

# Research Paper: The Role of Intelligence Profiles and Executive Functions (Selective Attention and Switching) in Predicting Creativity Components

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## ABSTRACT

**Introduction:** In recent decades, researchers in the field of creativity, have become interested in recognizing the factors associated with the growth and development of creativity in children. Therefore, the purpose of this descriptive, correlational study is to detect the role of intelligence profiles and executive functions (selective attention, switching) in predicting creativity components.

**Materials and Methods:** The statistical population included kids aged 13-15 years living in Isfahan City, Iran in 2015, and so 150 kids were selected by purposive sampling method. The study data were collected using the Delis-Kaplan Executive Function System (D-KEFS) CW simple Stroop test, Gardner's multiple intelligence questionnaire, and Torrance's creativity questionnaire, and analyzed by simultaneous multiple regression analysis and the Pearson correlation method in SPSS V. 22.

**Results:** There were significant positive relationships between intrapersonal intelligence and fluency component, as well as, between logical-mathematical intelligence and flexibility component. The results also showed a significant positive relationship between bodily-kinesesthetic intelligence and naturalist intelligence with the originality component. There were positive and significant relationships between logical-mathematical, bodily-kinesesthetic, intrapersonal, and naturalist intelligence with the elaboration component, as well as, between the selective attention and the fluency component.

**Conclusion:** The characteristics of intelligence and selective attention can predict the components of creativity

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## 1. Introduction

The main concerns of educational system policies of the present age are high-speed globalization, deep impacts of information technologies, increasing demands for social changes, international competitions, and preparation of future generations for facing these challenges [1]. One approach for preparing the future generation is emphasizing creativity and multiple intelligence nurturing which are considered as key elements for children's personal and professional achievements [2-4]. Creativity is a way to produce knowledge and know the world [1].

Despite its operational importance, the multi-dimensional nature of creativity makes it difficult to define and measure. According to Torrance's definition, creativity is sensing problems, issues, informational gaps, lost elements, odd things, then guessing and hypothesizing about these defects, next evaluating and testing these guesses and hypotheses, reconsidering, re-testing, and finally transferring the gained results [2]. Camp stated that creativity develops at the age of (about) 12 and decreases at 15 [3]. Therefore, creativity depends on different factors [4], and a phenomenon with metacognitive dimensions relating to the high-level mental processes [5].

Recent research studies define creativity as executive functions based on overlapping management [6]. In this regard, Gilhooly, Fiorato, Anthony, and Wynn (2007) commented that ingenious and unconventional production and use of one object needs the management of different overlapping resources [7]. Most of the creativity theories highlight flexibility, avoiding regular methods, and the ability to consider and combine unrelated concepts [8].

Hence, creativity may be more related to executive functions such as selective/inhibitory attention, cognitive flexibility, and different states of cognitive control [9]. Rudimentary concept of creativity points out that the absence of cognitive and behavioral inhibition identifies creative people. This concept may be simply due to the abilities of creative people in producing and combining ideas [10].

In this regard, thoughts of creative people are considered to be overinclusive in which ignoring unrelated information is reduced, whereas the results of research studies indicate the opposite. Creative people show advantages in low-level and high-level executive functions which signify an increase in selective attention, shorter reaction times in doing cognitive tasks with few over-

lapping, and longer reaction time in cognitive tasks with more overlapping [11].

Higher scores in creativity evaluation tests usually result from better performances in tasks related to executive functions such as the Stroop test [5]. Executive functions include the ability to adjust, control, and manage cognitive processes such as attention, inhibition, problem-solving, and switching [12]. Switching is allocating attention to a particular task in a context in which there are two potential tasks [13], and selective attention is the ability to process the related information and ignore the unrelated ones. Some believe that extensive and unfocused attention results in creativity [14]. Friedman et al. (2003) did several research studies and found that a wide or limited range of perceptual attention is followed by improvement or weakness of creativity [15]. Vartanian stated that most researchers define creativity as the ability to create a relationship between unrelated concepts, and the combination of two or more concepts requires attention to those concepts; therefore, the created differences at the center of attention can directly affect the ability to combine these concepts [16].

Increased selective attention can result in creative problem-solving when solving a problem requires applying the attention process to limit many possible options to a single solution; therefore, increased selective attention may enhance creativity [2]. In this regard, researchers studied the relationship between creativity, selective attention, and switching [5]. The findings of Gilhooly et al. (2007) displayed the ability of creative people in switching strategies which are of high-level executive functions [7].

