeconomic hardship, resulting in lower attendance rates and higher rates of mobility between schools. We hypothesized those variables would be most likely to play a systematic role in missing data, but we chose to run logistic regressions for additional variables of limited English proficiency, minority race/ethnicity, and student sex.

Table 2
Fit Indices and Unstandardized Parameter Estimates for RI-CLPM.

	Bivariate Models			Trivariate Model
	FLUxFLX	FLUxORIG	FLXxORIG	FLUxFLXx ORIG
Fit Indices				
χ^2(df)	87.28** (21)	72.57** (21)	113.01** (21)	146.674** (48)
CFI	.992	.996	.986	.995
RMSEA [90 % CI]	.049 [.039, .060]	.043 [.033, .055]	.058 [.048, .069]	.040 [.033, .047]
SRMR	.048	.040	.048	.052
Random Intercepts				
μFLU ↔ μFLX	0.426**			0.378**
μFLU ↔ μORIG		1.75**		1.684**
μFLX ↔ μORIG			0.697**	0.680**
Within-Wave Parameters				
Wave 1				
ψFLU1 ↔ FLX1	0.375**			0.398**
βFLX1 → ORIG1			2.652**	−0.176**
βFLU1 → ORIG1		1.710**		1.773**
Wave 2				
ψFLU2 ↔ FLX2	0.589**			0.630**
βFLX2 → ORIG2			3.078**	−0.364**
βFLU2 → ORIG2		1.787**		1.922**
Wave 3				
ψFLU3 ↔ FLX3	0.557**			0.594**
βFLX3 → ORIG3			3.126**	−0.120
βFLU3 → ORIG3		1.783**		1.832**
Wave 4				
ψFLU4 ↔ FLX4	0.492**			0.558**
βFLX4 → ORIG4			2.571**	−0.270**
βFLU4 → ORIG4		1.669**		1.779**
Wave 5				
ψFLU5 ↔ FLX5	0.520**			0.492**
βFLX5 → ORIG5			2.371**	−0.448**
βFLU5 → ORIG5		1.550**		1.769**
Between-wave Parameters				
Flexibility				
αFLX1 → FLX2	−0.003		0.043	0.018
γORIG1 → FLX2			0.024	−0.048
γFLU1 → FLX2	0.040			0.153
αFLX2 → FLX3	−0.134		−0.096	−0.073
γORIG2 → FLX3			0.052**	0.053
γFLU2 → FLX3	0.090**			−0.002
αFLX3 → FLX4	0.061		0.091	0.212**
γORIG3 → FLX4			0.081**	0.168**
γFLU3 → FLX4	0.142**			−0.180
αFLX4 → FLX5	0.227**		0.264**	0.342**
γORIG4 → FLX5			0.030	0.074
γFLU4 → FLX5	0.055			−0.107
Fluency				
αFLU1 → FLU2	0.168*	0.341		0.403
γFLX1 → FLU2	−0.137			−0.104
γORIG1 → FLU2		−0.098		−0.101
αFLU2 → FLU3	0.284**	−0.046		0.104
γFLX2 → FLU3	−0.398*			−0.280
γORIG2 → FLU3		0.118		0.101
αFLU3 → FLU4	0.308**	−0.065		−0.115
γFLX3 → FLU4	−0.027			0.210
γORIG3 → FLU4		0.242*		0.214*
αFLU4 → FLU5	0.202*	0.445*		0.167
γFLX4 → FLU5	0.334			0.556**
γORIG3 → FLU4		−0.042		−0.023
Originality				
αORIG1 → ORIG2		0.043	0.131**	0.026
γFLX1 → ORIG2			−0.286	−0.102
γFLU1 → ORIG2		−0.057		0.012
αORIG2 → ORIG3		0.039	0.114**	0.042
γFLX2 → ORIG3			−0.183	0.056
γFLU2 → ORIG3		−0.052		−0.080
αORIG3 → ORIG4		−0.005	0.074	−0.016
γFLX3 → ORIG4			−0.312	−0.192*

(*continued on next page*)

Table 2 (*continued*)

	Bivariate Models			Trivariate Model
	FLUxFLX	FLUxORIG	FLXxORIG	FLUxFLXx ORIG
γFLU3 → ORIG4		−0.032		0.076
αORIG4 → ORIG5		0.098	0.090	0.142
γFLX4 → ORIG5			−0.526*	−0.952**
γFLU4 → ORIG5		−0.566*		−0.159

Notes. ψ indicates within-wave correlation between predictors (fluency and flexibility). β indicates the within-wave regression coefficient. α indicates the within-factor autoregression effect from one wave to the next. γ indicates cross-lagged parameters of influence from one factor to carryover effect of the other. * $p < .05$, ** $p < .01$.

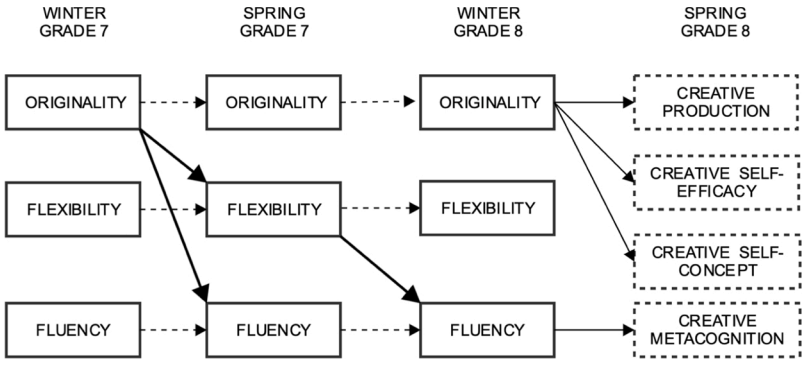

Fig. 4. This diagram focuses in on the final four of six waves and combines the results from both models to illustrate the unique roles of divergent thinking originality, flexibility, and fluency during early adolescence.

