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Trajectories of the Creative Process: A Multiple-Drafts Analysis of Graphic Design

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ABSTRACT

Most experimental analyses of creativity look at one-shot production tasks. However, real-world creativity occurs over long periods of time and involves extensive exploration and revision. We carried out a week-long study in which graphic design students created an advertisement for a fictional business, submitting daily drafts of their evolving ad. By analyzing the successive changes to these ads across the 7 daily drafts, we sought to characterize the *trajectory* of the creative process for each designer. In doing so, we elaborated on the core concept of the Geneplore model (i.e. generation + exploration) by proposing a 2 × 2 predictive scheme of creative trajectories in which a) the generative phase specifies either a global plan of the final product or merely a kernel idea for it, and b) the exploratory phase proceeds in either a linear or nonlinear manner, thereby resulting in four basic trajectories. We analyzed the relative frequency of these trajectory-types in our 37 graphic design students using a novel "change analysis" method. In addition, we examined how the novelty, quality, and stylistic features of the final ad related to the trajectory-type of the creator. The results revealed that there are multiple routes toward achieving a comparable level of novelty in a creative product.

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Introduction

Most experimental analyses of creativity look at one-shot production tasks (Beaty, Benedek, Barry Kaufman, & Silvia, 2015; Benedek et al., 2014; Bengtsson et al., 2007; Boccia, Piccardi, Palermo, Nori, & Palmiero, 2015; Borgianni, Maccioni, Fiorineschi, & Rotini, 2020; Camarda et al., 2018; Paulus & Brown, 2007; Przysinda, Zeng, Maves, Arkin, & Loui, 2017). However, real-world creativity occurs over long periods of time and involves extensive exploration and revision. This is typically described via "stage" models of the creative process (Amabile, 1983, 1988; Brown & Wyatt, 2010; Görlich, 2023; Mace & Ward, 2002; Mumford, Reiter-Palmon, & Redmond, 1994; Osborn, 2012; Perry-Smith & Mannucci, 2017; Wallas, 1926). However, is it the case that all creators employ a similar work style and thus a similar sequence of stages? If not, is work style one factor that distinguishes highly creative from less creative people?

Historical analyses of eminent creators across domains reveal that these people can have radically different processes for carrying out their creative work (Doyle, 2022; Ghiselin et al., 1953). For example, Weisberg's (2004) analysis of Picasso's creation of the painting *Guernica* in 1937 revealed that the artist worked according to a global plan in which the overall concept was established early on and that the creative process constituted a successive realization of that plan. This can be contrasted with Doyle's (1998) analysis of professional fiction writers, some of whom reported having no overall concept of their story at the start of the process and who instead created their story as they went along. Some authors even claimed that the story wrote itself or that the protagonist "possessed" the author and dictated the story's direction. Hence, one significant difference in work style relates to whether the creator establishes an overarching plan of the final product early in the creative process or instead starts out with some kernel idea that is then developed as the creator engages in their work (i.e., a create-as-you-go process).

While this "globality" feature relates to the generative phase of the creative process, virtually all contemporary theories of real-world creativity embody some version of a "dual-process" model that distinguishes the initial generation of a creative concept from the idea's later exploration, elaboration, revision, refinement, and implementation. Perhaps the most important of these is Finke, Ward, and Smith (1992) Geneplore model. According to this model, creativity arises as two recurring cycles of idea *generation* and idea *exploration*. The generative phase involves the formation of "preinventive

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structures" that promote creative discovery by serving as precursors to the final product. These ideas are then elaborated upon, transformed, and restructured during the exploratory phase. Depending on the creator's satisfaction with the first round of exploration, this can lead to either a return to the generative phase or additional bouts of exploration. Hence, creative work is intrinsically cyclic, establishing a trajectory for the creative process of each individual creator in terms of how that person navigates between generation and exploration.

Building upon the Geneplore model's dual phasing, we attempt to examine a second dimension of the creative process beyond the globality of the generative stage, namely whether the trajectory of the exploratory phase proceeds in either a relatively linear or nonlinear fashion. Picasso, in creating *Guernica*, not only started out with a global plan of the final product, but proceeded in a highly linear fashion over the month of the product's creation, working up elements of the painting in succession. For example, he developed a number of character-based studies that examined the painting's characters "individually or in small groups, with little or no attention paid to overall composition" (Weisberg, 2004, p. 27). The end result of this linearity is that the final product strongly resembled the initial plan.

However, many other creators work in a far more nonlinear fashion such that – regardless of whether the starting point is a global plan or a kernel idea – the work undergoes significant changes in direction to the point that the final product has only a sparse resemblance to the initial sketch, even if the overall concept remains the same. For example, although the concept for the musical *West Side Story* was based on a displacement of the Romeo and Juliet plot to contemporary Manhattan, the project initially started out as *East Side Story*, depicting a conflict between Irish Americans and Jewish immigrants on the lower east side (Long, 2001). Years of tumultuous collaboration and numerous changes in direction resulted in the musical that we now know as a conflict between Polish Americans and Puerto Rican immigrants on the upper west side. That product is quite different from the initial plan of the work, despite the retention of the Romeo and Juliet concept.

Our major interest in the present work is to think about the creative process not just as stages per se but instead as *trajectories*,[1] since not all creators abide by the same stages in their work and since stages can recur or be skipped altogether (Mace & Ward, 2002). An examination of creative trajectories requires that we have access to *intermediate drafts* in the creative process. Drafts can be thought of as footprints that track the creative path from start to finish. As Meyer (1989) points out, "sketches and drafts are significant because they affect our understanding of what the completed work actually *is* by making us aware of particular alternative versions of what it *might have been*" (p. 35, emphases in original). Relatively few studies in the creativity literature have examined intermediate drafts in the creative process, least of all experimental studies.

Studies that have assessed intermediate drafts have predominantly been case studies of single prolific creators. As mentioned previously, Weisberg (2004) analyzed the 45 intermediate drafts that Picasso made while painting *Guernica*. By looking at these sketches, Weisberg concluded that Picasso expanded a kernel idea into a global plan that he then revised over many drafts. Weisberg's analysis was in opposition to the previous belief that Picasso's process consisted of "wild experimentation" (Simonton, 1999).

Similarly, Kozbelt (2006) analyzed 22 intermediate drafts for Matisse's painting *Large Reclining Nude*. However, it should be noted that the goal of this study was less to analyze the trajectory of Matisse's creative process as to examine how both artist and non-artist raters judged the creativity of the intermediate drafts, in comparison to that of the final product. The results of this analysis were strongly reminiscent of Weisberg's analysis of *Guernica* in that a kernel idea emerged from the time of the first draft, but required significant honing and revision for its realization. However, unlike Picasso, who began with smaller ideas and elaborated them until the point of completion, Matisse began with far more a detailed plan, only to remove all ornamentation until his desired degree of abstraction was reached.

In another experimental study, Kozbelt and Serafin (2009) looked at the quality of emerging drawings by art students throughout their own creative process. The authors used quality scores (i.e., a metric encompassing multiple traits of the drawing, including novelty, realism, and technical skill) from both artists and non-artists to distinguish high-creativity final works from low-creativity works. The authors concluded that the quality of low-creative paintings increased linearly over time. In contrast, high-creative paintings showed a far more jagged trajectory in which increases in novelty caused substantial decreases in quality, which were later made up. However, the slopes of the high and low trajectories were only significantly different when rated by experts, thus indicating that experts were better able to predict and observe the underlying changes that affected the creativity of the final products. Overall, a more nonlinear trajectory made for a more novel final product.

Beyond the arts, several engineering studies have looked at intermediate drafts in the creative process. Chusilp and Jin (2006) showed that a larger number of

drafts in product development led to higher quality, while more frequent revisions resulted in higher novelty. Berg (2014) showed that, after the proposal of an initial product idea, its usefulness could be increased, but its novelty was firmly anchored by the initial idea.

The behaviors and strategies that underlie the production of intermediate drafts can also be examined. Getzels and Csikszentmihalyi (1976) demonstrated that early behaviors during the creative process could predict later behaviors by studying visual arts students' problem-solving while drawing. The students drew from a set of objects without rules or time limits. The study observed their behaviors during planning, drawing, and post-drawing phases, finding that initial exploratory behaviors during planning led to significantly more changes to their plans while drawing, which in turn resulted in more-creative final works. These findings underscore the importance of studying diverse strategies in creative production.

Toward a model of creative trajectories

A principal objective of the present study was not only to carry out a longitudinal study that could encompass the full creative process using multiple intermediate drafts, but to differentiate creators' work styles in terms of trajectories. In doing so, we elaborate on the core concept of the Geneplore dual-process model (i.e., generation + exploration) by proposing a two-dimensional (2 × 2) predictive scheme of creative trajectories in which a) a *globality* dimension specifies whether the generative phase (i.e., the initial draft) occurs as either a global plan of the final product or instead as a kernel idea for it based on an individual element, and b) a *linearity* dimension that specifies whether the exploratory phase of the work proceeds in either a linear or nonlinear manner across the creator's successive drafts. The end result is the set of four trajectories shown in Figure 1.