In their study, Benedek, Jauk, Sommer, Arendasy, and Neubauer (2014) demonstrated that creativity and selective attention are correlated [8]. Results of the studies by Groborz and Ecka (2003) revealed a relationship between cognitive control and the components of original creativity [17], selective attention and intelligence are correlated [2]. Different executive functions have different relationships with intelligence. Three executive functions (dominant reply inhibition/selective attention, updating representations of working memory, and switching between mental collections) are considered to have a little relationship with intelligence. In addition to its relationship with executive functions, intelligence has a relationship with creativity [2].

Gardner considered creativity as having the most impact on a human's mind in the realm of eight kinds of intelligence. He defines intelligence as the ability to solve

problems and produce things that are valuable in one or more cultures and stated that there are nine different and somehow independent kinds of intelligence [18]. Saville (2006) believed that creativity is a state of mind in which multiple intelligences perform unitedly and integrally. He stated that in this condition, creativity brings about states of super-ability in human that results in efficient focus for innovation and creation of innovative objects. Gardner believed that creativity is made up of some elements of intelligence, emphasizing on fluency, flexibility, originality, and elaboration, and refers to the degree of the productive thought of a human [6]. Carroll (1993) believed that creativity partially needs mental abilities [19].

According to the threshold theory, there is a constructive relationship between creativity and intelligence. Intelligence is a pre-requisite (but not sufficient element) for creativity [4, 8], i.e., a certain amount of intelligence is needed for creativity to emerge [4]. Studies based on the relationship between creativity and intelligence indicate a correlation between these two components. The results of the study of Bateya, Furnham, and Safiullina (2010) indicated a significant relationship between intelligence and creativity [20]. Also, the findings of the study by Furnham and Bachtiar (2008) demonstrated that intelligence does not predict creativity. Nusbaum and Silvia (2011) displayed the relationship of intelligence and creativity by the mediation of switching [6]. Still, the basic research about the relationship between creativity and intelligence has only found a moderate correlation [21].

Considering the mentioned information, the present study attempts to find a scientific answer to the basic question of whether or not the intelligence profile and executive functions (selective attention and switching) can predict the components of creativity.

## 2. Materials and Methods

This descriptive, correlational study has a cross-sectional design. The statistical population includes all the 13 to 15 years students in the advanced level of English language learning classrooms in language institutes in Isfahan City in 2015. Given that the study population was unknown, according to the nature of the study, the number of the samples was decided to be 150, and considering the probable dropout, 170 students were selected purposefully from the third district of Isfahan City. From the collected data, 20 subjects were excluded, because their questionnaires were incomplete and incapable of scoring, and finally, the study data were collected from 150 students (94 boys and 56 girls). The inclusion criteria were as follows: healthy students without any present

or past mental or neurologic disorder records, without any head injuries (decided by an interview with their parents), right-handed, and aged 13-15 years in 2015. The Mean $\pm$ SD of age of the subjects was 13.83 $\pm$ 1.02 years. All participants were informed of the study objectives, the questions, and their possibility to withdraw at any time they would like. In cases where the subjects were unable to understand the concepts, the researcher clarified it with more information. Finally, all data were collected during one month. The questionnaires about demographic characteristics, Gardner's multiple intelligence, simple Stroop test of D-KEFS, and Torrance's creativity measurement were used in this research.

### Demographic Information Questionnaire

Questions about age, parents' education, family's income, any record of present or past mental and/or neurologic disorder, and head injuries were asked from the participants.

### Gardner's Multiple Intelligence Questionnaire

Gardner's multiple intelligence questionnaire comprises 80 questions to measure each of the eight aspects of intelligence. Based on the Likert scale, each question has five options of very little: 1, little: 2, average: 3, much: 4, and very much: 5 in eight sections and ten questions in every section. This questionnaire is a self-report questionnaire.

Sharifi (2005) evaluated the reliability and internal consistency of each one of the eight scales and reported its Cronbach alpha as follows: linguistic-verbal intelligence: 0.7603; mathematical-logical intelligence: 0.7186; special-visual intelligence: 0.7458; bodily-kinesesthetic intelligence: 0.6396; musical intelligence: 0.7666; interpersonal intelligence: 0.6054; intrapersonal intelligence: 0.7058; and naturalist intelligence: 0.8488. To measure the validity of the questionnaire, Sharifi calculated the factor analysis by Varimax rotation and the results showed that the eight sections of the questionnaire explained 63.804% of the total variance [22].