The odds of missing data at Wave 1 was 1.60 times higher for students identified for SPED and 1.47 times higher for students eligible for FRL in Grade 6. Limited English proficiency (LEP), minority race/ethnicity, and student sex did not relate to higher odds of missing data in Wave 1. In Wave 2, a similar patterned resulted with the exception that the odds of LEP students missing data were 3.80 times higher than non-LEP students. In Wave 3, the odds of missing data followed the same pattern and similar levels of likelihood to Wave 1, where LEP students were not more likely to be missing data. In Wave 4, the odds of missing data were 2.12 times higher for SPED students, 1.40 times higher for LEP students, 1.59 times higher for FRL eligible students, and 0.23 times lower for female students. In Wave 5, the odds of missing data were 1.58 times higher for FRL eligible students; no other characteristic predicted missingness. In the final Wave 6, the same pattern of missingness was found from Wave 1. Those patterns indicate missingness of longitudinal variables were predicted by different variables, which were not variables of interest to this study. As such, missing at random (MAR) was a reasonable assumption, though parameter estimates may still be biased, to some degree, due to missingness.

3.1. Results overview

All parameters are reported as unstandardized path coefficients in the narrative and in Table 1 and as standardized parameters in Figs. 2 and 3. Models demonstrated close fit according to established criteria (Hu & Bentler, 1999). In evaluating the within-wave stability of the relation between fluency and flexibility on originality and the between-wave stability of the relations between all three factors, we found that the unconstrained trivariate model achieved good fit, which indicated some inconsistent patterns across Grades 6–8 in middle school. We fit the trivariate RI-CLPM in the *lavaan* package (Rosseel, 2012) in *R* open source software (R Core Team, 2014). Table 1 details results of the unconstrained model, which reached close fit according to multiple indices, $\chi^2(df) = 146.67$ (48), CFI = .995, and RMSEA = .040 (Hu & Bentler, 1999). We present the unconstrained trivariate model with both the within-wave relation of fluency and flexibility on originality and the between-wave relations between all three factors freely estimated in Table 2 and Fig. 1, where originality is regressed onto within-wave fluency and flexibility. When controlling for the shared variance of these two factors in predicting within-wave originality, only fluency demonstrated a positive relation.

During the second half of middle school from the middle of Grade 7 to Grade 8, a distinct pattern emerged. After accounting for the variance explained by the relations between each factor, we observed a statistically significant within-subject carryover effect in students' flexibility between waves three-to-four and four-to-five. That carryover effect indicates persistent change from the expected within-subject score, based on prior waves, from that point forward. Conversely, originality and fluency, on average, remained stable after accounting for the influence of the other factors—students did not score above or below their expected score from the prior

occasion. Higher levels of originality for students at Grade 7 led to an increase in fluency and flexibility at the end of Grade 7 compared to the individual's expected score. Higher level in flexibility for students led to an increase in fluency in Grade 8 compared to the individual's expected score. Fluency demonstrated a unique predictive contribution to creative metacognition at the end of Grade 8, and originality demonstrated a unique predictive contribution to creative illustration, creative self-efficacy, and creative self-concept. Fig. 4 illustrates the results of both models together.

3.2. Within-wave relation of fluency and flexibility on originality

By regressing originality on fluency and flexibility within each wave in the bivariate models, we found that both factors had a significant positive relation with originality. At each wave, when a students' fluency or flexibility deviated from their predicted score (either higher or lower), they also experienced a shift in the same direction in originality (e.g., when a students' fluency was lower than predicted, their originality was also lower than predicted at the same wave). However, when comparing these results to the unique influence of each factor after accounting for their shared variance in the trivariate model, a different pattern emerged. After accounting for the variance shared with flexibility, we still observed a significant positive within-subject, within-wave relation between fluency and originality ($\beta = 1.769–1.922$). Conversely, when examining the unique relation of flexibility on originality accounting for the variance shared with fluency, we found a small but generally statistically significant negative relation between flexibility and originality (as high as $\beta = -.0488$). In other words, after accounting for the variance shared between fluency and flexibility, when a subjects' flexibility was greater than the predicted value, their originality was lower in that same wave. When accounting for the shared variance between fluency and flexibility by including both variables in each regression, flexibility controls for the number of different categories an individual produced within the fluency score, which should isolate the fluency score as the persistence of an individual within categories. As such, it appears the unique variance in fluency has a much stronger within-person, within-wave relation with originality, supporting the persistence pathway in the dual pathway model.

3.3. Patterns of change across middle school

Though we found little change in the mean of factors across the first three measurement occasions, several exceptions were noteworthy in the autoregressions. We found that changes in flexibility at the middle of Grade 7 persisted until the end of Grade 7 ($\alpha = .21, p < .05$). Changes from the expected score at the end of Grade 7 in flexibility also persisted into the middle of Grade 8 ($\alpha = .34, p < .05$). All other autoregressive effects were not statistically significant in the trivariate RI-CLPM, indicating within-person stability over time around the expected mean score in flexibility, fluency, and originality, when controlling for between-factor influence.