The figure also includes metaphorical colloquial names for each trajectory in order to aid in comprehension and memorability. The global linear trajectory is represented by the Straight Arrow. At the onset of the creative process, global linear creators have a target in mind and tend not to stray from it in their exploratory work. This is contrasted with the global nonlinear trajectory, the Billiard Ball. In comparison to an archer – who always aims for a single, unique target – a billiard player changes their target based on the changing conditions of the game. Therefore, the Billiard Ball is a less direct trajectory than the Straight Arrow. This requires that creators devise novel plans throughout their process. The result is that their final work no longer resembles their initial plan.

The kernel linear trajectory is represented by the Snowball. This implies that the product emerges through a progressive accumulation of small changes. Such creators do not have a clear endpoint in sight but work up their kernel idea through continued exploration until they are satisfied with the finished product. This is a create-as-you-go strategy. Finally, the kernel nonlinear trajectory is represented by Fireworks. When fireworks are first lit, they appear as a single spark until they explode into a grand display of opposing colors and directions. This spark is akin to an undeveloped idea. There is no way to know from the spark alone what the final form will be. This trajectory is characterized by indecision. Creators flutter from idea to idea, rarely settling down long enough to develop any one idea to fruition.

There were two principal objectives of the current study as related, respectively, to *creation* and *creativity*. Regarding the qualitative process of creation, we wanted to examine the full creative process, from idea generation through to exploration and revision, and ultimately to completion. We wanted to examine this via an analysis of multiple intermediate drafts. We employed the 2 × 2 model from Figure 1 to characterize each participant's creative process as one of the four trajectories. We were particularly interested in whether all four cells of the 2 × 2 scheme would be populated equally, or whether the group of creators would show a disproportionate emphasis on certain work-styles to the exclusion of others. Regarding creativity, we wanted to assess how creative trajectories correlated with the novelty and quality of the resulting products so as to identify the work strategies that distinguish highly creative from less creative products.

In order to achieve this, we asked undergraduate graphic design students enrolled at a professional design school to create a single-page advertisement for a fictional business during seven daily sessions over the course of one week. Graphic design is an ideal medium for studying intermediate drafts in the creative process since the product is a single-page graphic item, as opposed to a performance work or a multi-page product like a story or song. Hence, identifying changes across each successive draft is a relatively straightforward procedure. In terms of real-world applications, graphic design straddles the divide between fine art and everyday utility. It employs aesthetic visual-art skills, and yet such skills are used in the service of the marketing of everyday commercial products. In addition, our use of trained graphic design students for a creativity study aligns with concepts in the psychology literature that creativity mainly depends on domain-specific skills and mechanisms (Baer, 2016) and that it takes advantage of precedent ideas in a given

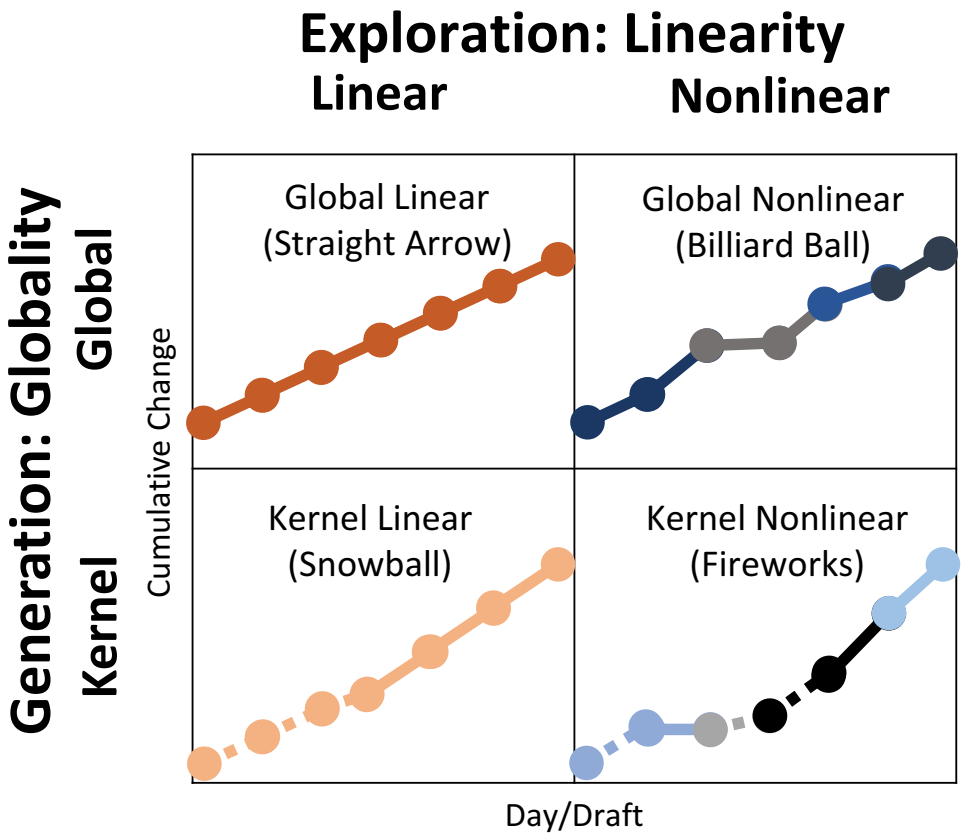

Figure 1. A two-dimensional model of creative trajectories. The generation phase of the geneplore model is represented here in terms of the "globality" of the initial concept, whereas its exploration phase is represented in terms of the "linearity" of the concept across successive drafts. Colloquial names for the trajectories are shown in parentheses. The four graphs show a hypothetical shape for each trajectory over the course of the work, as based on the pattern of accumulated changes to the product. Dots represent individual drafts. Changes in color represent changes in concept characterized by the nonlinear trajectories. Dashed lines reflect incomplete drafts, where certain features of the product are absent, as characterized by the kernel trajectories. Warm colors indicate linear trajectories, while cool colors indicate nonlinear trajectories. Darker shades indicate global trajectories, while lighter shades indicate kernel trajectories.

domain through what Weisberg (2020) calls analytic thinking and what (Heyes, 2023) calls emulation.

On each day of the weeklong study, participants created a draft of their ad along with a written reflection of their inter-draft changes and their reasoning for these changes. This allowed us to track the progressive evolution of the work as well as the decisions made by the designers throughout their creation of the ad. It also allowed us to characterize each designer's work-style with respect to one of the four trajectories, similar to how Weisberg (2004) described Picasso's creation of *Guernica*. In order to determine if a designer's work-style is related to the creativity of their product, we recruited expert graphic designers to rate each initial sketch and final ad in terms of its novelty and quality. This allowed us to assess whether the novelty of the initial sketch was predictive of the novelty of the final product (Berg, 2014), in keeping with theories of divergent thinking that strongly prioritize the generative phase of creativity (Beaty, Benedek, Barry Kaufman, & Silvia, 2015; Benedek et al., 2014; Bengtsson et al., 2007; Boccia, Piccardi, Palermo, Nori, & Palmiero, 2015; Borgianni, Maccioni, Fiorineschi, & Rotini, 2020; Camarda et al., 2018; Paulus & Brown, 2007; Przysinda, Zeng, Maves, Arkin, & Loui, 2017). Finally, we used principal components analysis and k-means cluster analysis to carry out a structural analysis of the final products to define clusters of stylistic similarity. We then examined the relationship between stylistic cluster and both novelty and quality, as well as whether cluster membership relates to the creative trajectory of the designer.

Prior to the data collection, we developed several hypotheses about the relationship between trajectory-type and both the novelty and quality of the final product, as shown graphically in Figure 2. While many studies have pointed to an inverse relationship between novelty and quality (Berg, 2014; Mueller, Melwani, &

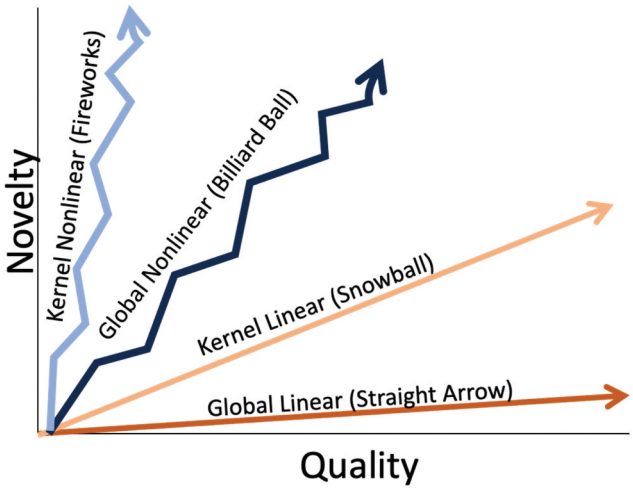

Figure 2. Predictions for the study. The figure presents predictions about the relationship between trajectory-type and the relative level of both novelty and quality for the final ads. The potential for either an inverse relationship or positive relationship between novelty and quality was predicted. Warm colors indicate linear trajectories, while cool colors indicate nonlinear trajectories. Darker shades indicate global trajectories, while lighter shades indicate kernel trajectories.

Goncalo, 2012; Steele, Hardy, Day, Watts, & Mumford, 2019), several others have pointed to a positive relationship between them (Chan & Schunn, 2023; Mugge & Schoormans, 2012). The latter is seen especially when experts are used as raters. When a rater judges a product to be high in novelty, this tends to pull the quality score higher. We thus predict that, despite the potential for an inverse relationship between novelty and quality in the final products, there may be a positive relationship between the two, notably since the ads will be evaluated by experts in graphic design. In this context, when a product is rated as novel, it is likely to receive a higher quality score.