In the present study, the internal consistency of items in all of the questionnaire was 0.90 (using the Cronbach alpha) and for the eight components of intelligence were the following: linguistic-verbal intelligence: 0.60; mathematical-logical intelligence: 0.75; special-visual intelligence: 0.68; bodily-kinesesthetic intelligence: 0.62; interpersonal intelligence: 0.63; intrapersonal intelligence: 0.63; musical intelligence: 0.70; and naturalist intelligence: 0.71.

### D-KEFS CW Simple Stroop Test

Stroop test was first designed and used by Ridley Stroop in 1935 to evaluate selective attention and cognitive flexibility and investigate different cognitive abilities. In this study, the computerized Farsi version of D-KEFS CW simple Stroop test from Ghawami, Raghobi, and Daryadar's research (2013) was used [23]. This test includes four stages. In the first stage, the subjects are asked to determine the colored square that is shown randomly in one of the four colors of red, blue, yellow, and green on the computer screen using one of the letters on the keyboard that are allocated for each square. The second stage is to read the words. In this stage, the subjects are asked to determine the color shown on the computer screen using one of the letters allocated for each color.

The third stage is the performance which is an inhibition test. In this stage, 50 colored, congruent, and incongruent words are shown randomly and consecutively (the congruent word is a word that its color is congruent with its meaning, e.g., the word blue is blue, incongruent is a word the color of which is not congruent with its meaning; e.g., the word blue is red.). The subjects should consider the color of the word without any attention to its meaning. The fourth stage is switching/inhibition in which the subjects should consider the meaning of the word when it is in a square, and consider the color of the word and ignore its meaning when it is not in a square. In the present study, the subjects' reaction times were recorded. This tool has proper stability and validity [24]. In the guide book of the test, its stability coefficient was reported between 0.84 and 0.98. Ghawami et al. (2013) used the computerized and Farsi version of this test and reported that its validity and stability are proper (the Cronbach's alpha: 0.95) [23].

### Torrance's Creativity Measurement Questionnaire

This questionnaire was designed by Torrance in 1974 [25]. It is a self-report tool and evaluates four subscales of fluency (representing many solutions for one problem), elaboration (planning and organizing), originality (representing new, uncommon, and different solutions), and flexibility (getting away from old thinking methods and sticking to new thinking methods). It has 60 multiple-choice items with three options. Each option determines low, medium, and high creativity levels. Zero score is given to low creativity level, one to medium creativity level, and two to high creativity level. The gross scores in each dimension show the lowest and the highest scores anyone can get in this test (of course everyone should answer all the questions). There are 15 items in the flexibili-

ty section, 15 items in the elaboration section, 15 items in the fluency section, and 15 items in the creativity section.

Abedi (1982) calculated the reliability coefficient of fluency, originality, flexibility, and elaboration sections using the retesting method. They were 0.85, 0.82, 0.84, and 0.80 respectively [26]. In another research done in Spain, the reliability coefficient of this test was calculated using the internal consistency of the Cronbach alpha, and the results were 0.75 for fluency, 0.76 for originality, 0.61 for flexibility, and 0.61 for elaboration. Abedi reported that the correlation coefficient of the scores of the first test with the final score of Torrance's creativity in the sample of 650 students of Tehran was 0.46 [27]. Its validity was investigated in some research in different countries such as Spain, using new methods of confirmatory factor analysis. In the present study, the internal consistency for all the questionnaires was gained 0.901 using the Cronbach alpha and for the four sections as 0.676 for fluency, 0.723 for flexibility, 0.744 for originality, and 0.69 for elaboration.

The descriptive statistical method, simultaneous multiple regression method, and the Pearson correlation method were used to analyze the relationship between intelligence profiles and executive functions. SPSS v. 22 software was used for data analysis. The confidence intervals were set at 95%. The results were considered significant at  $P < 0.05$ .

### 3. Results

The results of the subjects' demographic indicators, including age, gender, and parental education, can be seen in Table 1. The mean and standard deviation of selective attention, switching, and eight components of intelligence are presented for each sex in Table 2. Among the intelligence components, the highest mean was bodily-kinesthetic intelligence for boys (37.07) and interpersonal intelligence for girls (38.33), and the mean values of reaction time in selective attention test were 1079.66 and 1101.13 for boys and girls, respectively. The mean of reaction time in switching test were 635.76 and 1898.45 for boys and girls, respectively. The Pearson correlation coefficient was used to evaluate the relationship between selective attention, switching, intelligence profile, and creativity (Table 3).