3.4. Patterns of influence between fluency, flexibility, and originality

The cross-lagged effects detected several patterns of theoretical and practical importance. Originality at the middle of Grade 7 influenced change from within-person expected mean in both fluency ($\gamma = .21, p < .05$) and flexibility ($\gamma = .17, p < .05$) from the middle to end of Grade 7. Those results indicate that for every point higher in originality, students demonstrated an increase of .17 different categories of ideas and an increase of .21 ideas produced, generally, compared to their expected scores. Higher levels of flexibility at the end of Grade 7 led to subsequent changes in fluency from Grade 7 to Grade 8 ($\gamma = .56, p < .01$), indicating that for every new category produced, students experienced an increase of approximately half an idea in total, compared to their expected score. Those results suggest that during this phase of early adolescence as students are nearing the transition to high school, changes in their average originality in creative ideation positively influenced changes in the flexibility and fluency of idea production, not the other way around. That change in flexibility positively influenced further change in student's fluency of idea generation. The cross-lagged panel results depicted in Fig. 2 suggest that flexibility may mediate this influence of originality on fluency during that year of development experienced in early adolescence. Standardized coefficients reported in Fig. 2 suggest that the standardized effect size of originality on change in fluency ($\gamma = .40$) was a medium effect; originality on change in flexibility ($\gamma = .58$) was a large effect; and flexibility on change in fluency ($\gamma = .30$) was a medium effect. Results suggest that relationships between factors change substantially across the middle school years and indicate the dual pathway model may be insufficient to explain developmental changes among these factors.

3.5. Influence of fluency, flexibility, and originality on creative outcomes

We used a structural model with the divergent thinking factor scores at the middle of Grade 8 to predict creative outcomes at the end of Grade 8. Results indicated that, when controlling for the unique contribution of each factor within a multivariate model, fluency, flexibility, and originality measured four months prior demonstrated different influences on each outcome. The structural model in Fig. 3 included the creative production and metacognition ratings from three semi-expert raters each as indicators for each latent outcome and survey items as observed indicators for creative self-efficacy and creative self-concept. The model included all three predictors as observed average scores for fluency, flexibility, and originality. The goodness of fit (GOF) was evaluated based on Hu and Bentler (1999) criteria for close fit, reaching a SRMR = .036, CFI = .94, and RMSEA = .061 with a statistically significant χ^2 (203) =

706.12. Though falling just below close fit criteria, the model did surpass the good fit criteria and was accepted for further interpretation.

When inserted as distinct, individual predictors with creative description and creative illustration incorporated as separate outcomes, results suggest that only originality influenced creative illustration with an unstandardized estimate of $\beta = .13$, $p < .05$ and standardized path coefficient of $\gamma = .36$, $p < .05$. That relationship represents a medium standardized effect size. As can be seen in Fig. 3, no factor demonstrated a statistically significant effect on creative description, and flexibility did not demonstrate a statistically significant effect on any creative outcome. Only fluency in divergent thinking influenced creative metacognition with an unstandardized estimate of $\beta = .14$, $p < .05$ and standardized path coefficient of $\gamma = .44$, $p < .05$, representing a medium-to-large standardized effect size. Originality showed the only influence on creative self-efficacy with an unstandardized estimate of $\beta = .35$, $p < .05$ and standardized path coefficient of $\gamma = .44$, $p < .05$ representing a medium-to-large standardized effect size. Also, originality showed the only influence on creative self-concept with an unstandardized estimate of $\beta = .12$, $p < .05$ and standardized path coefficient of $\gamma = .42$, $p < .05$ representing a medium-to-large standardized effect size. Fig. 4 illustrates both models together.

4. Discussion

In this study we sought to understand the development of and relationships between the most commonly measured constructs of divergent thinking—fluency, flexibility, and originality—during the unique developmental period of early adolescence. We measured those constructs using two types of measures of divergent thinking, an alternate uses verbal task and figural-verbal divergent thinking task. Change in scores for those factors was modeled using the random intercepts cross-lagged panel model, which controls for autoregressive within-subject effect and between-subject, between-factor influences, when modeling change over time. This model improves on limitations of the typical cross-lagged panel model by dealing with the longitudinal data from a multilevel perspective, where occasions are nested within individual students. The RI-CLPM provides less biased estimates by separating out the within-person level from the between-person level.

4.1. Implications for dual pathway model

Several results from the RI-CLPM were notable. While students' originality and fluency showed relative stability from wave-to-wave, flexibility demonstrated growth from expected values for students from the middle of Grade 7 to Grade 8; yet, flexibility did not contribute a unique influence on creative production, metacognition, or self-belief outcomes. Additionally, flexibility demonstrated a negative relation with originality within each wave, consistently, which indicates that during early adolescence, flexibility in divergent thinking may come at a cost to originality. Across waves, change in flexibility had an influence on change in subsequent fluency late in middle school, further adding to the possibility that the cognitive development for flexibility plays a mediating role. The flexibility pathway suggested by the dual pathway model (Nijstad et al., 2010) serves as one means to arrive at creative ideas or solutions through exploring different conceptual categories of ideas. Taken together these results suggest that flexibility may play an indirect rather than direct role in how creative ideation occurs, develops across time, and influences creative outcomes creative thinking and production, such as creative metacognition and self-beliefs.