We hypothesized that the global linear trajectory (Straight Arrow) would produce the highest-quality final advertisement, but also the least novel. This would be due to the unwavering commitment of such designers to a single design concept. At the other extreme would be the kernel nonlinear trajectory (Fireworks). Its high novelty and low quality would be the result of the greatest amount of experimentation, coupled with the least amount of revision and refinement. The two remaining trajectories would represent intermediates between these extremes that balance novelty and quality. We predicted that the kernel linear trajectory (Snowball) would have higher quality than both nonlinear trajectories (but lower than global linear), since there would be more time for refinement. Finally, the global nonlinear trajectory (Billiard Ball) would have higher novelty than all of the trajectories except the kernel nonlinear trajectory (Fireworks) and have a moderate level of quality.

Methods

Participants

Thirty-seven undergraduate students from a graphic design college in Toronto, Canada were recruited to participate in this study (Table 1). All participants were either enrolled in a graphic design program or were recent graduates of the program at the time of participation. Recruitment took place through posters, word of mouth, and classroom advertisement by professors. All participants provided written informed consent prior to their participation. The study was approved by both the McMaster Research Ethics Board (MREB 5384) and the Research Ethics Board of George Brown College (6004752). Due to COVID-19 restrictions, data collection was carried out remotely using Zoom. Participants were compensated monetarily for their time.

Procedure

On Day 1 of the study, the first author met with each participant individually on Zoom in order to provide instructions for the 7-day experiment. Participants were tasked with developing a letter-paper-sized advertisement for a fictional company over the course of 7 consecutive days of work. They were randomly assigned to have this ad be about either a food delivery app named "Supper," or a gym named "Vigour." Participants were presented with a brief that explained that the company prioritizes novelty and innovation in both their products and their advertisements. Their aim was to come up with a final ad for submission on Day 7 after a week of daily work sessions.

The sketches and final advertisements were required to have three components 1) graphic elements, 2) a logo, and 3) a background. For analysis purposes, we considered a fourth, but optional, component of "copy" to capture slogans and all other text beyond the logo (e.g., phone numbers). Participants were randomly assigned to one of two brainstorming categories on Day 1. Half of the participants were instructed to immediately begin the first draft of their advertisement, while the other half was instructed to spend the first one-hour session sketching a minimum of three different design concepts. The latter was inspired by standard divergent-thinking approaches to creativity that are grounded in brainstorming processes (Runco, 2010). The overall task was the same regardless of condition.

Table 1. Demographic data about the participants and expert raters.

	Sample size	*Mean age (SD)*	*Gender*	*Graduates*	*Median experience*[2]
Participants	$n = 37$	23.7 (6.3) years	Female: 24 Male: 10 Non-Binary: 3	7	3 years
Expert raters	$n = 4$	54.0 (4.9) years	Female: 3 Male: 1	4	32.5 years

Participants completed questionnaires on Day 1 to assess demographic information, graphic design background, vividness of visual imagery (Marks, 1973), frequency of creative behaviors (Dollinger, Burke, & Gump, 2007), and Big 5 personality traits (McCrae & Costa, 1987). The questionnaire results are not reported here. At the end of Day 1, participants were told that they may either choose one of the sketches they had just created or devise an entirely new design concept.

Participants were asked to carry out daily sessions of work on their advertisements at home for a maximum of one hour per day, at a daily time of their choosing. They were instructed to work alone, and that all ideas and drawings had to be their own. At the end of each day's session, participants were asked to submit their draft online, rate its quality on a scale from 1 to 5, and complete a short written response outlining the changes they had made compared to the previous day's draft and the reasons why. They were also asked to make note of any inspirations for their work, for example advertisements they had seen or reference-images they had sought. On Day 7, after the final draft was submitted, the first author met with participants again on Zoom for a final interview. They were asked to explain their overall creative strategy, identify which changes they believed were most important in achieving their final design, and which changes, if any, they still wished to make.

To obtain expert ratings on the novelty and quality of the ads, we recruited four professional graphic designers through word of mouth (see Table 1 for demographic information). They were compensated monetarily for their participation. Using an online format, the raters were presented with all final advertisements in a random order, followed next by all of the initial sketches in a random order. They were asked to rate the novelty and quality of each item using separate 5-point Likert scales. We chose to present the final advertisements first, rather than combine the initial and final advertisements into a mixed stimulus set. Our primary interest was in the final ads, and so we were concerned that the variable quality of the initial sketches might influence the ratings of the final ads. We were also concerned that the raters might develop predictions about how the final ads might look based on the initial sketches, which would affect their ratings of the final ads. We used Cronbach's alpha (Cronbach, 1951; Hair, Page, & Brunsveld, 2020) to assess interrater reliability among the expert judges.

Data analysis

Change analysis. The first step in categorizing the designers into trajectory-types was in performing a *change analysis* on their weekly collection of 7 drafts and examining both 1) the nature of the initial draft (global vs. kernel) and 2) the retention or modification of elements from the first draft to the final draft (linear vs. non-linear). The change analysis described daily changes to the structural features of the ad, focusing on how and when these features changed over the course of the exploratory phase of the work. Changes refer to modifications of the ad relative to both the initial sketch and the preceding day's draft.

There was no preceding draft to refer to for the first draft, and so changes were compared to blank paper. The presence or absence of each design feature was directly related to whether the trajectory was coded as global or kernel. If all features (other than copy) were indicated on the first draft, the trajectory was coded as global. However, if one or more feature was entirely missing, it was coded as kernel. The change analysis was purely descriptive and did not take either novelty or quality into account. Figure 3 presents a listing of structural features that were used to assess changes.

For each element and feature, a rater and an interrater gave an evaluation of the amount of change from 0 (no change) to 3 (large change) for each of the 7 drafts, compared to the preceding day's draft. The two raters consisted of the first author, who had no formal training in graphic design, and a second rater, who received a Bachelor of Fine Arts from a college of art and design. The changes were graphed with the drafts from Day 1 to Day 7 along the x-axis, the total accumulated change on the y-axis, and separate lines for each of the four elements (see Supplementary Figures S1–4 for examples). While this is a predominantly qualitative analysis, it allows for a quantification of the overall magnitude of change, the slope of change, a comparison among each of the four elements, and individual differences among participants. Each change analysis was completed

separately by the first author and an inter-rater. Cronbach's alpha revealed extremely high interrater reliability (items: 1028, $\alpha = 0.99$). Disagreements were settled by means of discussions until consensus was reached on all features and trajectories.

The goal of this study was to define the trajectories of the creative changes occurring over the course of a creator's work with respect to globality and linearity (see Figure 1). In addition, we superimposed a basic phasing of the creative process onto the 7-day trajectory, spanning from conception (the initial sketches) to development (the daily iterations) to completion (the final product). This analysis examined changes occurring over time to the features listed in Figure 3, for example the addition, removal, replacement, or refinement of graphic elements, or the change in focus from global to local features of the ad, among others. Examples of phasing are shown in Supplementary Figures S1–4 for the four trajectory types, respectively.

Trajectories of the creative process. The same method of inter-rater agreement used for the change analyses was used to classify each designer's creative process with respect to the four trajectory categories shown in Figure 1 (items: 74; $\alpha = 0.83$: indicating good agreement). For an advertisement to be considered global, all the required elements (graphic, logo, background) and some degree of composition were required to be present in the initial draft on Day 1. If an element was missing, if no composition was present, or if the page contained multiple ideas, the ad was considered as a kernel idea.

Next, linearity was assessed by examining the stylistic continuity or discontinuity of the successive drafts compared to the initial draft. A trajectory was defined as linear if the participant retained elements from the initial draft in their final draft. It was defined as nonlinear if the participant deviated from the concept of the initial draft either by presenting a stylistically new draft or by reporting a change in direction in their written reflections. The absolute number of changes did not impact the trajectory. If there was at least one change in concept, the trajectory was categorized as nonlinear. If not, it was categorized as linear.

Structural analysis of the ads. The 37 final ads were analyzed with respect to their structural features using a principal components analysis (PCA) in order to investigate stylistic groupings. The analysis was adapted from Ellis et al. (2018) stylistic clustering of vocal improvisations. We initially began with a subset of 10 non-redundant structural features derived from the change analysis (see Figure 3), each of which was rated on a scale of 1–3 by the first author and the same inter-rater (see Table 2). PCA was conducted on a matrix of 37 rows (each ad) and 10 columns (each feature). Eigenvalues for each feature were calculated. If the value was < 0.3 for either components 1 or 2, or if the weightings were approximately equal for both components, then that feature was removed from the cluster analysis. This procedure left 6 features remaining for the final cluster analysis (see asterisks in Table 2): prevalence of text versus graphic elements, implied depth, implied movement, color palette, structural detail, and the background.

Finally, k-means clustering was carried out in R (Lê, Josse, & Husson, 2008), where the number of clusters was chosen using the elbow method for the scree plot and through visual inspection. After the number of clusters was chosen, the clusters were used as a factor in a 1-way analysis of variance (ANOVA) to assess differences in the novelty and quality of the clusters. Finally, a chi-squared test was used to assess whether creative trajectories were associated with cluster membership and thus with the stylistic features of the ad.