As is seen in Table 3, the mathematical-logical intelligence, naturalist intelligence, intrapersonal intelligence, and linguistic intelligence have positive correlations with fluency, flexibility, originality, and elaboration components ( $P < 0.01$ ). Special-visual intelligence has a

**Table 1.** The demographic characteristics of the subjects

| Variables          |                      | No. (%)   |
|--------------------|----------------------|-----------|
| Sex                | Female               | 52 (7.34) |
|                    | Male                 | 98 (3.65) |
| Father's education | High school          | 21 (14)   |
|                    | High school graduate | 50 (33.3) |
|                    | Associate degree     | 14 (9.3)  |
|                    | Bachelor degree      | 41 (27.3) |
|                    | Graduate degree      | 17 (11.3) |
| Mother's education | PhD.                 | 7 (7.4)   |
|                    | High school          | 25 (16.7) |
|                    | High school graduate | 52 (34.7) |
|                    | Associate degree     | 8 (5.3)   |
|                    | Bachelor degree      | 43 (28.7) |
|                    | Graduate degree      | 19 (12.7) |
|                    | PhD.                 | 3 (2)     |

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positive correlation with fluency, flexibility, originality, and elaboration components ( $P < 0.01$ ). Bodily-kinesthetic intelligence, musical intelligence, and interpersonal intelligence have positive correlations with flexibility, originality, and elaboration components ( $P < 0.01$ ). Selective attention has negative correlation with fluency and flexibility components ( $P < 0.01$ ) and switching has negative correlation with fluency ( $P < 0.01$ ), flexibility, originality, and elaboration components ( $P < 0.01$ ).

We used multiple regression test to evaluate the predictability power of intelligence profile and executive functions (selective attention and switching) in subscales of creativity. Subscales of creativity as the criteria variable (separately), and different kinds of intelligence, selective attention, and switching as the predictor variables were entered into the regression equation. The results of the regression analysis of fluency subscales based on intelligence profile, selective attention, and switching are presented in [Table 4](#).

As is seen in [Table 4](#), the values of beta related to intrapersonal intelligence variables ( $P < 0.05$ ) and selective attention are significant ( $P < 0.001$ ) and the beta values of other variables are not. The share of selective attention is negative and that of the intrapersonal variable is positive. Also, the coefficient of the intrapersonal intel-

ligence variable is higher than the coefficient of selective attention. According to the value of  $R^2$ , the intelligence profile and executive functions (selective attention and switching) predict 27% of the fluency component of creativity. The results of the regression of the flexibility component based on the intelligence profile, selective attention, and switching are presented in [Table 5](#).

As is seen in [Table 5](#), the variable of mathematical-logical intelligence is a significant predictor of the flexibility component of creativity ( $P < 0.05$ ). Also, the coefficient of mathematical-logical intelligence is higher than other coefficients; therefore, it has a greater role in predicting flexibility. Based on the value of  $R^2$ , the intelligence profile, selective attention, and switching predict 41% of the variances of flexibility component.

The results of the regression analysis of originality component based on intelligence profile, selective attention, and switching are presented in [Table 6](#). As is seen in [Table 6](#), the values of beta related to bodily-kinesthetic and naturalist intelligence variables are significant ( $P < 0.001$ ) and the beta values of other variables are not. The share of these variables is positive. Also, the naturalist intelligence coefficient is higher than that of bodily-kinesthetic intelligence. Therefore, it has a greater role in predicting the originality component of creativity. According

**Table 2.** The Mean±SD of selective attention, switching, eight components of intelligence and components of creativity