When controlling for influence of prior level of originality, originality showed a positive influence on changes in flexibility and fluency as Fig. 4 describes, not the other way around. Originality demonstrated the strongest influence on creative illustration, prospective creative self-efficacy for the illustration task, and retrospective creative self-concept in school. Creative ideational fluency, representing the production of many ideas rather than the resulting uniqueness or uncommonness of ideas, demonstrated an influence on creative metacognition. Fluency did have a consistent within-wave positive relation with originality, even when controlling for shared variance with flexibility. Taken together, those results suggest that the persistence pathway in the dual pathway model, approximated by fluency, may play a primary role in creative ideation during early adolescence and, to a degree, alongside creative metacognition. Indeed, a common metacognitive strategy employed by early adolescent students consisted of thinking about many ideas, avoiding premature closure on a single solution, before completing the task to invent and draw a mythological creature (Anderson & Haney, 2020). The apparent growth in flexibility from Grade 7 to Grade 8 (ages 12–14) indicates that the cognitive flexibility pathway toward creative ideation may be under development during this period and yet fully accessible. This possibility, and the potential of different types of creative thinking training to accelerate the growth of cognitive flexibility, needs more research.

4.2. The leading role of originality in early adolescents' creative development

Though highly related with one another, both statistically and conceptually (Dumas & Dunbar, 2014), divergent thinking factors demonstrated distinct directionality of influence and developmental patterns in the RI-CLPM, partialling-out the contributions that each factor made. The lack of change in fluency and originality across the two middle grades contrasts with others' research (a) suggesting a decline during this period (e.g., Anderson, 2019; Kim, 2011) and (b) suggesting continuous growth in some aspects of creative potential until age 15 (Kleibeuker et al., 2016). Notably, the current study included controls at the within-person, between-person, and between-factor levels, which those other studies did not do. Results of little to no change in fluency and originality, on average, could relate to a balance between competing factors. For instance, an increase in premature closure to ideas and

pressures toward conformity in more rigid school structures may contrast with cognitive developments in a growing knowledge base from which to generate creative ideation and potential for explorative thinking (Anderson, 2019). That net result of stability across time suggests a confrontation between expected developmental change and environmental conditions that may have a stifling effect. Still, wide variance in scores suggests wide between-student variance at each wave, which could result from the existence of different types of longitudinal trajectories as past research has explored through group-based trajectory modeling (Anderson, 2019; Nagin, 2005).

In the aggregate, students' originality after Grade 7 appeared to play the most important role in change in creative ideational fluency and flexibility and future creative illustration and creative self-beliefs. As a measure of creative potential, originality in creative ideation represents the capacity to imagine, invent, and describe new possibilities from the mundane and relates highly to unconventionality (Andreas et al., 2016). Results suggest that this capacity buttresses a positive self-concept about one's creative abilities and instills a sense of confidence to be successful on a creative task when projecting into the future about expected performance. Subsequent flexibility and fluency increased in relation to higher originality. On their own, these two underlying components of the dual pathway model did not explain developmental change in average originality of ideas. As the dual pathway model suggests (Nijstad et al., 2010), contextual and dispositional factors may play a role. As such, originality is likely linked to the sense of agency that, in part, forms creative behavior (Karwowski & Beghetto, 2018). For instance, attitudinal factors such as students' self-beliefs, openness, and tolerance for ambiguity and key affective factors, such as creative anxiety (Daker, Cortes, Lyons, & Green, 2019) may interact with each proposed pathway in creative ideation in early adolescence. Strength in divergent thinking originality also contributed to the invention of a more creative mythological creature in its illustrated form, but not in its written descriptive form.

Importantly, the fluency to generate lots of ideas predicted creative metacognition to reflect effectively on strategy, self-awareness, context, and self-regulation. Metacognitive capacities are becoming more and more accessible during the early adolescent period of development (Flavell, 1979). However, the mechanisms that drive the originality to produce unconventional ideas appear to overlap with and be explained by metacognitive capacities linked to idea generation, generally. Results indicate that general fluency in idea generation is important to develop creative metacognition and the development of capacity for originality in creative ideation, specifically, is important to reinforce students' creative self-beliefs and production.

4.3. Implications for practice

In creative ideation, generating novel and original possibilities takes both practice and clarity about what makes an idea unique and surprising and the confidence and persistence to move forward with an idea that others may not see as worthy or strong (Sternberg, 2017). In middle school, the opportunities to think divergently and explore possibilities have been rare in observation studies (Katz-Buonincontro & Anderson, 2020; Pitts, Anderson, & Haney, 2018). That issue is likely due to pressure toward conventional thinking for a single "right answer" and teachers' hesitation to follow seemingly distracting tangents that students may find compelling (Gajda, Beghetto, & Karwowski, 2017; Glaveanu & Beghetto, 2017). Indeed, middle school in the U.S. includes at least six transitions between classrooms in a day and a rigid scope and sequence that becomes more competitive and accelerated (Juvonen, Le, Kaganoff, Augustine, & Constant, 2004). Unconventionality in school can often be seen as a hinderance to teachers (Beghetto & Kaufman, 2014). As such, more conscientious students and students valuing conformity may aim for the approval of their teacher and peers and, as a result, develop weaker skills for thinking and behaving with unconventionality.

