RUNNING HEAD: A study of the creative process in visual art

The creative process in visual art: A longitudinal multivariate study

Guillaume Fürst[1, 2], Paolo Ghisletta[1, 2], & Todd Lubart[3]

[1]University of Geneva; [2] Distance Learning University, Switzerland; [3] University of Paris Descartes, France

Correspondence concerning this article should be addressed to Guillaume Fürst, Faculté de Psychologie et des Sciences de l'Education, Boulevard du Pont d'Arve, 40, 1211 Genève 4. E-mail : guillaume.fuerst@unige.ch

Submission date: 05.10.2011

Abstract

The purpose of this research was to study the creative process in real life settings. In a multi-componential perspective of creativity, we first offer a synthetic review of the theories of the creative process based on two main sets of sub-processes (e.g., divergent and convergent thinking, generation and selection of ideas). We then discuss the relations between the creative process and other important variables (mood, personality, and the creative product). We emphasize the importance of modeling the dynamics of the process and to test predictive validity with respect to a final creative product. The data analyzed were collected in four applied art schools (n = 41) in Switzerland, during mandatory workshops. Using latent growth modeling to estimate the trajectories of the sub-processes *Generation* and *Selection*, we found that the former had an overall decreasing pattern through time, whereas the latter had an inverted U-shaped pattern. We also found important individual differences in both sub-processes and related variables, many of which had strong predictive validity. Indeed, using process and personality variables, we were able to account for about 70% of the variance of the evaluation of the final product.

Keywords: creative process, creative product, mood, personality, multi-componential approach of creativity, multivariate analysis, latent growth modeling.

The creative process in visual art: a longitudinal multivariate study

Traditionally, creativity research distinguishes person, process, and product components (e.g., Runco, 2004). The person component refers to personality and motivation, affect (mood and emotion) and cognitive abilities. The process refers to how ideas and specific sub-processes are articulated dynamically in time. To a certain degree, cognition and process are confounded, or at least highly related. But the process is not only limited to the cognitive skills: it also can be described by itself, as a way of proceeding or solving creative problems (in a general way or specifically relating to a given domain). Ultimately, the process leads to the third component, which is the product, the observable creative output.

In this paper we focus mainly on the dynamics of the creative process. Additionally, as the process is strongly connected to the other components, we also consider variables from the person as well as the product (see Figure 1). Because of the components' dependencies, we argue that it is important to use a multivariate approach to better understand how personality, affect and process are interlaced, and their consequences on the creative product.

Insert Figure 1 about here

The creative process

Among the various models of the creative process (for a review, see Lubart, 2000) many are based on the concept of iterations or complementarity between two main sets of sub-processes. We choose to base the present study on this theoretical approach because it does not impose a predefined structure to the process (i.e., it does not require a determined succession of specific sequences). Such theories have a long tradition in psychology, coming for example from evolutionary and psychoanalytic perspectives, both of which fall within a broader view of human functioning and consider creativity as a central aspect for normal development and well being.

More specifically, an evolutionary perspective on the creative process (Campbell, 1960; Simonton, 1999) suggests that creativity (and knowledge acquisition) comes from the interplay between blind variation and selective retention processes. Simply put, blind variation produces novelty through random chance (or search without specific foresight), whereas selective retention sorts, evaluates, and eventually rejects or stocks in memory the ideas coming from blind variation.

Similarly, psychoanalytic theories (Kris, 1952; Suler, 1980) suggest that the core of the creative process is a specific interaction between primary and secondary process. In this tradition, the primary process represents loose, illogical, and even chaotic thinking, whereas the secondary process is conscious, systematic, and represents critical thinking. Hence, the flexible use of both processes is supposed to be the motor of creativity.

A long tradition of cognitive research has also made similar suggestions. For example, Guilford distinguished between divergent thinking (i.e., production of many original, unusual ideas) and convergent thinking (i.e., evaluation and analysis of ideas). Although creativity research has massively focused on divergent thinking, Guilford believed that both convergent and divergent thinking were important for the creative process (Guilford, 1950).

The Creative Process Solving (CPS) approach offers similar propositions. According to Treffinger, Isaksen, & Stead-dorval (2006), the “heart beat” of CPS is composed of two complementary processes: (1) generating many, varied, and unusual options (divergent thinking or ideation); (2) focusing thinking constructively (convergent thinking or evaluation). The CPS approach also suggests that divergent and convergent thinking are required all along the different phases of the creative process (see also for example Basadur, 1995 and Brophy, 1998).

In the field of experimental cognitive psychology, Finke, Ward, & Smith (1992), proposed a model called *Geneplore*, which proposes that the creative process relies on an

alternation of Generative and Exploration phases, the former leading to the construction of preinventives structures (temporary mental construction) whereas the latter is responsible for testing and expanding these preinventives structures. Functioning in cooperation, these two sub processes are constantly searching, exploring and testing information, and progressively expanding knowledge.

Moreover, artificial intelligence and computer programming use algorithms that mimic such processes. For example Partridge & Rowe (2002) have designed and tested "discovery" computer programs that are, for example, able to extract rules during a game. These programs are based on two key algorithmic functions: a so-called *terraced scan* function (see Hofstadter, 1995, for further details), whose role is to explore many possibilities, and an evaluative function that tests specific criteria. When no (or very few) criteria are met, the *terraced scan* function searches widely (in a divergent way), performing only superficial testing. Conversely, as criteria are progressively met, the *terraced scan* reduces search horizon (in a convergent way) and performs deeper criteria testing.

In an important review on cognitive regularities in creative activity, Bink & Marsh (2000) offer a synthesis of such iterative or dialectical views of the creative process, actually largely based on the Geneplore model. They suggest that the creative process is made of dialectical steps between *Generation* (or generative processes) and *Selection* (or selective processes). Generation represents initial, incomplete forms of knowledge, scattered new ideas, or rough syntheses of a few ideas (e.g., remote associations). In order to be adaptive or useful, this raw cognitive material needs to be refined and developed by selection processes. Selection processes are higher level processes whose role is to evaluate ideas or subsets of information coming from generative processes. Ultimately, selection leads, through critic and refinements of ideas, to high quality final products.

In sum, these theoretical frameworks suggest a similar view: the creative process consists of equilibrium between *Generation* (divergent thinking, ideation) and *Selection* (convergent thinking, evaluation). Such a framework makes no strong assumptions about the serial or parallel occurrence of Generation and Selection, hence both are possible. However, Generation and Selection are supposed to work in cooperation through the whole creative process, at possibly different intensities at different moments. It can also reasonably be argued that Generation should be of greater importance, hence most intensely used, at the beginning of the process (when the situation is not well defined and a lot of exploration and wide scanning is needed to generate ideas). In a complementary fashion, Selection might be more intensely used during the second half of the process, which is generally when formalization and refinement of ideas occur the most.

As the pattern of use of Generation and Selection in real creative work has rarely been empirically traced and studied in detail, the principal objective of this study is to shed light on these questions. Additionally, our purpose is also to investigate how mood and personality variables can influence the creative process and, most importantly, which of theses variables are the best predictors of the creative product.

Person variables related to the creative process

The person component encompasses personality and motivation, affect (mood and emotion), as well as cognition. In this study we focus on mood and personality variables; we do not explicitly focus on motivational variables. However, motivational aspects are related to personality variables such as persistence, which are important in Generation and Selection processes.