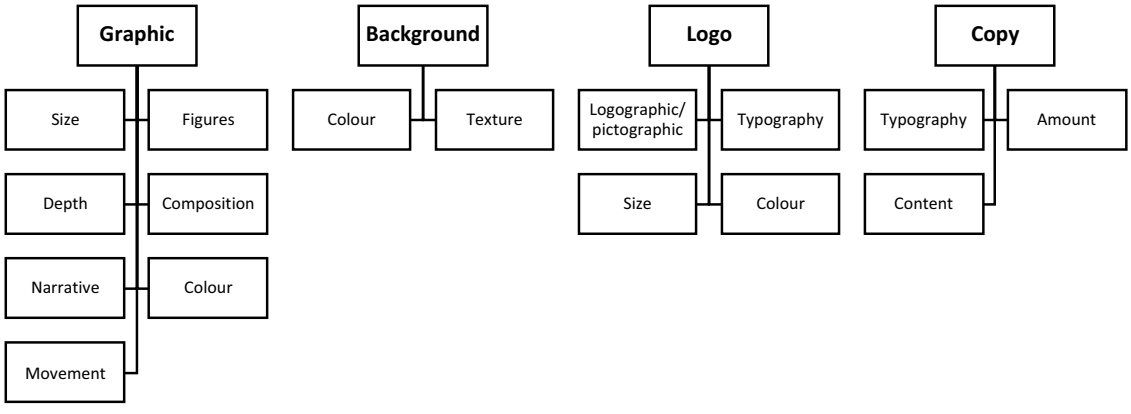

Figure 3. Structural features of the ads that were examined in the change analysis. The four elements of the ads are shown along the top, with sub-categories listed below each one.

Table 2. Structural features of the final ads used for the PCA analysis. Out of the 10 features initially explored, the 6 features with an asterisk were used in the final analysis (see text). Abbreviations: 2D, two-dimensional; 2.5D, two-and-a-half-dimensional; 3D, three-dimensional.

#	Feature	Coding
1	Narrative content	1: none, 2: proto-narrative, 3: full narrative
2	Text vs. graphics *	1: text-based, 2: mixed, 3: graphic-based
3	Dimensionality/Implied depth *	1: 2D, 2: 2.5D, 3: 3D
4	Implied movement *	1: static, 2: some implied movement, 3: significant implied movement
5	Color palette *	1: black and white, 2: limited color palette, 3: full color
6	Size of the main graphic element	1: small (< 50% of page), 2: medium, 3: large (most of page)
7	Detail of the main graphic element *	1: minimal, 2: some detail, 3: very detailed
8	Complexity of the composition	1: simple, 2: moderate complexity, 3: complex
9	Detail of the background features *	1: simple (single color), 2: moderate detail, 3: detailed (many features/integral to understanding the ad)
10	Types of figures	1: none, 2: part of a person, 3: whole person

Results

Change analysis

Overall, the interrater reliability between the main author and the quasi-expert interrater was extremely high (items: 1028; α = 0.99). When separated by design element, there was good reliability for the main graphic items (257, α = 0.84) and excellent reliability for the logo (items: 257; α = 0.97), background (items: 257; α = 0.99), and copy (items: 257; α = 0.99). The results of the change analyses revealed both generalizable characteristics of creation and trajectory-specific features. These could be categorized quantitatively in terms of 1) the magnitude of change, as well as qualitatively by the 2) the designer's focus and 3) the subprocesses. Figure 4 demonstrates that, regardless of the trajectory-type, the main graphic underwent significantly more changes and refinements than the other elements of the ad (*p*s < .02). The background and logo were not significantly different from one another ($t_{952} = 1.5$, $p = .45$) and received more change compared to the copy (*ps* ≤ .05), which underwent the least amount of change between drafts.

Looking to the trajectories, there was a main effect of both Globality ($F_{1,952} = 6.5$, $p = .01$) and Linearity ($F_{1,952} = 37.8$, $p < .001$) on the overall amount of change, and there was a significant interaction between them ($F_{1,\ 952} = 4.6$, $p = .03$), indicating that each trajectory-type yielded a different overall magnitude of change. After correction for multiple comparisons, post-hoc tests revealed no significant differences in the overall magnitude of change between the global and kernel trajectories (*ps* > .20). By contrast, the nonlinear trajectories underwent significantly more change than the linear trajectories (*p*s < .005). Taken together, while there is some indication that a global sketch on Day 1 decreases the amount of change throughout the process, the largest accumulated change occurs when a designer re-concepts their idea and follows a nonlinear path.

The trajectories could be broken into three phases of creation: 1) planning, 2) execution and 3) refinement

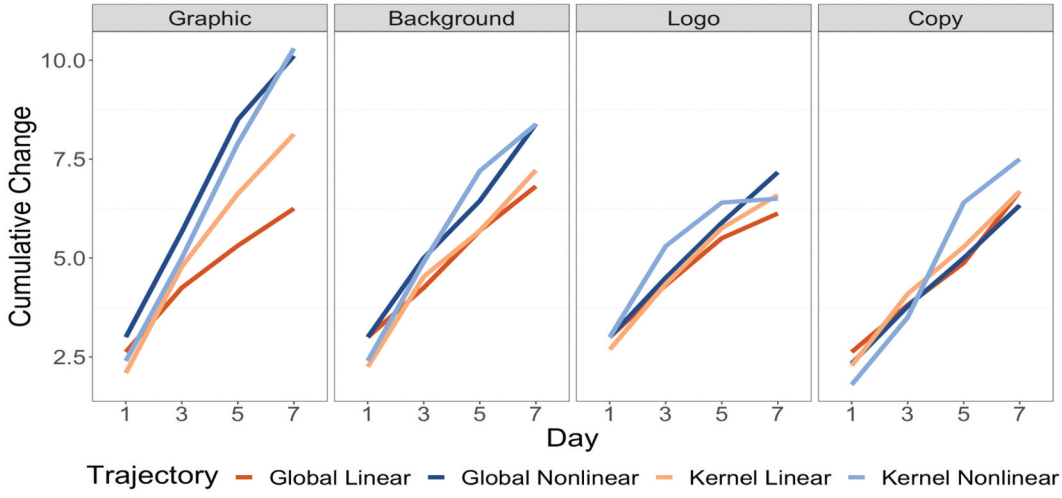

Figure 4. Change analyses as a function of element-type and trajectory-type. The nonlinear trajectories produced greater amounts of change for all features, especially for the graphic. The maximum possible value for the y-axis is 21. Warm colors indicate linear trajectories, while cool colors indicate nonlinear trajectories. Darker shades indicate global trajectories, while lighter shades indicate kernel trajectories.

(see Supplementary Figures S1–4 for examples). Figure 4 shows that the greatest amount of change occurred earlier in the process and then leveled off as the week went on. The amount of change compared to the previous day's draft was significant for Day 1 to Day 5 ($ps < .05$). However, this leveled off for Day 6 ($p = .09$) and Day 7 ($p = .10$), thus characterizing the revision phase. This trend was clearest for the linear groups (the orange lines in Figure 4). The nonlinear groups tended to display steadier change throughout the week.

Trajectories

Figure 5 presents representative examples of the seven daily drafts for each of the four trajectory types. We now describe each trajectory with regard to its salient features.

Global linear (Straight Arrow)

The global linear trajectory was unique in that the final advertisement bore a striking resemblance to the initial sketch (Figure 5(a)). It was characterized by extensive planning and a switching of focus between the global and elemental levels. Some designers switched focus between levels nearly every day, whereas others changed focus only once. The latter designers dispensed their effort evenly among the elements such that each element underwent a comparable amount of change throughout the week. The global linear trajectory showed more change during the first half of the process, followed by smaller changes or plateaus in the second half. It displayed the least amount of idea generation, experimentation, and change. This made it significantly different from the nonlinear trajectories ($ps < .01$), but not from kernel linear ($p = .30$). Since these designers spent a significant amount of time planning their design, much of their process was characterized by a rendering of a preplanned design and the making of subtle refinements.