Given that unconventionality links so highly with original creative ideation (Andreas et al., 2016), the effect of those conditions toward *sameness* may inhibit the persistence and flexibility pathways toward creative ideation and the development of skills and habits to think of, evaluate, and pursue original possibilities in creative ideation. Middle school students have shared they need modeling, practice, confidence, and sense of belonging to take risks and be more unconventional and novel in the academic setting (Anderson, Porter, & Adkins, 2019). The results of this current study suggest that a focus on both the cognitive capacity for and attitudinal and affective disposition toward originality during early adolescence could result in improvements toward other person-level resources of creative behavior, creative affect, and creative thinking.

There are several immediate ways that educators and youth development professionals can focus attention on this skill and capacity. Numerous divergent and creative thinking exercises can be built into classroom routines to help shift students out of the demand for conventional thinking into a space of explorative possibility. Instructional resources are available through educational programs, such as Austin Independent Schools' Creative Learning Intitiative and the makeSPACE project in Oregon[1] . Educators can provide ambiguous prompts related to the material being studied and *unplan* moments of structured uncertainty (Beghetto, 2019) into lessons and class periods. For instance, in science, a middle level educator could follow the alternate uses task and prompt students to think of as many uses for a chemical substance they are learning about or the many ways that they can observe a scientific process, such as evaporation, unfold in nature. In English language arts, teachers could ask students to come up with new original metaphors for the universal experiences they are reading about in texts, such as oppression, using fruit as a source domain. By providing unusual prompts as source domains for those kinds of challenges, educators can help students move beyond conventionality and consider new, unusual and surprising ways to think about seemingly ordinary subject matter.

Educators should engage in these creative thinking routines as well in order to model the will to be unconventional, experience the difficulty that students may face early on, and identify techniques and strategies to share with students. However, training

[1] Go to https://creativelearningatx.wordpress.com/ to find out more about the Creative Learning Initiative and www.makespaceproject.org to learn more about creative routines in the makeSPACE project.

opportunities are rare and often face attitudinal and systemic barriers (Anderson et al., 2019). After the initial attempts at such tasks, educators may consider asking students to go back to the same task and persist for a little longer to remain open to uncharted pathways they may not have seen the first time around (cognitive flexibility) and to pay attention to the strategies they choose, the role their cultural strengths may play, and the contextual knowledge they may be able to bring to the challenge. Those aspects of creative metacognition are likely to serve them well across diverse learning contexts, knowing when and how to be creative in the most effective way (Beghetto & Kaufman, 2014). The level of growth students experience in both knowledge and associative and exploratory capacity for insight during the middle school years should be seen as a critical asset to the development of creative resources and engagement in school. As Beghetto (2019) outlined, building in opportunities for structured uncertainty and carefully considering constraints early on will likely support risk-taking and tolerance for ambiguity, the cognitive capacities undergirding originality, and the agentic creative self-beliefs for creative action.

4.4. Limitations

Many scholars (Glaveanu et al., 2019) are urging the field to explore new measurement and research design paradigms to learn about the process of creative ideation in the socio-cultural context in which it arises and to move theory beyond the limitations that traditional divergent thinking measures have demonstrated in past research. Thankfully, the field has new measures under development (Barbot, 2018) ready to be applied with different age groups and in different study designs. Though those limitations of divergent thinking measures are legitimate, more longitudinal research is also needed to understand the development of creative ideation during adolescence using existing data—longitudinal studies for this age group are rare. With six waves of data across the three years of traditional middle school, this study provides some new insights on the development of creative ideational fluency, flexibility, and originality. However, the degree of multicollinearity between divergent thinking factors requires a strong fitting model to converge a meaningful solution in structural equation modeling. Even still, the fluency contamination effect can't be dealt with entirely, as the high correlations in this current study reveal. Additional research should be conducted with new middle school samples and new measures to test if the patterns found in this study hold. A greater understanding of the malleable factors that predict high levels of originality would also help to understand how to shape the learning conditions early in middle school to foster development of creative ideation.

The results from this study should be generalized with caution outside of the study's geographic and demographic context. As a longitudinal study with historically marginalized students facing socioeconomic challenges, missing data was present and could result in biased parameter estimates. Estimation techniques with full-information maximum likelihood are robust to missing data and provide confidence in results; nevertheless, it is impossible to know by how much estimates may differ if no students were missing data on any occasion and how the variables that predicted systematic missingness may bias the results in unexpected ways.

4.5. Conclusion

This study provides new understanding about how creative ideational fluency, flexibility, and originality develop during early adolescence in the middle school context. Originality influenced subsequent increases in flexibility and fluency and was the only factor to demonstrate an influence on multiple creative outcomes. Early adolescent learners appear to be arriving at original ideas through the persistence pathway rather than the flexibility pathway, and additional attitudinal and affective factors may be playing a large role in how those pathways take shape. The capacity for originality in creative ideation requires an understanding about what makes an idea original alongside routine practice, modeling, and application in the school learning context. Results indicate that a focus on this specific creative resource could optimize other dimensions of creative health in the early adolescent learner.

Author statement

Lead author, Ross C. Anderson, played a lead role in conceptualization of the study and study aims, some aspects of the methodology and analysis, the drafting, editing, and revising of most sections of the manuscript, project administration, and funding acquisition.

Second author, Matthew Graham, played a lead role in designing the main method and analysis, drafted, reviewed, and revised some of the method section and most of the results, and created some of the data visualizations.