According to Fürst, Ghisletta, & Lubart (in preparation), the many personality traits related to creativity can be synthesized into three second-order factors. Both Plasticity (high openness, extraversion, inspiration) and preference for Divergence (high non-conformism and

distraction proneness, low agreeability and conscientiousness) are positively related to Generation. Preference for Convergence (high conscientiousness, critical sense, precision, and persistence) positively predict Selection.

Mood variables have also been shown to strongly influence the creative process. Positive mood, in particular activation or energy, is known to enhance divergent thinking (producing a high number of ideas) and more generally Generation-like processes (Baas, De Dreu, & Nijstad, 2008; Isen, Daubman, & Nowicki, 1987; Isen, Johnson, Mertz, & Robinson, 1985; Vosburg, 1998). In contrast, negative affect can also influence creativity, although it is unclear whether it enhances Generation or Selection. According to the "mood as information" theory (Schwarz, 1990; Schwarz & Bless, 1991), negative mood can lead to higher persistence through dissatisfaction and the feeling that "something is wrong" or at least "not good enough". These apparently conflicting results have been recently synthesized in the "dual pathway to creativity model" (DeDreu, Baas, & Nijstad, 2008). This model proposes that both positive and negative mood may enhance Generation; the former acts through higher flexibility, the latter does so through persistence.

In a different perspective, variability in mood (neuroticism, moderate affective instability) has also been shown to be positively associated to creativity (e.g., Frantom & Sherman, 1999; Richards, Kinney, Lunde, Benet, & Merzel, 1988). For example, Mardindale, Vartanian, and colleagues (see for example Vartanian, 2009) suggest that creative people can switch easily between focused attention (relevant for well defined task) and defocused attention (relevant for ill defined, ambiguous tasks, such as early stages or beginning of the creative process).

Predictors the creative product

Both for theoretical and applied reasons, a good model of the creative process should be able to explain why some creative products are better than others. In other words, such a

model should be able to describe the creative process (i.e., commonalities in the sub processes involved and their temporal organisation), but also, and most importantly, to be able to identify what are the process' variables related to a final product of high creative quality.

In this perspective Csikszentmihalyi & Getzels (1971), in a quasi experimental design, demonstrated that the "problem-formulation" stage was of crucial importance for the originality of the creative product. Concretely, the authors found that the more time people spent to explore and manipulate the material given for the task, the better they performed. This result suggests that a high level of Generation (i.e., exploration and active search of ideas) at the beginning of a task is a positive predictor of the final creative product.

Lubart (1994, 2000) has experimentally shown that, for a creative writing task (but not for a drawing task), early evaluation of ideas led to higher creativity. This suggests that the use of Selection processes at the beginning of a creative task may have repercussions on the creative product.

Finally, it is also possible that affect and personality influence (directly or indirectly) the creativity of the product. For example, in real-life organizational settings, Amabile, Barsade, Mueller, & Staw (2005) have shown that there is a positive relationship between self-rated positive mood and peer-rated creativity.

Method

Participants

Participants were students in applied art schools in two French speaking cities of Switzerland (Geneva and Vevey). They were contacted through the schools' teachers and directors. The study procedure was described to the students collectively. The students were then given a choice to participate; most of them accepted (only one refused). A remuneration of 20 CHF (≈20US$) was offered.

The final sample consisted of four different groups, each corresponding to a specific workshop: advanced photographs (2nd year of Master), relatively advanced designers (3rd year of Bachelor) and novice illustrators and decorators (2nd year of Bachelor). Despite of the differences in the students' curricula, the difficulty level of the workshops was comparable (i.e., adapted to the knowledge and expertise of each group). Each workshop was mandatory and part of students' curricula. During these workshops, students were asked to initiate, develop and finish a creative product on the precise theme of their workshop.

We chose to implement our study in such workshops for the following reasons: (a) to maximize the ecological validity of our study, (b) to assess the whole creative process; (c) to obtain an observable final product; (d) to have the same time span for all students within a given workshop; (e) to have similar conditions (instruction, material) for every student within a group.

Measures

We measured the Big 5 personality factors (for an introduction, see for example Pervin & John, 1999). Additionally, we also assessed inspiration, non-conformism, distraction proneness, critical sense, precision, and persistence. All personality items were assessed with three to eight short adjectives or very brief sentences. Participants were asked to evaluate the degree to which they felt that adjectives or sentences described them. Answers were given on a 5-point scale, ranging from 1= "not all" to 5="absolutely". All these personality variables were measured once, at the beginning of the workshop. The construction rational and empirical testing of these scales are described in detail in Fürst et al. (in preparation); we present here only a brief overview. The Big 5 scales were a French adaptation of the best marker in English (e.g., John & Srivastava, 1999; Saucier, 1994). Tested in a first sample of undergraduates (n = 111), the reliability of these scales was satisfactory (mean Cronbach alpha's = .72) and the factor correlation pattern between factors was similar to that of the

classical Big 5 instruments. Recent retesting of these scales in another undergraduate sample (n=254) showed good convergent validity with the NEO-FFI (Costa & McCrae, 1989): the correlations between the analogous factors of the two scales were about .90 (except for Extraversion, which correlated at .75, probably because our scale focuses more on sociability and less on energy than that of the NEO FFI's). For virtually all analyses described in this paper, the Big 5 factors and the additional scales were organized in higher (second) order factor[1] as follow: (1) Plasticity loaded positively on Openness, Extraversion, and inspiration; (2) Divergence loaded negatively on Agreeableness, and Conscientiousness, as well as positively on Non-Conformism, and Distraction Proneness; (3) Convergence loaded positively on Conscientiousness, Critical Sense, Precision, and Persistence.

The sub processes Generation and Selection were repeatedly measured at the end of each significant period of work (day or mid-day). For each dimension, six short sentences were presented. Participants were asked to evaluate the degree to which they felt that each sentence described their recent work, using a 5-point scale, ranging from 1= "not all" to 5="absolutely". For the Generation subscale, items were designed and chosen to focus on idea production, originality, experimentation and exploration; for the Selection subscale, the focus was on evaluation, criticism, verification, and formalization. As for the personality scales mentioned before, this scale was pre-tested twice in an undergraduate sample (n=153 and 111; in the context of everyday creativity). As expected, exploratory and confirmatory factor analyses showed a two-factor structure; weak or ambiguous items (i.e., items with low and/or complex saturations on both factors) were excluded. Appendix I details all original and English translated items, as well as detailed results of confirmatory factor analyses run on the final scale.

[1] Second order factors are factor that loads on other, lower order factors. For example, we estimate first order factor "A", "B" and "C" and define a second order factor that load on these three first order factors.

Additionally, two dimensions of mood (Activation, and Valence or hedonic tone) were repeatedly measured at the end of each significant period of work. These mood variables were assessed with six adjectives per dimension. For example, items such as “full of energy” or “tired” (reversed item) were used to assess activation. This mood questionnaire was developed at the same time and in the same way as the personality questionnaire. The reliability of these two mood factors is high (mean Cronbach alpha’s = .80), they correlated moderately (about .50) and their pattern of correlations with personality factors are in accordance with standard results (e.g., Yik & Russell, 2001): Activation correlated about .60 with Extraversion and -.40 with Neuroticism; and Valence correlated about .50 with extraversion and -.60 with Neuroticism.