Global nonlinear (Billiard Ball)

The global nonlinear trajectory (Figure 5(b)) was characterized by its consistent global focus throughout the week, even if that global concept changed. No other

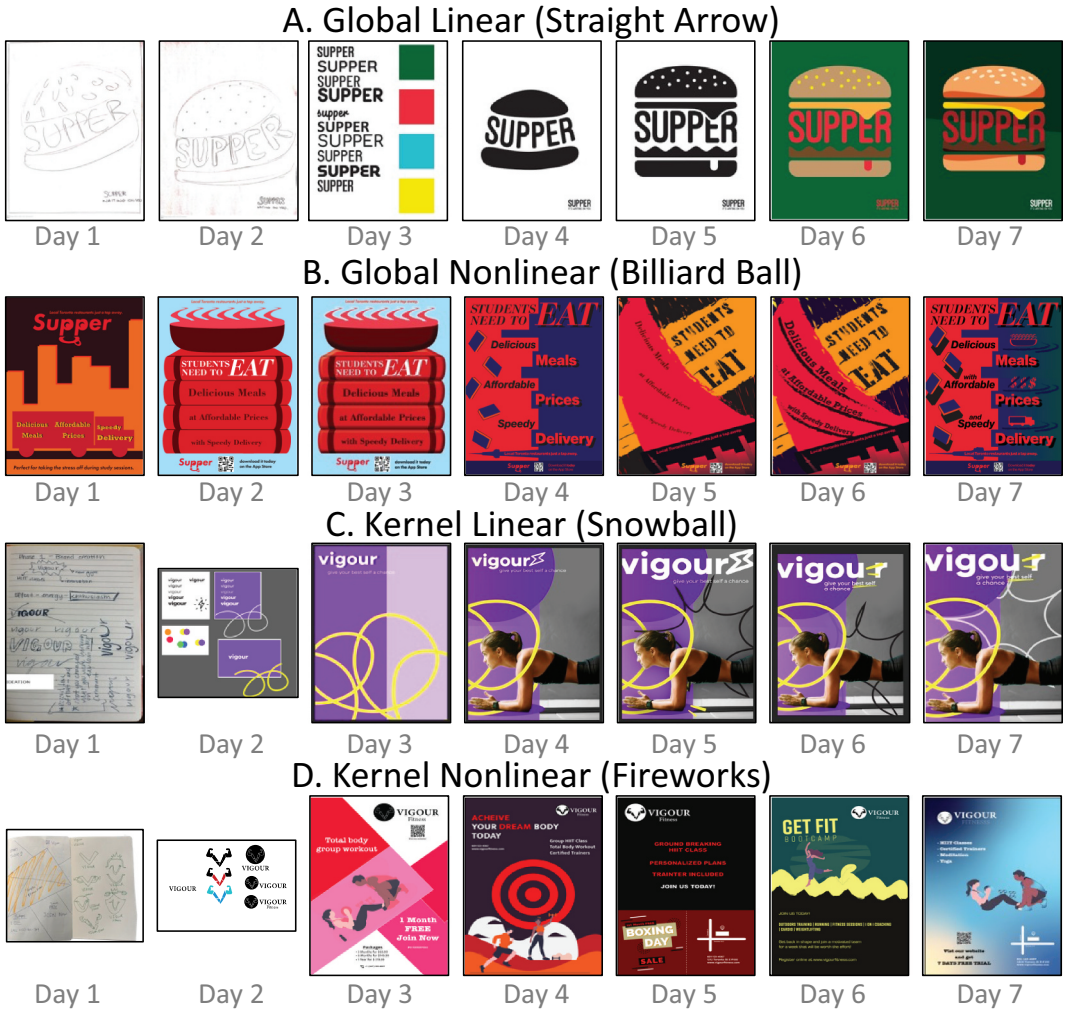

Figure 5. Representative examples of the seven daily drafts for each of the four trajectory types.

group displayed such a sustained holistic focus. A key feature of global nonlinear designers is that, when they pivoted from one idea to another (distinguishing them from the global linears), their new design was a global plan, rather than a kernel idea. Some of these designers displayed "wild experimentation," in which they continuously re-concepted their design, resulting in multiple drafts that could be considered as "final" drafts, but without a shared concept among them. Not every element was redesigned; composition, color, and graphic elements were the features most commonly altered. This concept of wild experimentation was common to both of the nonlinear trajectories, as seen in each kernel nonlinear trajectory (Fireworks).

Kernel Linear (Snowball)

The snowball metaphor for the kernel linear trajectory is exemplified by notion of accumulation. These designers began without a detailed plan, instead choosing to focus on a single element or feeling (Figure 5(c)). They then developed their ad through an accumulation of elements above and beyond those present in the kernel idea or the preceding day's draft. The kernel linear designers tended to work on one element at a time, and only rarely worked on multiple elements during the same session. This trajectory entails numerous small modifications, as well as trial and error. By the end of the week, a clear resemblance could be seen between the initial draft and the final advertisement, hence making this a linear trajectory.

Kernel Nonlinear (Fireworks)

The kernel nonlinear trajectory is characterized by experimentation (Figure 5(d)). The fireworks metaphor relates to notion that these designers had multiple flashes of inspiration and multiple design-concepts during the course of the week. Such designers appeared to be highly indecisive, favoring dramatic changes between drafts over small refinements. As with the global nonlinear creators, these designers maintained certain features across drafts, rather than re-concepting every element. Although the final result bore little resemblance to the initial idea, there was often a thread that could be traced throughout the week. These creators seemed to discover what they were creating *as* they were creating it. They tended to conserve few stylistic choices between their drafts, instead generated new ideas each day. This mainly impacted the overall composition, main graphics, and color, whereas the logo and copy were more likely to stay the same. Despite this experimentation, there still tended to be a kernel idea that tied the drafts to one another.

Relative frequency of the trajectory types

By classifying our participants into these four trajectory-types, we created a quasi-factorial design that allowed traditional methods of statistical analysis to be applied. A chi-squared test of independence showed that not all trajectories were equally likely among the participants $X^2(3, N = 37) = 8.5$, $p = .049$. To a first approximation, three of the four trajectories in the 2×2 scheme shown in Figure 1 had comparable frequencies, with kernel nonlinear being the only infrequent trajectory (Figure 6). When this was broken down by trajectory-type, we observed no significant difference in frequency between global and kernel trajectories X^2 $(1, N = 37) = 1.32$, $p = .25$. However, regardless of the generative phase, there was a trend favoring a linear, rather than a nonlinear, exploratory phase $X^2(1, 37) = 3.8$, $p = .07$. Whereas designers who started out with a global plan were equally likely to follow a linear or nonlinear path (see Figure 6; $X^2(1,2) = 0$, $p = 1$), those who started out with a kernel idea were far more likely to pursue this idea linearly ($X^2(1,2) = 8.1$, $p = .02$), thereby resulting in kernel nonlinear being the least prevalent of the four trajectory-types.

Novelty and quality

Four professional graphic designers rated each of the final and initial advertisements with regard to both novelty and quality. The final and initial ads were tested for normality using a Shapiro-Wilk Test of the residuals. If normality was not met, a Mann-Whitney-Wilcoxon Test was used instead. Because this test cannot assess interactions, only main effects were tested in such

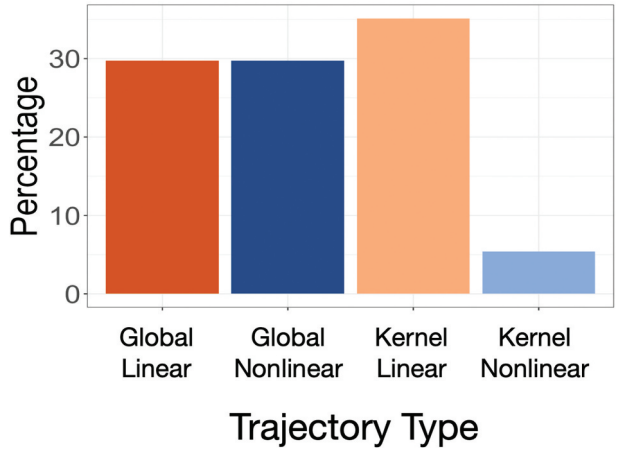

Figure 6. The relative frequency of the designers in each trajectory category. Warm colors indicate linear trajectories, while cool colors indicate nonlinear trajectories. Darker shades indicate global trajectories, while lighter shades indicate kernel trajectories.

instances. We conducted 2-way ANOVA's on the expert ratings, with Globality and Linearity as factors.

There was higher inter-rater agreement for the final drafts (novelty: 37 items; α = .78 indicating good agreement, quality: 37 items; α = .67 indicating acceptable agreement) than the initial drafts (novelty: 37 items; α = .64 indicating acceptable agreement, quality: 37 items; α = .52 indicating poor agreement). As a proof of concept, we assessed the effect of the brief (food delivery service vs. gym) on the novelty and quality of the final products. Unsurprisingly, there was no effect on quality ($t_{35.7} = 0.35$, $p = .70$). Since the novelty scores did not meet the normality assumption in a Shapiro-Wilk normality test (W = 0.93, $p = .03$), we used the non-parametric Wilcox test instead. As with quality, there was no effect of brief on novelty ($W = 209$, $p = .40$).

Association with trajectory types

A Wilcox test showed no effect of Globality ($W = 123$, $p = .11$) or Linearity ($W = 188$, $p = .43$) on the novelty scores (Figure 7(a)). Moreover, a type III ANOVA revealed no main effect of Globality ($F_{1,34} = 0.34$, $p = .56$) or Linearity ($F_{1,34} = 0.07$, $p = .8$), nor an interaction between them ($F_{1,34} = 0.18$, $p = .67$), on the quality of the final drafts (Figure 7(b)). Taken together, these results indicate no effect of trajectory-type on either the novelty or quality of the final advertisements. Figure 7 reveals that there was a non-significant trend for the kernel linear (Snowball) trajectory to have the highest level of both novelty and quality.

Novelty/quality correlations

There was a positive correlation between initial novelty and final novelty ($r = .45$, $p = .005$; Figure 8(a)). However, there was no significant relationship between initial quality and final quality ($r = .23$, $p = .16$; Figure 8(b)). Conversely, contrary to the hypothesis outlined in Figure 2, there was a significant and strong positive correlation between the novelty and quality of the final drafts ($r = .78$, $p < .001$; Figure 8(c)). This indicated that higher-novelty final products tended to be of higher quality as well.