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Appendix A

Table A1

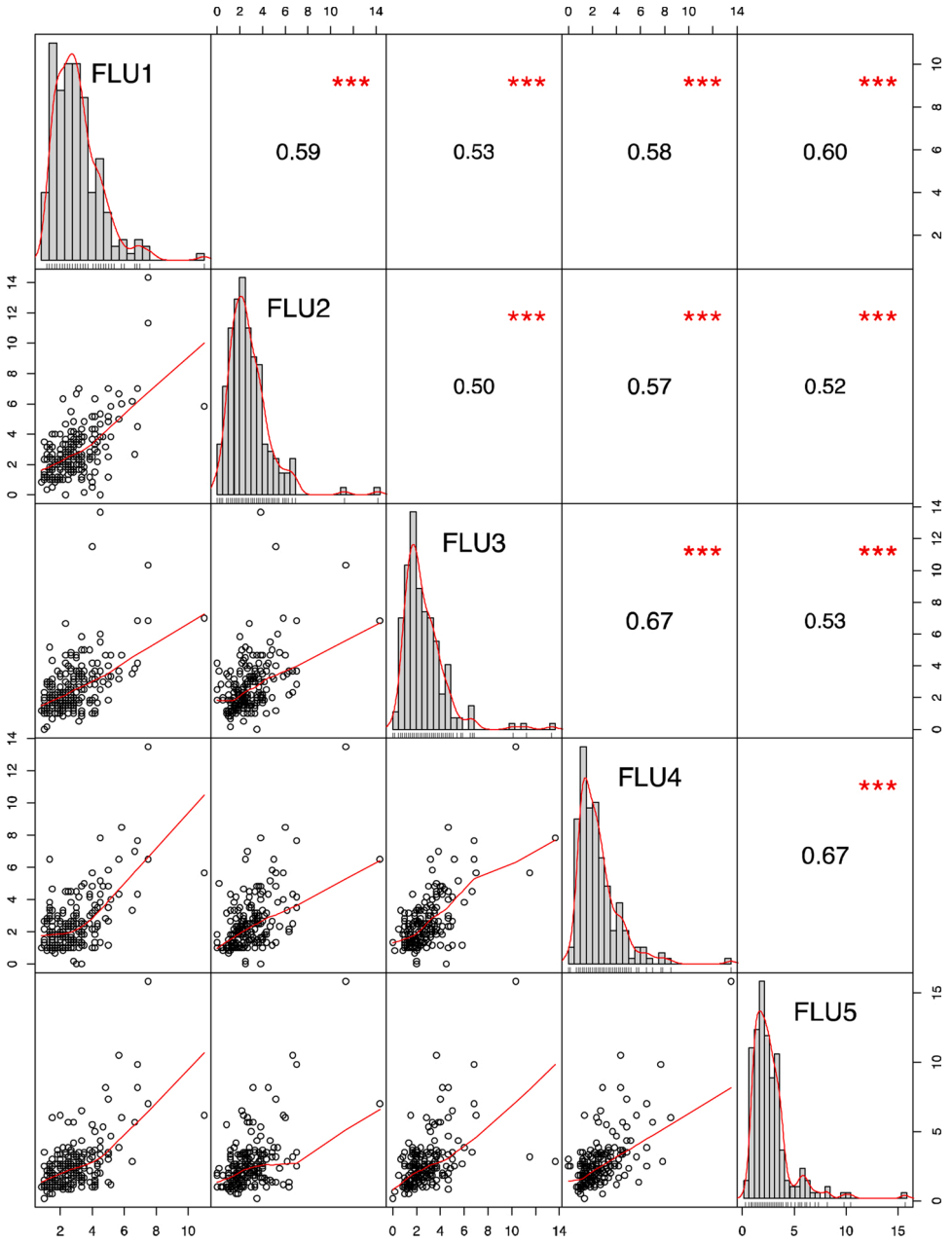

Fig. A1. This figure illustrates the distribution of fluency scores in five histograms along the diagonal for Waves 1–5. Below the diagonal are scatterplots of correlations depicted between the intersecting waves; numerical correlations are included above the diagonal.