Finally, in three groups the creativity of the final product was assessed by the workshop’s teacher. In two groups we were able to implement the use of a standard adjective check list (in the third group, the teacher used her own evaluation grid, which was quite similar to ours). The construction and items selection of this adjective check list was based on already existing evaluation tools in English (Amabile, 1982; Besemer & O’Quin, 1999; Csikszentmihalyi & Getzels, 1971). Originally, this scale was made of six subscales: (1) relevance to task constraint, (2) coherence and harmony, (3) technical quality, (4) originality/novelty, (5) complexity, and (6) dynamism/vividness. When pre-tested in a sample of undergraduate students to evaluate paintings, the subscales correlated moderately to highly (mean r=.52), as in the present data (mean r = .56). Factor analyses suggest the presence of only one factor (i.e., only 1 eigenvalue was greater than 1), accounting for 60% of the variance. Moreover, the item “creative”, added to the original check list, was the one with the highest saturation. Hence, we decided to use only one general composite score for creative product assessment. Appendix II details all original and English translated items, as well as detailed results of factor analysis.

Procedure

In all four groups, a questionnaire was distributed to every participant at the beginning of the workshop. This questionnaire included first personality items, and then repeated sets of process and mood items. The personality items were endorsed only once, at the beginning of the workshop. The process and mood items were endorsed each day or mid-day. Teachers collaborated by allocating a few minutes at each class so students could answer these items.

Insert Table 1 about here

Data structure and definition of time

The four workshops took place at different time periods and had different durations (from one week to eight weeks). To compare the temporality of the creative process across all workshops we scaled all measurements' timing as a function of the overall duration, expressed from 0 (beginning) to 1 (last session). This *time = process* definition assures that despite the heterogeneity in the workshops' timings, the creative process can be analyzed in relative yet comparable terms across the four workshops (Singer & Willett, 2003; Wohlwill, 1970). The obvious underlying assumption of this scaling is that the creative process does not need to evolve over a fixed time span. Rather, the process may evolve at different rates, yet it covers the whole time span of each workshop. For example, for the photography workshop, there were 10 waves of measurement (the workshop lasted 5 days and participants filled the questionnaire twice a day); in the decoration workshop there were 8 waves (once a week for 8 weeks). Using *time = process*, wave 8 corresponds to time=8/8=1, the end of the decoration workshop and time=8/10=.8 for the photography workshop[2].

Analyses

[2] We also tested a more natural scaling of the time process, which consists of respecting the unequal intervals of time between repeated measures. In the photography workshops this means that rather than using a fixed interval of 8/10=.8 we used intervals that respected the actual timing of data collection. The two measures a day were collected approximately at 12 noon and 3pm, which correspond to the 12th and 15th hour of the day. This second scaling hence attributed the values 12/(24*5) and 17/(24*5) to the data of the first day, (12+24)/(24*5) and (17+24)/(24*5) to those of the 2nd day, etc. This second type of scaling was statistically inferior to the first (i.e., model fits were worst), hence we did not use it.

To formally study the dynamics of the process component we used Latent Growth Models (LGM; Meredith & Tisak, 1990), estimated in Mplus 5.2 (Muthén & Muthén, 2007). We used the full-information maximum likelihood estimation algorithm, which allowed us to use all available data, without either imputing or dropping data when incomplete.

LGM can be seen as specifically constrained structural equations models or multilevel models (for further details, see Ghisletta & Lindenberger, 2004). The basic idea of LGM is to postulate a common time-based trajectory for a group (via so-called fixed effects) and to represent individual deviations from the sample trajectory via so-called random effects to allow for individual specific trajectories. Hence, LGM seems to be an appropriate tool for the study of the creative process, as both general trends (fixed effects) and idiosyncrasies (random effects) can be represented.

Here, the first level of analysis was the effect of time on the process variables:

$$Y_{ij} = \beta_{0i} + \beta_{1i}*t_{ij} + \beta_{2i}*t^2_{ij} + e_{ij} \qquad (1)$$

where Y_{ij} is the dependent variable (the score of Generation or Selection of individual *i* at time *j*), β_{0i}, called the Level, is the predicted value of Y at time zero (the first class of the workshop), β_{1i}, called the Linear Slope, represents the linear effect of time t_{ij} on Y_{ij} and β_{2i}, the Quadratic Slope, represents the quadratic effect of time on Y_{ij}. More concretely, the Level (β_{0i}) reflects the mean score of a group at the beginning of the workshop (independently of its possible change across time). The Linear Slope (β_{1i}) represents the mean linear change of the dependant variable across time; it is the general linear change trend for the group. If this parameter is significant, it means that on the average the value of Y changes in time (for example Generation decreases linearly across time). Similarly, the Quadratic Slope (β_{2i}) represents the average quadratic change and allows the estimation of a curvilinear trend (for example a steep acceleration of Selection at the beginning of a workshop).

At the second level of analysis we tested how individual characteristics, such as type of workshop attended, influence the parameters of the level-1 equation (eq. 1). Hence, in the equations below, parameters βs of equation (1) are expressed as a function of which workshop was attended:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}*\text{DECORATORS} + \gamma_{02}*\text{ILLUSTRATORS} + \gamma_{03}*\text{DESIGNERS} + u_{0i} \quad (2)$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}*\text{DECORATORS} + \gamma_{12}*\text{ILLUSTRATORS} + \gamma_{13}*\text{DESIGNERS} + u_{1i} \quad (3)$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21}*\text{DECORATORS} + \gamma_{22}*\text{ILLUSTRATORS} + \gamma_{23}*\text{DESIGNERS} + u_{2i} \quad (4)$$

$\gamma_{\bullet 0}$ represent the value of $\beta_{\bullet i}$ for the group of reference (the photographers). The deviations from these effects for decorators, illustrators, and designers are represented by $\gamma_{\bullet 1}$, $\gamma_{\bullet 2}$, and $\gamma_{\bullet 3}$, respectively. These parameters allow us to estimate a mean level and mean change specifically for each group and to formally compare them to test whether they are different or equal. Last, $u_{\bullet i}$ represents the residual variance across individuals in the parameters of equation (1) after accounting for workshop membership. These parameters represent inter-individual differences among all participants beyond their group membership. For example, if the residual variance of the linear slope (u_{1i}) is large, this indicates that participants differ a lot in their linear slope, meaning that some of them have a steeper change than others, and perhaps even that some deviations are positive whereas other are negative (e.g., some students have an important decrease in Generation, whereas some others do not, or may even experience an increase).

We applied LGMs to all variables assessed repeatedly (Generation, Selection, Activation, and Valence). First, for each group separately, we compared models with the original time basis (i.e., days or mid-days) and models with the *time = process* definition. For linear change functions, small differences in models' fit were found, most often in favor of the *time = process* conceptualization; additionally, most models predicting linear and quadratic change could not be estimated (i.e., did not converge) when using the original time basis. In

addition to the theoretical reasons exposed before, this indicates that statistically the *time* = *process* is a superior approach.