Brainstorming

There was no significant association between trajectory type and brainstorming, ($X^2(3,38) = 5.40$, $p = .15$). Furthermore, there was no effect of brainstorming on the novelty ($W = 204.5$, $p = .48$) or quality ($t_{35.5} = -0.35$, $p = .72$) of the initial drafts, nor was there an effect on the novelty ($W = 222.5$, $p = .21$) or quality ($t_{34.5} = 0.79$, $p = .43$) of the final drafts.

Expert vs. self-ratings

Given that participants rated themselves on the overall success of each draft, this singular success score was

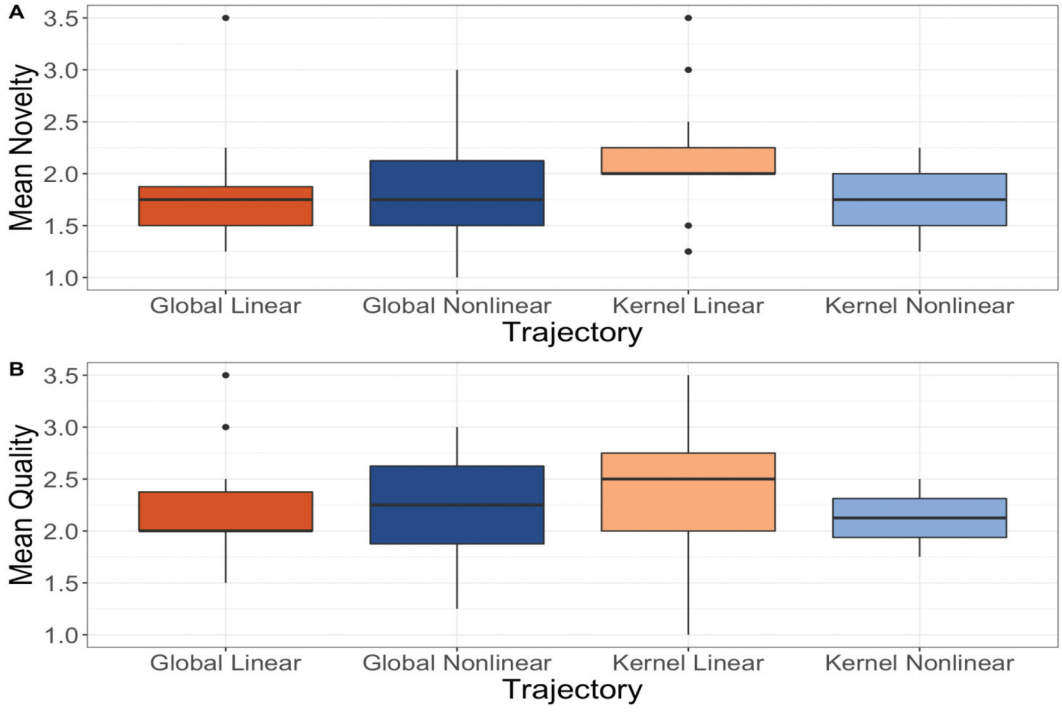

Figure 7. Expert ratings of the novelty and quality for the final ads as a function of trajectory type. Boxplots are shown for the (a) novelty and (b) quality of the final ads. Box length represents the interquartile range. The horizontal line within the box indicates the median value. Whisker length indicates 95% confidence intervals. Single dots represent outliers.

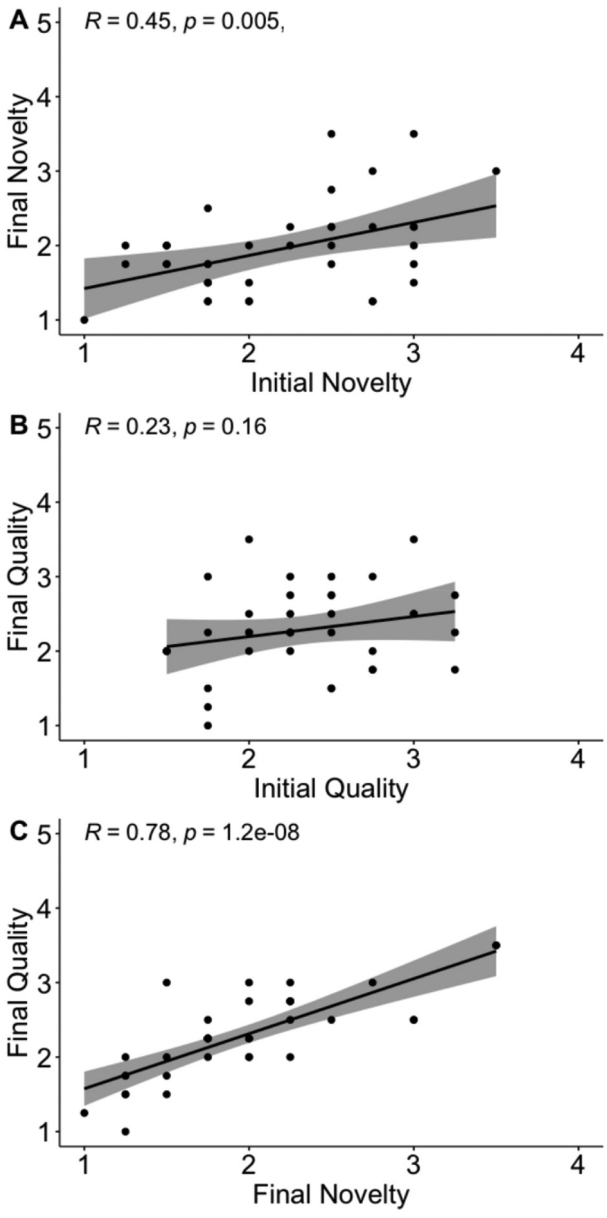

Figure 8. Correlations between expert ratings of the initial and final drafts. Initial/final correlations are shown with respect to (a) novelty and (b) quality. Panel C shows the correlation between final quality and final novelty. R-values were calculated as Pearson correlations. The grey regions represent 95% confidence intervals.

compared to a combined average novelty/quality score given by the judges. Participants and experts had similar ratings on the initial drafts, but not on the final drafts. There was a moderate correlation between self-ratings and expert ratings ($r = .34$, $p = .04$) for the initial draft (Figure 9(a)). However, there was a poor correlation between self and expert ratings ($r = .18$, $p = .3$) for the final drafts (Figure 9(b)). In general, designers rated their own final drafts as being much higher in creativity ($M = 4.34 \pm 0.71$) than did the experts ($M = 2.30 \pm 0.57$; $t_{37} = -15.35$, $p < .001$).

Structural analysis of the ads

A 2-dimensional PCA and k-means cluster analysis revealed that the final ads reliably fell into three discrete stylistic clusters (Figure 10). The first two principal components accounted for 59.5% of the variance. The first component was comprised primarily of dimensionality and detail, followed by reliance on graphics versus text, and implied movement. A higher loading on this dimension indicated an ad with greater dimensionality (3D vs. 2D), detail, implied movement, and decreased text. This component accounted for 35.1% of the variance. The second component was made up primarily of color palette and background complexity. A higher loading on this dimension indicated a broader color palette and a more complex background. This dimension accounted for 24.4% of the variance.

Despite these structural differences among the clusters, there was no difference in novelty ($F_{2,34} = 0.7$, $p = .51$) or quality ($F_{2,34} = 1.6$, $p = .21$) between the clusters. A chi-squared test revealed no relationship between cluster membership and globality ($X^2(2,37) = 1.6$, $p = .46$), linearity ($X^2(2,37) = 4.0$, $p = .14$) or trajectory ($X^2(6,37) = 5.6$, $p = .47$). Hence, the structural features of the ads were independent of both the creative process itself and the level of creativity of the final ad.

Discussion

We carried out one of the first experimental studies to look at the creative process longitudinally using a full series of intermediate drafts. We utilized participants from a graphic design program who had relevant domain-specific skills and grounded the study in a two-dimensional predictive scheme based on Finke, Ward, and Smith's (1992) Geneplore model. The creative trajectories of the designers varied with respect to the globality of the generative phase as well as the linearity of the exploratory phase, resulting in four trajectory types (see Figure 1). We found that three of the four cells of our 2 × 2 scheme were populated nearly equally, the major exception being the most extreme trajectory, the kernel nonlinear (Fireworks), which had the lowest frequency. This is in keeping with previous research showing that the work style of creators varies significantly across individuals (Doyle, 2022). In addition, we observed a positive correlation between the novelty and quality of the final ads, but no other predicted relationships.