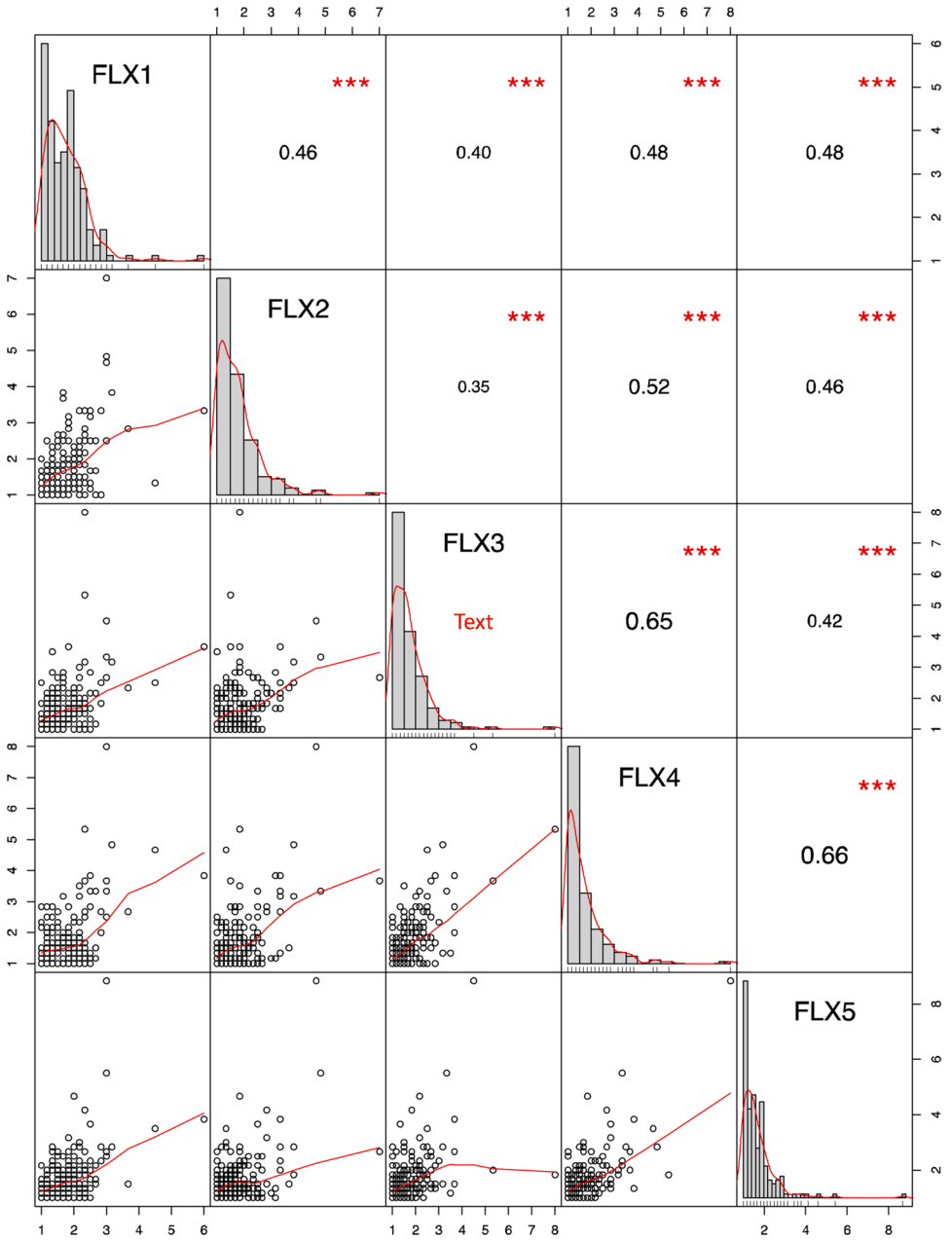

Fig. A2. This figure illustrates the distribution of flexibility scores in five histograms along the diagonal for Waves 1–5. Below the diagonal are scatterplots of correlations depicted between the intersecting waves; numerical correlations are included above the diagonal.