In a second step, we estimated models mixing all participants, but including the group variables explained in equations (2-4), which allowed for specific estimations for each group. For both Generation and Selection we compared three different change functions: linear only, quadratic only, and linear and quadratic. We compared models with likelihood ratio tests based on each model's deviance statistic (which is indicative of the model's statistical adjustment to the data) in relation to the number of parameters estimated. Differences in deviances of increasingly complex models follow a chi-square distribution with as many degrees of freedom as the difference in the number of estimated parameters.

In a third step of analysis, once we assessed the best fitting model of each variable, we computed a Bivariate LGM (BLGM) with Generation and Selection. This allows estimating the covariances of the $\beta_{\bullet i}$ parameters, which indicate the linear relation between the intercepts, the linear, and the quadratic change components of the two processes. These correlations allow answering questions such as, Do those with a high initial level of Generation also have a high initial level of Selection? Do those who change a lot in Generation also change in Selection?

Finally, based on the LGMs, we estimated factorial scores of the Intercept and of the linear and quadratic Slopes. That is, for each participant we estimate his or her initial Generation and Selection score, as well as his or her linear and quadratic change scores. To assess the impact of these process and mood scores on the quality of the final product we ran multiple linear regressions with judgment of the final product as the dependent variable. Besides the Generation and Selection estimated factors and the mood scores we also considered the personality factors to predict the final creative product.

Results

Trajectories of Generation and Selection

Table 2 details results of the BLGM on Generation and Selection. For Level, Linear Slope, and Quadratic Slope there are four lines of parameters. The first line refers to the reference group, the photographers, whereas the remaining lines represent the deviations from the reference group of each of the other groups. Based on the estimates of the fixed effects we graphed the predicted average trajectory of each workshop (Figure 2a and 2b).

Insert Table 2 about here

Insert Figure 2a and 2b about here

For Generation, we can first note that all groups have an overall decreasing trajectory. However, there are some differences. In particular, photographers and designers have no decrease in Generation in the first half of the process, but decrease during the latter half. Conversely, illustrators and decorators to a lesser extent experience a steep decrease during the first half of the workshop. Whereas decorators continue decreasing in Generation until the end, illustrators, however, increase slightly during the last third of the workshop.

For Selection, random effects of both Linear and Quadratic slopes were not significant. This means that according to the model, all individuals tended to have a similar change pattern. However, the students differed with respect to their initial Level of Selection, as shown by the significant variance of the Level of Selection. Quite surprisingly, illustrators and decorators (the two less advanced and younger groups) rated themselves as being more selective than photographers (the oldest students).

With respect to correlations, Levels of Generation and of Selection correlated positively (r = .69). This mean that student with high scores on Generation were also the ones with high scores on Selection. Additionally, Level of Generation correlated negatively with the Linear Slope, which indicates that individuals with the higher initial Level of Generation were the ones that experienced the steeper decrease of Generation during the workshop.

Relations between Process, Personality and Mood

As for the process variables, LGMs were estimated for both mood variables (energy, and valence). Random effects of Levels were significant for both dimensions of mood, which means that there were substantial interindividual differences in the mood states at the beginning of the workshop. Not surprisingly, these Levels correlated highly (r = .85), indicating that people experiencing a mood with positive valence (happiness), were also the ones with a feeling of energy. We did not detect any group difference on these Levels.

The only mood dimension on which participants changed during their workshop was energy, for which a positive linear change (b_1 = 1.28, p = .004) and a negative quadratic change (b_1 = -0.97, p = .029) occurred. Thus, activation/energy increased quite steeply during the first half of the workshop to then reach an upper asymptote and decrease slightly thereafter. Note that the variance parameters of these changes were not significant, suggesting that individual differences in this change pattern were very small.

The relations between mood and process variables were smaller than expected and influenced by one extreme observation (a person with the lowest score on both dimensions of mood at the end of his or her workshop). When including this person in the sample, no significant relation between mood and process was found. Exclusion of this observation revealed a marginally significant positive correlation between Level of Generation and Level of valence of mood (r = .14, p = .059) as well as Level of activation (r = .12, p = .064). These results show that positive mood was slightly related to higher scores of Generation. For Selection, with or without the extreme observation, no significant relation was found.

Last, virtually no relations were found between personality and process. The only exception was a marginal effect of Divergence on the linear slope of Generation (b = 1.44, p = .064), which suggests that people high on Divergence decrease less in Generation than do people low on Divergence.

Predictors of the Final Product

To test the predictive power of personality, process and mood factors on the final creative product we applied a series of multiple linear regressions. We also tested the effect of intraindividual variability (iiv) in Generation and Selection on the final product. We operationalized iiv in Generation and Selection by calculating the standard deviation of the level-1 LGM residuals of each subject (i.e., e_{ij} in equation (1)). This operationalization allows separating the overall trend (individual trajectories) from the deviations from such a trend, so that the iiv indices are not confounded with indices of level in performance. We could not consider the photographers group given that the teacher of that workshop did not provide a final product evaluation.

To consider possible differences in final product rating among the three teachers we also added as predictors, similar to the LGM analyses, variables marking workshop membership. We observed that no across-workshop differences emerged ($F(2,32) = 0.29$; $p = .97$; $R^2=.001$). In the second step we added personality variables, which exerted a strong effect and significantly increased the proportion of explained variance to $R^2=.38$ ($F(3,28) = 5.89$, $p = .003$). The further addition of the random effects in the process variables[3] in the third step resulted in a significant improvement of the model ($F(3,25) = 3.14$, $p = .043$, $R^2 = .56$). Finally, adding the iiv information in the process variables further improved the model ($F(2,23) = 4.96$, $p = .016$, $R^2=.69$, with a 95% confidence interval between .58 and .80). Results of this final model are detailed in Table 3. Adding mood variables in the model did not improve further the prediction of the final creative product.

Insert Table 3 about here

More specifically, Plasticity and Divergence had a surprising negative effect (see below for further investigation), whereas Convergence had the expected positive effect on

[3] The quadratic slope of Generation was not included in this model because of it extreme colinearity with the three other process variables (about 99% of shared variance).

evaluation. As expected as well, the mean level and iiv of Generation were positive predictors of evaluation, which mean that having high and variable score on Generation is favorable fro creativity. Additionally, the linear decrease of Generation had a marginally significant positive effect, which suggests that participants who had a slow decrease of generation succeed more. Finally, the mean level and iiv of Selection were negatively related to the creativity of the final product.

To better understand the unexpected effect of Plasticity and Divergence, we also performed a multiple regression with the original Big 5 factors predicting the final product. This model shows that Extraversion had a negative effect (standardized b= -.44, *p*=.024) whereas Openness had a marginally significant positive effect (standardized b=.31, *p*=.089). Additionally, Conscientiousness also had a marginally significant positive effect (standardized b=.28, *p*=.099).

Additionally, we tested for interactions and found one between Plasticity and ivv of selection (standardized b=.58, *p*=.001), indicating the effect of high ivv of selection was detrimental only for people low on Plasticity; conversely, high ivv of selection had a positive effect on creativity for people high on Plasticity.

Discussion

Process trajectories

First, we have seen that a general, mean change throughout the workshops exist for both Generation (linear decrease) and Selection (inverted U-shaped trajectory). These results show that Generation is particularly important at the beginning or first phases of the process, just as the *terraced scan* function of discovery computer programs must search widely (in a divergent way), when the situation is ill-defined (Hofstadter, 1995; Partridge & Rowe, 2002). Then, as criteria are progressively met and the project becomes better defined, the Generation

processes become less important and deeper analyses of the ideas are performed by Selection processes or convergent thinking.