Creation

There were two principal objectives of the current study as related to creation (the process) and creativity

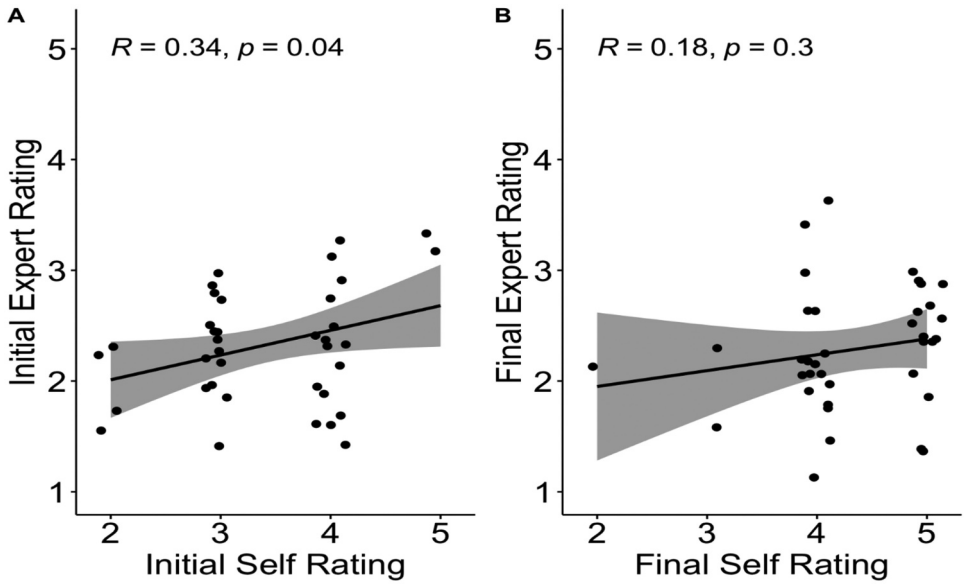

Figure 9. A comparison of expert ratings and self-ratings. This is shown for (a) the initial drafts and (b) the final drafts. Note that a jitter of 0.15 has been added to the x-axis to reduce the visual overlap of points. R-values were calculated as Pearson correlations. The grey regions represent 95% confidence intervals.

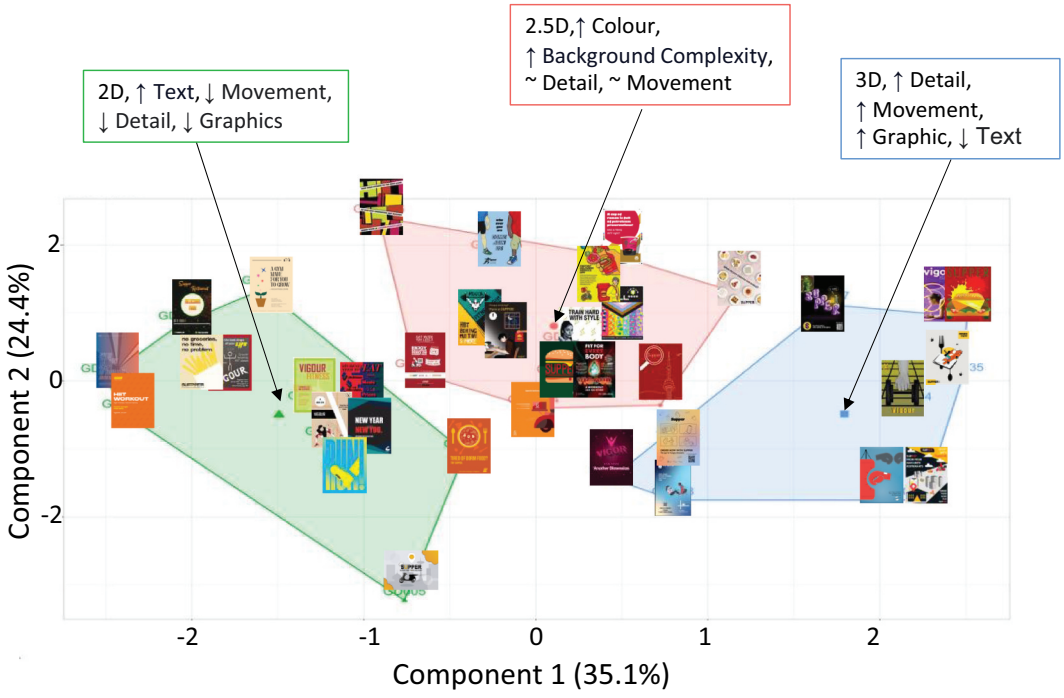

Figure 10. Principal components analysis of the structural features of the final ads. The graphic of each final ad is overlayed onto its location in the PCA. Three major clusters are shown. The geometric shapes (green triangle, red circle, and blue square) represent the centroid of each cluster. The colored boxes above the PCA list the major structural features of each cluster with respect to the six features used in the analysis (see Table 2).

(the final product), respectively. Regarding the process of creation, we wanted to examine the full creative process from idea generation to final product. This is one of the first experimental studies to examine the series of intermediate drafts leading up to a final product. In general, our hypotheses regarding creation were supported.

In keeping with observations on eminent creators showing that work-styles can vary radically across individuals (Doyle, 2022; Zaidenberg et al., 1953), we found

that three of the four cells of the 2 × 2 predictive scheme showed nearly equal frequencies among the 37 designers, with only kernel nonlinear showing a significantly lower frequency. This finding might seem surprising given the relatively homogeneous backgrounds of students coming from the same graphic design program. As a result, it points to the strong influence of individual differences on the creative process.

The analysis of frequencies showed an important interaction between globality and linearity (see Figure 6). If a designer was a global planner during the generative phase, they were equally likely to follow either a linear or nonlinear trajectory during the exploratory phase. However, if a designer was a kernel planner, they had a very strong tendency to follow a linear trajectory. This would suggest that working in a nonlinear manner is easier to achieve when there is a global concept from the start, even if the final product deviates from it. The predictive scheme jibes with indications from historiographic analyses of eminent creators that a fundamental contrast in creative styles is that between a global planner who works linearly to completion (see the discussion of Picasso's *Guernica* in the Introduction) and a create-as-you-go creator whose ideas only emerge during the course of producing the work, much like a form of improvisation.

While there were stark differences between individuals, there were also similarities, perhaps describing a more general method of designing advertisements. The change analyses revealed that the greatest amount of change occurred to the ads' graphic elements, followed by the background, logo, and copy of the ad. This was especially the case for the nonlinear designers. This may indicate that the designers viewed the graphic elements as the most important features, and only changed the other elements if there was sufficient time.

Designers reliably fell into each of the trajectories-types and showed a distinct shape and pattern of subprocesses. More generally, the trajectories of the designers followed the phases of creation outlined in both dual-process models (Finke, 1996; Finke, Ward, & Smith, 1992; Howard-Jones, 2002) and stage models (Amabile, 1988; Mace & Ward, 2002). These results highlight the importance of looking at differences within the described stages. Although each of the designers could be said to follow similar phases, the shape of their design process varied greatly. Linear paths tended to begin with large creative bursts, followed by smaller revisions, whereas nonlinear paths were characterized by more-constant levels of change.

This manner of describing the trajectories of the creative process has applications to other domains of creativity. This is especially so for graphic domains like creative writing, where changes to the plot and characters of a story can be tracked through additions and deletions to the evolving text. A similar approach could be taken with notated music, which is a graphic representation of a performance work. In principle, it should be possible for any type of creative project to be analyzed with regard to whether the initial sketch of the product specifies the endpoint or not (globality) and whether successive drafts propel the idea in a relatively more linear or nonlinear manner (linearity).

The use of the change analysis allowed us to view the creative process as a series of modifications, where the final product could be reliably traced back to previous drafts. It was rare for designers to completely restart their work. Instead, they tended to spend their time blending, altering, and refining their ideas, rather than generating completely new ideas from scratch. Moreover, designers tended to follow more-linear paths, completing the ideas that they initially concepted, rather than abandoning them in favor of greener ideas. Even for the nonlinear designers, it was rare for them to entirely restart. Instead, smaller features, such as logos, tended to be conserved through many drafts. In addition, it was rare for participants to start anew more than once. In fact, only three of the 37 participants changed their ideas more than one time.

The present work provides an advancement over traditional psychological approaches to creativity. A recent meta-analysis of neuroscientific studies of creativity found that nearly 75% of the studies were based on verbal reasoning tasks, and over half of those were divergent thinking tasks (Benedek, Christensen, Fink, & Beaty, 2019). Significantly, all such studies represent one-shot production tasks. For example, the Alternate Uses Task – which is the gold standard for studies of divergent thinking in psychology – is a 2-minute-long listing of uncommon uses for common objects. It is limited to a generative phase and is completely devoid of any concept of exploration and thus trajectories of the creative process.

Creativity

The impact of trajectory on novelty

Regarding creativity, we predicted that the nonlinear trajectories would lead to higher levels of novelty than the linear trajectories. This prediction was not borne out. The ANOVA found no main effect of either globality or linearity on either novelty or quality, nor was there an interaction. While there was a trend for the kernel nonlinear (Snowball) trajectory to have the highest level of novelty (and quality) of the four trajectory types, this effect was

not statistically significant. It is noteworthy that both the high and low outliers for novelty appeared in the kernel linear category, making it the most diverse category.

Additional null results about creativity included the absence of a relationship between novelty and either the stylistic features of the ad or an imposed process of brainstorming on Day 1. Overall, we were not able to identify work strategies that distinguished highly creative from less creative products. While creativity-training programs attempt to provide recipes for enhancing creativity (Baer, 2015; Chusilp & Jin, 2006; Tran, Kudrowitz, & Koutstaal, 2020), our study examined what creators do in the absence of such external guidance and, in doing so, revealed the importance of individual differences in the manner of creation.

These results point to a model of *equipotentiality* when it comes to creativity, as well as the significant role of individual differences in the creative process. There seem to be many ways to create, and it is up to the individual creator to decide on which method best fits the task and their individual inclinations. The results showed that, regardless of the method of creation, success is possible. This accords with common views of creativity and with people's general fascination about how geniuses create.