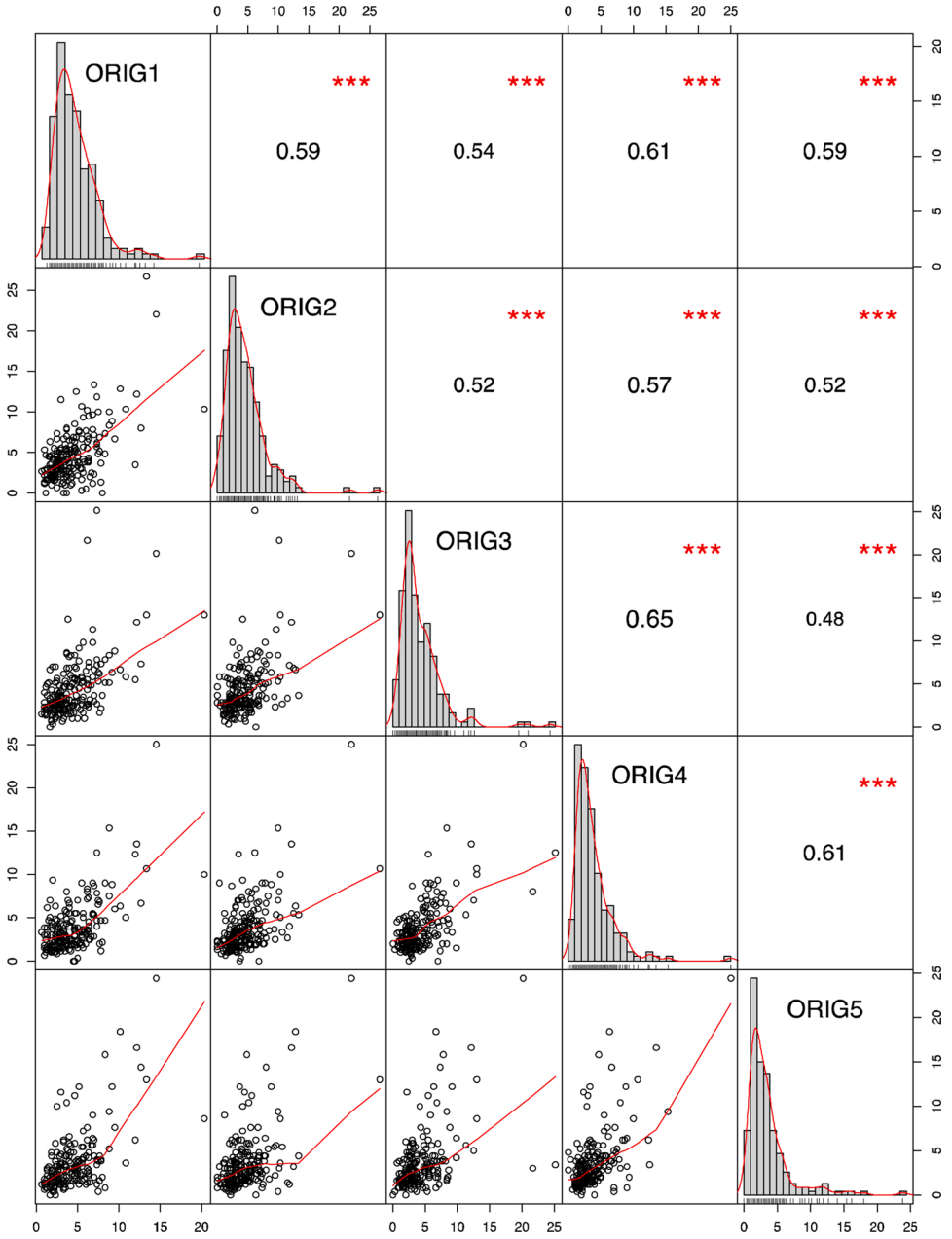

Fig. A3. This figure illustrates the distribution of originality scores in five histograms along the diagonal for Waves 1–5. Below the diagonal are scatterplots of correlations depicted between the intersecting waves; numerical correlations are included above the diagonal.

Table A1
Split-half reliability analysis.

	Split-half reliability		Best-fitting Model
	Half A	Half B	FLUxFLXxORIG
Fit Indices			
χ^2(df)	206.55** (96)		146.674** (48)
CFI	.995		.995
RMSEA [90 % CI]	.042 [.034, .050]		.040 [.033, .047]
SRMR			.052
Within-Wave Parameters			
Wave 1			
ψFLU1 ↔ FLX1	0.332**	0.453**	0.398**
βFLX1 → ORIG1	−0.093	−0.219**	−0.176**
βFLU1 → ORIG1	1.728**	1.806**	1.773**
Wave 2			
ψFLU2 ↔ FLX2	0.644**	0.604**	0.630**
βFLX2 → ORIG2	−0.544**	−0.206*	−0.364**
βFLU2 → ORIG2	1.975**	1.884**	1.922**
Wave 3			
ψFLU3 ↔ FLX3	0.532**	0.642**	0.594**
βFLX3 → ORIG3	−0.063	−0.128	−0.120
βFLU3 → ORIG3	1.824**	1.827**	1.832**
Wave 4			
ψFLU4 ↔ FLX4	0.556**	0.574**	0.558**
βFLX4 → ORIG4	−0.423**	−0.141	−0.270**
βFLU4 → ORIG4	1.896**	1.681**	1.779**
Wave 5			
ψFLU5 ↔ FLX5	0.464**	0.496**	0.492**
βFLX5 → ORIG5	−0.227	−0.495*	−0.448**
βFLU5 → ORIG5	1.780**	1.745**	1.769**
Between-wave Parameters			
Flexibility			
αFLX1 → FLX2	−0.017	0.063	0.018
γORIG1 → FLX2	−0.102	0.020	−0.048
γFLU1 → FLX2	0.257	0.011	0.153
αFLX2 → FLX3	−0.108	0.019	−0.073
γORIG2 → FLX3	0.110	0.011	0.053
γFLU2 → FLX3	−0.103	0.039	−0.002
αFLX3 → FLX4	0.331**	0.107	0.212**
γORIG3 → FLX4	0.211**	0.147*	0.168**
γFLU3 → FLX4	−0.346*	−0.065	−0.180
αFLX4 → FLX5	0.433**	−0.233*	0.342**
γORIG4 → FLX5	0.150*	0.041	0.074
γFLU4 → FLX5	−0.325*	0.044	−0.107
Fluency			
αFLU1 → FLU2	0.262	0.407	0.403
γFLX1 → FLU2	0.015	−0.200	−0.104
γORIG1 → FLU2	−0.043	−0.101	−0.101
αFLU2 → FLU3	−0.238	0.330	0.104
γFLX2 → FLU3	−0.398	−0.039	−0.280
γORIG2 → FLU3	0.314*	−0.091	0.101
αFLU3 → FLU4	−0.478	0.068	−0.115
γFLX3 → FLU4	0.297	0.182	0.210
γORIG3 → FLU4	0.336*	0.185	0.214*
αFLU4 → FLU5	−0.374	0.565	0.167
γFLX4 → FLU5	0.778**	0.344	0.556**
γORIG3 → FLU4	0.201	−0.174	−0.023
Originality			
αORIG1 → ORIG2	−0.031	0.078	0.026
γFLX1 → ORIG2	−0.149	−0.026	−0.102
γFLU1 → ORIG2	0.128	−0.106	0.012
αORIG2 → ORIG3	−0.017	−0.096	0.042
γFLX2 → ORIG3	−0.087	0.195*	0.056
γFLU2 → ORIG3	0.126	−0.269*	−0.080
αORIG3 → ORIG4	−0.108	0.069	−0.016
γFLX3 → ORIG4	−0.136	−0.160	−0.192*
γFLU3 → ORIG4	0.245	−0.098	0.076
αORIG4 → ORIG5	−0.116	0.143	0.142
γFLX4 → ORIG5	−0.558**	−1.191**	−0.952**
γFLU4 → ORIG5	0.359	−0.326	−0.159

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.tsc.2021.100816.

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