Additionally, mean level of Generation and Selection were positively correlated, which suggests certain unity of the concept of creative process (people high on Generation are also high on Selection). This correlation between Generation and Selection probably reflects the constant cooperation and interdependence of these two processes. For example, when an idea is found by Generation, it must be tested by Selection and eventually improved, which requires the search and evaluation of ways of improving it. Such a dialectical or iterative relation between Generation and Selection is exactly what is suggested by the Geneplore model (Finke et al., 1992) and the cognitive regularities in creative activity reviewed by Bink & Marsh (2000).

Beyond these very general trends, we found differences between groups, as well as between individuals (for Generation in particular), which show an important diversity in the strategies or patterns associated with the creative process. Specifically, the more advanced groups have no decrease of Generation at the beginning of the process. As this pattern was found in both more advanced groups (designers and photographers), we can hypothesize that it is related to expertise, and not to the discipline of the workshop.

If we try to draw a parallel between these results and sequential models of the creative process (see Lubart, 2000, for a review), we could say that younger students start very quickly with the illumination (idea production) phase and do not come back much to it later, probably spending most of the second half of the process on execution and verification of their work. In contrast, the more advanced students start slower, maybe spending more time on the preparation phase, and then having a more enduring and productive incubation and illumination phases.

Process, mood and personality

Overall, relations between mood and process were modest. However, we did found an increase of positive mood (activation) throughout the workshops, which may be representative of the state of flow described by Csikszentmihalyi (1996); this increase in activation may indeed represent a growing absorption in the creative task and its associated thrill. Additionally, mean level of positive mood was associated with mean level of Generation. This is in line with classical results that show a positive relation between Generation-like processes (such as divergent thinking) and positive mood in general, and activation/energy in particular (e.g., Baas et al., 2008; Isen et al., 1987; Vosburg, 1998).

Last, personality was unexpectedly unrelated to the process. The only exception was a small positive relation between Divergence and the linear slope of Generation, indicating that students high on Divergence decrease more slowly on Generation. This means that these students tended to use Generation all throughout the workshop (instead of using it only massively at the beginning), which may have had positive repercussions on the final product (see next section below). Aside from this exception, Plasticity and Divergence did not predict the mean level of Generation, and Convergence did not predict the mean level of Selection. This is surprising because in previous research (Fürst et al., in preparation; Fürst, Ghisletta, Lubart, & Dufour, 2010) we found quite strong positive relations between these variables. One possible explanation is that situational effects (i.e., specificity of the task/workshop) were very high. Personality may be related to the creative process only in a very general way, in questionnaire based survey, but these relations may be inexistent or inconsistent in real life specific tasks.

Predictors of the creative product

Two sets of variables, personality and process related, predicted about 70% of the variability in evaluation scores for the quality/creativity of the final product, which is substantial.

Personality variables played an important role in this prediction, although some results were unexpected. The negative effect of Divergence and Plasticity was not expected, because such factors are most often positively related to creativity (Eysenck, 1993; Silvia, Nusbaum, Berg, Martin, & O'Connor, 2009). However, results about Plasticity are all relative, as Extraversion had a negative effect on the final product, whereas Openness had a positive effect. These two results are in accordance with past research, which suggests that creative people might be more introvert and open (Feist, 1998; McCrae, 1987). The negative effect of Divergence is more difficult to explain. Technically, this is probably related to the positive effect of Consciousness (which loaded negatively on divergence), but it remains surprising because Consciousness is most often found to be negatively related to creativity (e.g., Feist, 1998). This result is probably due to the context of this study, which took place in applied art schools. In such an educational setting, respect of the workshop's goals and work methods taught throughout are encouraged, whereas non-conformism, disorganization, and independent behaviors are discouraged. Moreover, in virtually all workshops students had to craft, design or paint products; the point of the workshop was not only to generate highly creative ideas, but also to carefully make a refined product. However, we did find that Convergence had a strong positive effect on the quality/creativity of the final product. This positive role of Convergence was expected, as it has already been shown that specific traits such as critical sense, perseverance and precision are important for creativity (e.g., Barron & Harrington, 1981; Fürst et al., in preparation).

Concerning the process, as expected, the mean level of Generation was found to have a positive impact on the product. This result certainly illustrates the importance of exploration and idea production in the creative process (e.g., Csikszentmihalyi & Getzels, 1971). It also appeared that a high level of Generation all along the creative process (or a least a slow, as opposed to a steep, decrease) led to a final product of higher quality. Additionally, the

positive impact of iiv of Generation on the product seems to indicate that, beyond the decrease in Generation found in all groups, it is important to be variable on Generation, alternating between high and low Generation phases during the whole process. This demonstrates that Generation remains important all along the process, as the CPS approach suggests (e.g., Treffinger et al., 2006), for example when a problem is encountered during the development of the project and new ideas need to be found in order to solve it.

Conversely, both the mean level and iiv of Selection had a negative effect on the evaluation of the final product. These results indicate that it is best to have a constant low level of Selection during the creative process, which is in accordance with some theoretical approaches suggesting that Selection is detrimental to creativity (e.g., Osborn, 1953). However, we consider this negative impact of Selection with caution, as a growing literature emphasizes the importance of idea Selection and critical processes for creativity (see for example Runco, 2003). In independent work, we found that this negative effect of Selection was moderated by an interaction with Generation (Fürst et al., in preparation; Fürst et al., 2010). More specifically, this interaction indicated that a high level of Selection was detrimental only for people low on Generation. In these data, we observed an interaction showing that the ivv of Selection was detrimental for people low on Plasticity but beneficial for people high on Plasticity. As Plasticity is highly related to energy and inspiration, we can suppose that a constant low level of selection is preferable for people with low energy and inspiration, because Selection may lead to rejection of ideas that consequently imply inspiration and effort to continue the work. In contrast, a variable level of Selection (including occasionally high or severe Selection) is preferable for people with high energy and inspiration who can cope with a high degree of idea rejection. Conversely, we can also note that being high on Plasticity is pointless without a minimum of Selection.

Limitations and suggestions for future research

In this study, the frequency of measurement (once or twice a day) was not very high; it is possible that a more intensive repeated-measures design would reveal short-term interactions between Generation and Selection (Lubart, 2000). We should also emphasis that the relative generality of patterns observed in the data across the four groups probably depends highly on the very structured time frame the students had to complete their projects. Indeed, we do not claim or imply that the creative process should follow the same pattern during all time frames or in all contexts. Instead, we do believe that less structured or longer creative endeavors might show different patterns (e.g., a succession of more clearly distinct divergent and convergent phases).

Moreover, despite the fact that we have four groups, our sample was quite small. For this reason, we were not able to detect significant variance in the slopes of Selection. A replication of this study in a larger group would lead to more statistical power and may permit detection of significant individual differences in slopes of Selection. In this study, the absence of significant variance in the Slope of Selection did not allow us to test hypotheses about the relation between the creative product and the patterns of Selection across time. For example, an increasing level of Selection might positively impact the final product (not too much Selection at the beginning to avoid premature rejection of ideas, but a high level of Selection at the end to better formalize and complete the product). By extension, it would be interesting to inquire about the relations between slopes of Selection and Generation, to clarify if these processes function simultaneously or alternatively.