There are many cultural examples that support the notion that success does not come from a single specific method of creation. For example, Mozart and Beethoven are two of the most esteemed classical composers in the history of music. Mozart was notorious for "composing faster than his pen could write," being able to sit down at the piano and write a piece of music in a single session, never looking back to revise (Hertzmann, 1957). Beethoven, on the other hand, was equally notorious for his painstaking and tortuous process of writing and rewriting scores, doing so nearly illegibly due to the sheer number of edits (Solomon, 1980). Despite the vast difference between Mozart and Beethoven regarding their creative process, both achieved comparable levels of eminence in the canon of classical music. Such differences can be seen for famous painters such as Matisse and Picasso as well, as mentioned in the Introduction (Kozbelt, 2006; Weisberg, 2004). The creative process appears to be as unique as the artworks themselves. One strategy does not reliably lead to better products. This is in contrast to previous results that do emphasize particular methods of enhancing the novelty of a product (Borgianni, Maccioni, Fiorineschi, & Rotini, 2020; Chusilp & Jin, 2006; Getzels & Csikszentmihalyi, 1976; Stones & Cassidy, 2007).

The novelty/quality relationship

As mentioned in the Introduction, the relationship between novelty and quality could have been either a positive or negative one. We ended up observing a significant positive correlation between the novelty and quality of the final drafts ($r = .78$), in contrast to previous studies emphasizing a trade-off between novelty and quality (Berg, 2014; Mueller, Melwani, & Goncalo, 2012; Steele, Hardy, Day, Watts, & Mumford, 2019). One reason for this may be that the raters used in the present study were highly experienced experts in the field of graphic design. Previous work has shown that experts value novelty over quality (Kozbelt & Serafin, 2009; Serafin, Kozbelt, Seidel, & Dolese, 2011), whereas some of the previously cited studies used lay individuals as judges (Berg, 2014, 2019). In the realm of creative writing, Kaufman et al. (2008) found that expert raters tended to evaluate poems more critically in terms of creativity compared to novices, and that the interrater reliability among non-experts was notably lower. In our study, experts rated novelty and quality as medium to low, aligning with these expectations. Additionally, Kozbelt and Serafin (2009) demonstrated that experts tended to place a higher value on novelty. This may suggest that the present quality ratings may have been influenced by the judges' novelty scores.

The novelty/quality relationship is a complicated one in the study of creativity. On the one hand, there are professionals such as graphic designers whose corporate clients prevent them from unleashing unbridled novelty into their work and who must prioritize high quality over high novelty. On the other hand, there are revolutionary works of art – such as Berlioz's *Symphonie Fantastique*, Stravinsky's *Rite of Spring*, and Picasso's *Les Demoiselles d'Avignon* – that are considered works of the very highest quality in which no tradeoff at all is present between novelty and quality. It thus seems unreasonable to argue that highly creative people are required to sacrifice quality in their most novel works. By contrast, it seems highly reasonable to presume that certain professions are required to sacrifice novelty in their work to appeal to an intended audience.

We also observed a significant positive correlation between initial novelty and final novelty. This is in line with previous work showing that the novelty of a final product appears to be strongly anchored by the novelty of the initial idea – what Berg (2014) calls the "primal mark" – and that prioritizing novelty early in the process is a key prescription for enhancing creativity. Research in other domains, such as creative writing, also emphasizes the importance of early novelty for the achievement of final novelty (Fürst, Ghisletta, & Lubart, 2017). In contrast to this, we did not observe an initial/final relationship for quality, suggesting that quality – unlike novelty – can be successfully infused into the product later in the creative process (Berg, 2014).

Self-ratings vs. expert ratings

One of the most unexpected findings of the study was that the designers' ability to accurately judge their own work – as referenced to the experts' ratings – was only present at the beginning of the work cycle. Sometime beyond this point, the participants lost the ability to objectively assess their own work. Previous literature on this topic has been mixed, with some studies showing that creators can accurately evaluate their own work (Eisenman & Robinson, 1968) and others indicating that they are poor assessors (Berg, 2019; Reiter-Palmon, Robinson-Morral, Kaufman, & Santo, 2012; Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012). One factor that may moderate this relationships is that greater expertise seems to lead to greater alignment with expert judges (Kaufman, Beghetto, & Watson, 2016), and that our participants were still in training. A question that is left unanswered by the present study is the point at which this change occurs. Given that there was a significant shift toward higher self-ratings than expert ratings on Day 7, then what happens when artists work on a piece for months or years, and how can these "rose-colored glasses" be overcome? Does taking a break from the work allow for fresh eyes, or are additional eyes always needed? Further research is needed to address this point.

Limitations

There are several important limitations of this exploratory study. First, the sample size was relatively small, although larger than many other production-based studies of creativity (Botella, Zenasni, & Lubart, 2011; Doak, Jambura, Knittel, & Rule, 2013; Fonseca, Abril-de-Abreu, & Fernandes, 2020; Mace & Ward, 2002; Puppe, Jossberger, & Gruber, 2020). This was driven both by the longitudinal nature of the experiment and by the use of a specialized population of graphic designers. The sample size affected the trajectory analysis, since the number of observations in each of the four cells of our predictive scheme was relatively low. Another factor related to the participant cohort is that all of the designers underwent formal training at the same professional college. As part of their course instruction, they were taught about "design thinking" (Dorst, 2011; Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013) and optimal creative techniques. Design thinking emphasizes early visualization and prototyping, and this may have skewed our designers toward being global planners, although nearly 40% of them did not adopt this strategy. Finally, by using students as our participants, we examined people having an intermediate level of expertise in their domain. The results may have been different if we had examined a professional group of graphic designers.

Another significant limitation of the study was the narrow range of the novelty and quality scores by the expert raters. In addition, the ratings were all at the low end of the scale, spanning only 1–3 on the 5-point Likert scale (see Figure 7). The raters provided rather harsh appraisals of the ads, with no stand-out ads scoring in the 4–5-point region of the scale. The narrowness of the ratings unquestionably diminished our ability to see an impact of our predictors on the novelty ratings, since there was very little variability for these predictors to account for. This problem was amplified by the relatively low inter-rater reliability of the expert ratings, most noticeably for the initial drafts. This situation is in no way unique to the present study on creativity (Ellis et al., 2018; Lubart, 1994). It further highlights the subjective nature of creativity metrics, especially with regard to the predictive nature of early ideas on final novelty (Berg, 2019).

Another consideration relates to the time limit of the task. Participants were constrained to complete their ad in one week, working no more than one hour per day on the ad. While many creators work within the constraints of deadlines, our daily session may have been too short for some of the designers, which is what several of them commented on in the final interview. The time limit may have broken the creative flow that some designers experience (Laing, Apperley, & Masoodian, 2017). In terms of the creative process, the designers may have engaged in less experimentation than they would have in a more unconstrained session, again pushing people toward linear trajectories.

A further limitation relating to the trajectory classification is that, because the change-analysis ratings are based on the amount of change that occurs relative to the preceding day's draft and the initial draft, nonlinear trajectories are almost always going to lead to larger amounts of change than linear trajectories. While it is possible for linear changes to incrementally outpace those in a nonlinear trajectory, this is unlikely to occur in general. This circularity may be an unavoidable confound when assessing the amount of change that a product goes through.

The final limitation to consider is that, since the participants only submitted one draft per day, much of their creative work was invisible to us. All of the intra-session modifications, experimentations, and refinements were absent if the designer did not feel that it added to the product. Since the designers knew that their drafts were being viewed by the experimenters, they may have leaned on the side of submitting a more polished draft at the end of each session. Future studies may employ recordings of the sessions to assess what changes occur within a session.

Conclusions

We carried out one of the first longitudinal experimental studies of the intermediate drafts leading up to the final product of the creative processes. The basic finding of the study was that the group of 37 graphic designers adopted many different strategies for creating their ads and that no single trajectory showed a superior effect on the novelty and quality of the final product. This suggests a general equipotentiality of these strategies and the need to give serious consideration to individual differences. Important methodological features of the study beyond the production of intermediate drafts included the change analysis and the predictive scheme that we developed for analyzing creative trajectories, as based on an elaboration of the Geneplore model's two phases of generation and exploration. These methods can be applied to the study of creativity in all domains. In addition, they can be applied not just to solo creators but to the trajectories of collaborative teams as well. Finally, it should be possible to manipulate trajectory experimentally, for example by providing creators with feedback midway through their process. Positive feedback should support linearity, whereas negative feedback should lead to redirection.

It will be important to know if the equipotentiality seen in the present study is a product of the domain, participant cohort, and/or experimental design, or whether it applies broadly across domains of creativity. In other words, our inability to identify a single "best practice" for carrying out creative work might either be a limitation of the study or instead a reflection of the true nature of creativity that needs to be embraced by creativity researchers.

Notes

1. Creative trajectories for individual works should not be confused with the lifetime professional trajectories of eminent individuals, as analyzed in historiographic studies by researchers such as Simonton (2010) and Kozbelt (2008).
2. The median was used instead of the mean since one participant had completed a graphic design degree in 1992 in another country and was undergoing a secondary program in Canada. It was decided that this participant met eligibility requirements since they were currently enrolled in a graphic design program.

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