Most variables were self reported, and this may not distinguish well interindividual differences in aptitudes for Generation and Selection. Formal testing in a quasi experimental, controlled situation would provide a finer, more objective estimation of these aptitudes. Additionally, it would also probably be important to refine the questionnaire used for the measurement of the process and to design scales that allow for repeated assessments of more

specific sub-processes (e.g., problem construction or category combination) known to have a positive impact on the creative product (Mumford, Supinski, Baughman, Costanza, & Threlfall, 1997).

Last, the final creative product was evaluated by one person only, whereas this correspond to the reality of a workshop, where only the teacher judges the final products, it would be preferable, from a psychometric viewpoint, to obtain final evaluations by a panel of experts.

Conclusion

In this work we showed that it is possible and useful to measure three components of creativity – person, process and product variables – in ecologically valid settings of creative productions. These components are related in a complex way and testing theoretical propositions about such relations requires measuring and modeling such components simultaneously. Excluding any one of them may provide but a partial picture of the overall process. For example, not taking into account personality factors in this study would have lead to poorer results, as this omission would have greatly decreased the prediction of the final creative product.

The dynamic modeling of the components of the creative process (trajectories and iiv) offers important potential for a better understanding of the process. Applying a commonly used statistical model for longitudinal data, we observed both important communalities in the creative process across individuals attending different workshops and manifestations of idiosyncratic behavior during the process. Ultimately, this contribution illustrates a potential new approach to the creative process, which will need to be refined in the future.

References

Amabile, T. M. (1982). Social Psychology of Creativity: A Consensual Assesment Technique. *Journal of Personality and Social Psychology*, *43*(5), 997-1013.

Amabile, T. M., Barsade, S. G., Mueller, J. S., & Staw, B. M. (2005). Affect and Creativity at Work. *Administrative Science Quarterly*, *50*, 367-403.

Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, *134*(6), 779-806. doi:10.1037/a0012815

Barron, F., & Harrington, D. (1981). Creativity, intelligence, and personality. *Annual Review of Psychology*, *32*, 439-476.

Basadur, M. (1995). Optimal Ideation-Evaluation Ratios. *Creativity Research Journal*, *8*(1), 63-75.

Besemer, S. P., & O'Quin, K. (1999). Confirming the Three-Factor Creative Product Analysis Matrix Model in an American Sample. *Creativity Research Journal*, *12*(4), 287-296.

Bink, M. L., & Marsh, R. L. (2000). Cognitive regularities in creative activity. *Review of General Psychology*, *4*(1), 59-78.

Brophy, D. R. (1998). Understanding, measuring, and enhancing collective creative problem solving efforts. *Creativity Research Journal*, *11*(2), 199-230.

Campbell, D. T. (1960). Blind variation and selective retention in creative thought as in other knowledge processes. *Psychological Review*, *67*, 380-400.

Costa, P. T., & McCrae, R. R. (1989). *The NEO-PI/NEO-FFI manual supplement.* (Psychological Assessment Resources.). Odessa, FL.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the Psychology of Discovery and Invention.* New York, NY, US: HarperCollins Publishers.

Csikszentmihalyi, M., & Getzels, J. W. (1971). Discovery-Oriented Behavior and the Originality of Creative Products: A Study with Artists. *Journal of Personality and Social Psychology, 19*(1), 17-52.

DeDreu, C. K. W., Baas, M., & Nijstad, B. A. (2008). Hedonic Tone and Activation Level in the Mood–Creativity Link: Toward a Dual Pathway to Creativity Model. *Journal of Personality and Social Psychology, 94*(5), 739-756. doi:10.1037/0022-3514.94.5.739

Eysenck, H. J. (1993). Creativity and Personality: Suggestions for a Theory. *Psychological Inquiry, 4*, 147-178.

Feist, G. J. (1998). A Meta-Analysis of Personality in Scientific and Artistic Creativity. *Personality and Social Psychology Review, 2*(4), 290-309.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition: Theory, research, and applications*. Cambridge, MA, US: MIT Press.

Frantom, C., & Sherman, M. F. (1999). At What Price Art? Affective Instability Within a Visual Art Population. *Creativity Research Journal, 12*(1), 15-23. doi:10.1207/s15326934crj1201_3

Fürst, G., Ghisletta, P., & Lubart, T. I. (in preparation). Toward an Integrative Model of Creativity & Personality: Theoretical Suggestions and Preliminary Empirical Testing. *In preparation*.

Fürst, G., Ghisletta, P., Lubart, T. I., & Dufour, F. (2010). *Approche multivariée de la créativité: validation de modèles avancés [Multivariate Approach of Creativity: Validation of Advanced Models]*. Poster presented at the XIXth Journées de Psychologie Différentielle, Marseille, August 25-27th.

Ghisletta, P., & Lindenberger, U. (2004). Static and Dynamic Longitudinal Structural Analyses of Cognitive Changes in Old Age. *Gerontology, 50*(1), 12-16. doi:10.1159/000074383

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*, 444-54.

Hofstadter, D. R. (Ed.). (1995). *Fluid Concepts And Creative Analogies: Computer Models Of The Fundamental Mechanisms Of Thought* (1st ed.). Basic Books.

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology, 52*, 1122-1131.

Isen, A. M., Johnson, M. M. S., Mertz, E., & Robinson, G. F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of Personality and Social Psychology, 48*, 1413-1426.

John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. In L. A Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (pp. 102-138). New York, NY, US: Guilford Press.

Kris, E. (1952). *Psychoanalytic Explorations in Art*. New York, NY: International Universities Press.

Lubart, T. I. (1994). *Product-centered self-evaluation and the creativeprocess.* Unpublished doctoral dissertation, Yale University, New Haven, CT.

Lubart, T. I. (2000). Models of the Creative Process: Past, Present and Future. *Creativity Research Journal, 13*(3-4), 295-308.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*(6), 1258-1265.

Mumford, M. D., Supinski, E. P., Baughman, W. A., Costanza, D. P., & Threlfall, K. V. (1997). Process-Based Measures of Creative Problem-Solving Skills: V. Overall Prediction. *Creativity Research Journal, 10*(1), 73-85.

Muthén, L. K., & Muthén, B. O. (2007). *Mplus v.5.2*. Los Angeles, CA: Muthén & Muthén.

Osborn, A. (1953). *Applied Imagination: Principles and Procedures of Creative Problem Solving.* New York, NY, US: Charles Scribner's Sons.

Partridge, D., & Rowe, J. (2002). Creativity: a computational modeling approach. In T. Dartnall (Ed.), *Creativity, cognition, and knowledge: an interaction* (pp. 211-238). Wesport, CT.: Praeger Publishers/Greenwood Publishing Group, Inc.

Pervin, Lawrence A, & John, O. P. (Eds.). (1999). *Handbook of Personality: Theory and Research* (2nd ed.). New York, NY, US: The Guilford Press.

Richards, R., Kinney, D. K., Lunde, I., Benet, M., & Merzel, A. P. (1988). Creativity in manic-depressives, cyclothymes, their normal relatives, and control subjects. *Journal of Abnormal Psychology*, *97*(3), 281-288.

Runco, M. A. (2004). Creativity. *Annual Review of Psychology*, *55*, 657-687.

Runco, M. A. (Ed.). (2003). *Critical creative processes.* Cresskill: Hampton Press, NJ, US.

Saucier, G. (1994). Mini-markers: a brief version of Goldberg's unipolar big-five markers. *Journal of Personality Assessment*, *63*(3), 506-516.

Schwarz, N. (1990). Feelings as information: Information and motivational functions of affective states. In E. T. Higgins & R. M. Sorrentino (Eds.), *Motivation and cognition: Foundations of social behavior (vol. 2)* (pp. 527-561). New York, NY, US: Guilford Press.

Schwarz, N., & Bless, H. (1991). (1991). Happy and mindless, but sad and smart? The impact of affective states on analytic reasoning. In J. P. Forgas (Ed.), *Emotion and social judgment* (pp. 55-71). Elmsford, NY, US: Pergamon Press.

Silvia, P. J., Nusbaum, E. C., Berg, C., Martin, C., & O'Connor, A. (2009). Openness to experience, plasticity, and creativity: Exploring lower-order, high-order, and interactive effects. *Journal of Research in Personality*, *43*(6), 1087-1090. doi:10.1016/j.jrp.2009.04.015

Simonton, D. K. (1999). Creativity as Blind Variation and Selective Retention: Is the Creative Process Darwinian? *Psychological Inquiry*, *10*(4), 309-328.

Singer, J. D., & Willett, J. B. (Eds.). (2003). *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence* (1st ed.). Oxford University Press, USA.

Suler, J. R. (1980). Primary process thinking and creativity. *Psychological Bulletin, 88*(1), 144-165.

Treffinger, D. J., Isaksen, S. G., & Stead-dorval, K. B. (2006). *Creative Problem Solving: An Introduction, Fourth Edition* (4th ed.). Waco, TX.: Prufrock Press.

Vartanian, O. (2009). Variable Attention Facilitates Creative Problem Solving. *Psychology of Aesthetics, Creativity, and the Arts, 3*(1), 57-59. doi:10.1037/a0014781

Vosburg, S. K. (1998). The effect of positive and negative mood on divergent thinking performance. *Creativity Research Journal, 11*(2), 165-172.

Wohlwill, J. F. (1970). The age variable in psychological research. *Psychological Review, 77*(1), 49-64. doi:10.1037/h0028600

Yik, M. S. M., & Russell, J. A. (2001). Predicting the Big Two of Affect from the Big Five of Personality. *Journal of Research in Personality, 35*, 247-277.

Appendix

Appendix 1.

Items and fully standardized model results of confirmatory factor analyses of the Generation (G) and Selection (S) scales.

Original item (English translation)	Loading (G)	Loading (S)
Produire beaucoup d'idées (Have a lot of idea)	.60	
Explorer des possibilités inhabituelles (Explore unusual possibilities)	.52	
Avoir des idées folles, fantaisistes (Have wild ideas)	.56	
Essayer, expérimenter différentes choses (Try, experiment differents things)	.56	
Faire des associations d'idées originales (Make original idea associations)	.71	
Inaugurer, partir sur de nouvelles pistes (Searching, moving in new directions)	.68	
Trier, sélectionner vos idées (Sort, select your ideas)		.44
Critiquer, évaluer votre travail (Criticize, evaluate your work)		.44
Vérifier, corriger des imperfections (Verify, correct imperfections)		.64
Evaluer le potentiel d'une idée (Evaluate the potential of an idea)		.49
Rechercher des améliorations (Search for improvements)		.68
Formaliser une idée (Formalize an idea)		.42

Appendix 2.

Items and fully standardized model results of factor analyses of the product scale.

Original item (English translation)	Loading
Approprié, pertinent (Appropriate, relevant)	.78
Bien pensé (Well designed)	.94
Cohérent (Coherent)	.76
Harmonieux, équilibré (Harmonious, balanced)	.66
Bien réalisé (Well crafted)	.68
Techniquement réussi (Technically good)	.70
Spécial, unique (Special, unique)	.33
Inattendu, surprenant (Unexpected, suprising)	.39
Riche, dense (Rich, dense)	.72
Complexe (Complex)	.74
Vif, dynamique (Vivid, dynamic)	.81
Stimulant, percutant (Stimulating, impacting)	.79
Dans l'ensemble, considérez-vous ce travail comme créatif ? (Overall creativity of the work)	.90

Tables

Table 1.

Description of the four samples.

Sample	Type	n	t	Total duration	Measurement frequency
1	Photographs	6	10	1 week	Twice a day
2	Decorators	10	8	4 weeks	Twice a week
3	Illustrators	16	12	6 weeks	Twice a week
4	Designers	9	10	10 weeks	Once a week

Note. n = sample size; t = number of measurement waves.

Table 2.

Results of latent growth model for Generation and Selection.

		Generation (G)			Selection (S)		
	parm.	est.	s.e.	*p*-val.	est.	s.e.	*p*-val.
Fixed effects							
Level							
intercept/mean	b_{00}	2.66	0.314	<0.001	2.34	0.192	<0.001
decorators	b_{01}	0.71	0.39	0.070	0.483	0.220	0.028
illustrators	b_{02}	0.58	0.36	0.104	0.567	0.201	0.005
designers	b_{03}	0.20	0.42	0.636	0.385	0.225	0.087
Linear Slope							
intercept/mean	b_{10}	0.94	1.48	0.525	2.14	0.42	<0.001
decorators	b_{11}	-2.64	1.87	0.114	@0	@0	@0
illustrators	b_{12}	-4.75	1.71	0.006	@0	@0	@0
designers	b_{13}	0.20	1.90	0.917	@0	@0	@0
Quadratic Slope							
intercept/mean	b_{20}	-1.39	1.33	0.296	-1.96	0.41	<0.001
decorators	b_{21}	2.41	1.70	0.155	@0	@0	@0
illustrators	b_{22}	4.40	1.56	0.005	@0	@0	@0
designers	b_{23}	-0.38	1.72	0.824	@0	@0	@0
Random effects							
Variances							
Level	r_{0i}	0.194	0.117	0.099	0.124	0.040	0.002
Linear slope	r_{1i}	5.08	2.82	0.072	@0	@0	@0
Quadratic slope	r_{2i}	3.64	2.41	0.131	@0	@0	@0
Residual	e_{ij}	0.484	0.043	<0.001	0.495	0.039	<0.001
Correlations							
Gr_{0i}-Gr_{1i}		-0.69	0.18	<0.001			
Gr_{0i}-Gr_{2i}		0.70	0.22	0.001			
Gr_{1i}-Gr_{2i}		-0.92	0.53	<0.001			
Sr_{0i}-Gr_{0i}		0.69	0.27	0.010			
Sr_{0i}-Gr_{1i}		-0.18	0.28	0.528			
Sr_{0i}-Gr_{2i}		0.44	0.31	0.154			

Note. parm. = parameter; est. = estimation; s.e. = standard error of estimation; p-val. = p-value. @0 = parameter fixed at zero (and not estimated).

Table 3.

Results of multiple regression: predictors of the evaluation of the quality/creativity of the final product.

		b	s.e.	p-value	Total R^2
groups' differences					0.001
	decorators	-0.141	0.415	0.738	
	illustrators	0.402	0.374	0.293	
personnality factors					0.36
	Plasticity	-0.418	0.169	0.021	
	Divergence	-0.766	0.202	0.001	
	Convergence	0.383	0.157	0.023	
random effects in the process variables					0.56
	Selection (mean level)	-3.005	0.732	0.000	
	Generation (mean level)	2.870	0.922	0.005	
	Generation (linear slope)	0.182	0.106	0.098	
iiv in the process					0.69
	iiv of Generation	1.650	0.616	0.013	
	iiv of Selection	-1.359	0.574	0.027	

Note. s.e. = standard error; iiv = intraindividual variability. The group of reference for this analysis is the designers' (i.e., the effect of "decorators" and "illustrators" predictors represent the differences between these groups and the designers).

Figures

Figure 1.

Multivariate model of creativity and the creative process: personality, cognition and affect are closely related to the process, which in turn predict the final product; additional relations may also exists, for example if personality is directly related to the product.

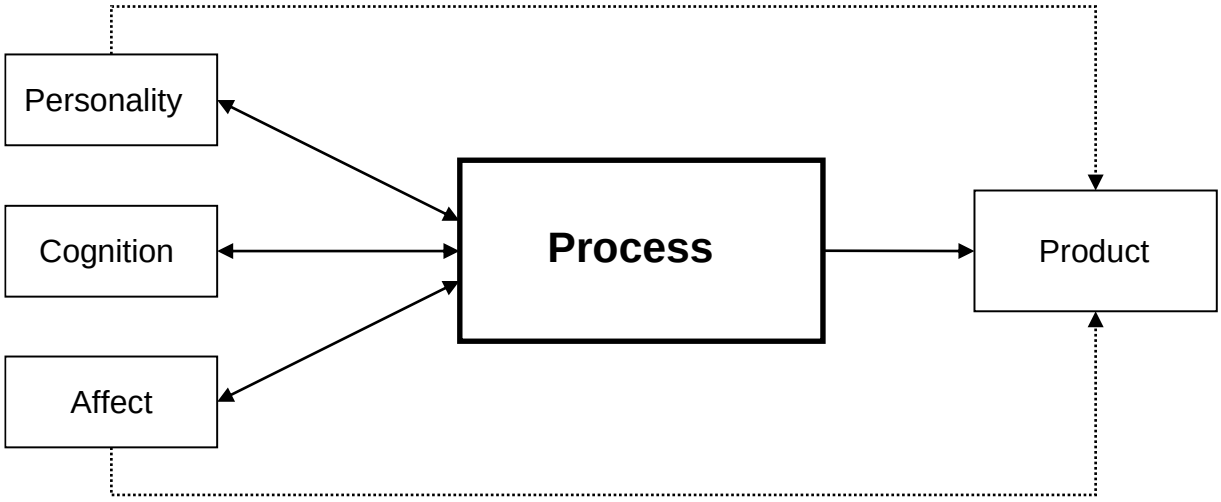

Figure 2a.

Trajectories of Generation in the 4 groups (thick black lines are the estimated change using LGM; thin grey lines are raw individual scores; dotted black lines are mean raw score at each measurement point).

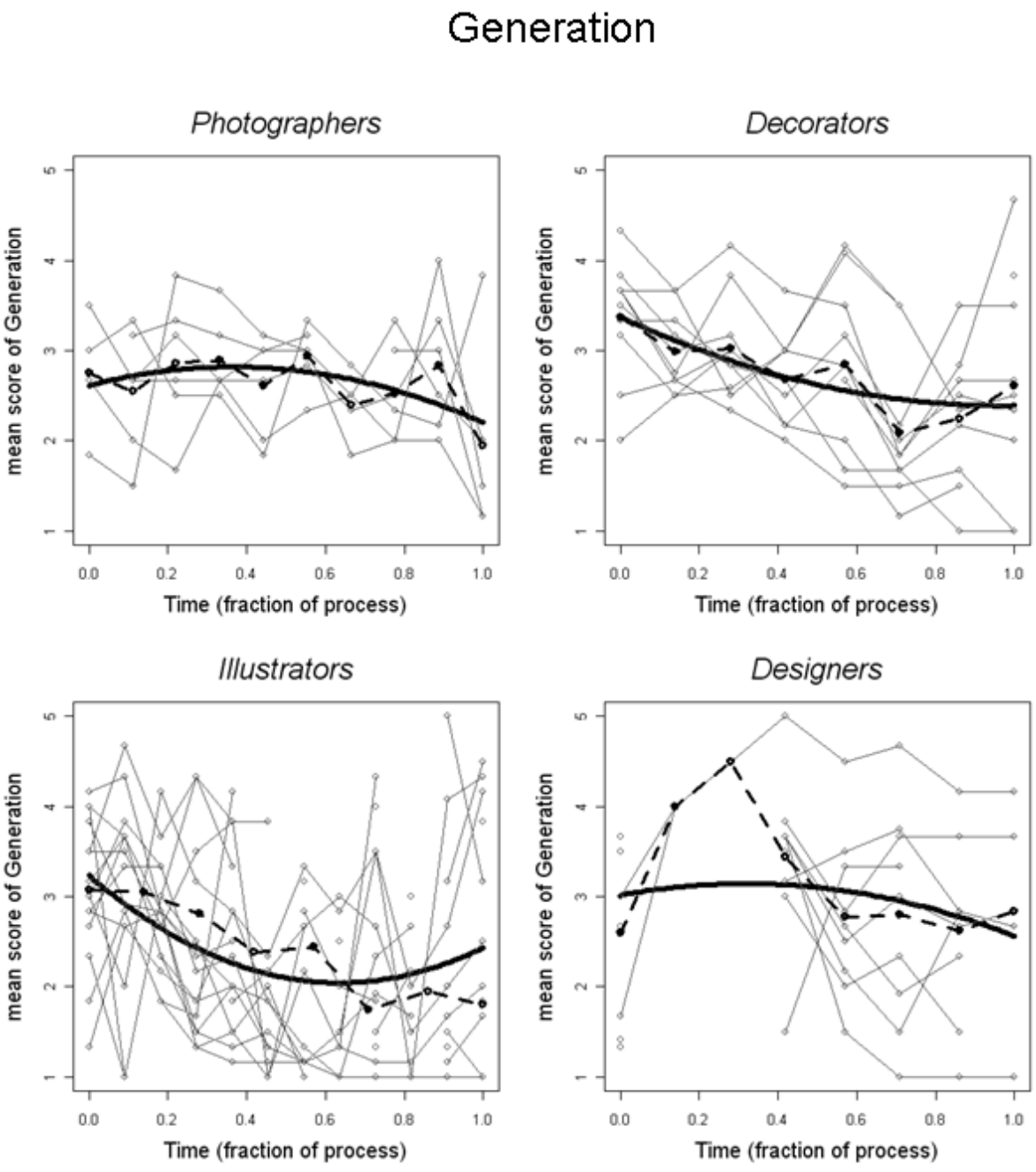

Figure 2b.

Trajectories of Selection in the 4 groups (thick black lines are the estimated change using LGM; thin grey lines are raw individual scores; dotted black lines are mean raw score at each measurement point).