| Variables                             |        | Mean±SD        | Skewness | Kurtosis | Max     | Min    |
|---------------------------------------|--------|----------------|----------|----------|---------|--------|
| Age (y)                               |        | 13.85±0.99     | -0.43    | -0.88    | 15      | 12     |
| Mathematical-logical intelligence     | Male   | 33.24±8.66     | -0.47    | 0.27     | 48      | 15     |
|                                       | Female | 35.71±8.78     | -0.68    | -0.15    | 48      | 15     |
|                                       | Total  | 34.10±8.75     | -0.39    | -.043    | 48      | 15     |
| Special-visual intelligence           | Male   | 35.38±5.75     | 0.02     | 0.08     | 49      | 20     |
|                                       | Female | 35.96±7.19     | -0.14    | -0.21    | 49      | 20     |
|                                       | Total  | 35.58±6.27     | -0.02    | -0.01    | 49      | 20     |
| Bodily-kinesthetic intelligence       | Male   | 37.07±5.50     | 0.32     | -0.60    | 48      | 25     |
|                                       | Female | 37.15±5.80     | -0.44    | -0.44    | 47      | 25     |
|                                       | Total  | 36.89±5.59     | 0.03     | -0.61    | 48      | 25     |
| Interpersonal intelligence            | Male   | 34.97±6.51     | 0.31     | -0.13    | 50      | 23     |
|                                       | Female | 38.33±7.50     | -0.02    | -0.66    | 50      | 25     |
|                                       | Total  | 35.90±6.96     | 0.23     | -0.42    | 50      | 23     |
| Intrapersonal intelligence            | Male   | 34.96±6.75     | -0.02    | 0.32     | 50      | 16     |
|                                       | Female | 34.38±9.61     | -0.42    | -0.41    | 50      | 16     |
|                                       | Total  | 34.76±7.83     | -0.30    | 0.18     | 50      | 16     |
| Musical intelligence                  | Male   | 33.12±9.17     | 0.11     | -0.84    | 50      | 17     |
|                                       | Female | 36.21±9.18     | -0.37    | -0.47    | 50      | 17     |
|                                       | Total  | 34.19±9.26     | -0.04    | -0.84    | 50      | 17     |
| Naturalist intelligence               | Male   | 32.27±7.01     | 0.24     | -0.49    | 47      | 19     |
|                                       | Female | 35.23±7.29     | 0.02     | -0.14    | 50      | 21     |
|                                       | Total  | 33.29±7.22     | 0.18     | 0.19     | 50      | 19     |
| Linguistic intelligence               | Male   | 29.61±8.26     | 0.07     | -0.37    | 46      | 14     |
|                                       | Female | 32.02±10.01    | -0.52    | -0.61    | 46      | 14     |
|                                       | Total  | 30.45±8.95     | -0.13    | -0.60    | 46      | 14     |
| Reaction time for selective attention | Male   | 1079.66±338.29 | 0.73     | -0.23    | 1747.68 | 565.59 |
|                                       | Female | 1101.13±359.67 | 0.27     | -1.20    | 1747.68 | 565.9  |
|                                       | Total  | 1066.81±349.50 | 0.55     | -0.70    | 1747.68 | 565.59 |
| Reaction time for switching           | Male   | 635.76±638.02  | -0.33    | -0.39    | 3128.6  | 443.64 |
|                                       | Female | 1898.45±652.31 | -0.56    | 0.29     | 3008.72 | 443.64 |
|                                       | Total  | 1855.42±642.81 | 0.40     | 0.26     | 3128.60 | 443.64 |
| Fluency                               | Male   | 19.04±4.92     | -0.67    | 0.34     | 30      | 7      |
|                                       | Female | 18.38±5.89     | -0.40    | -0.55    | 29      | 7      |
|                                       | Total  | 18.81±5.26     | -0.57    | -0.06    | 30      | 7      |
| Flexibility                           | Male   | 19.49±5.18     | -0.64    | 0.68     | 30      | 6      |
|                                       | Female | 19.21±6.24     | -0.45    | -0.26    | 30      | 6      |
|                                       | Total  | 19.39±5.55     | -0.56    | 0.24     | 30      | 6      |
| Originality                           | Male   | 17.72±5.36     | 0.01     | -0.82    | 29      | 7      |
|                                       | Female | 17.52±5.33     | 0        | -0.67    | 29      | 7      |
|                                       | Total  | 17.65±5.34     | 0.01     | -0.78    | 29      | 7      |

| Variables   |        | Mean±SD     | Skewness | Kurtosis | Max | Min |
|-------------|--------|-------------|----------|----------|-----|-----|
| Elaboration | Male   | 20.28±4.04  | -0.47    | 0.27     | 30  | 11  |
|             | Female | 20.31±5.22  | -0.17    | -0.79    | 30  | 11  |
|             | Total  | 20.29±4.47  | -0.31    | -0.20    | 30  | 11  |
| Creativity  | Male   | 76.56±15.31 | -0.22    | 0.25     | 110 | 37  |
|             | Female | 75.42±18.92 | -0.22    | -0.73    | 112 | 41  |
|             | Total  |             |          |          |     |     |

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to gained R2 intelligence profile, selective attention and switching predict (in sum) 46% of the variance of originality variable. Table 7 presents the results of the regression analysis of the elaboration component based on the intelligence profile, selective attention, and switching.

According to beta coefficients in Table 7, among the predictor variables, mathematical-logical intelligence, bodily-kinesthetic intelligence, intrapersonal intelligence, and naturalist intelligence can significantly predict the elaboration component (P<0.05). Shares of these variables are positive, and also the naturalist intelligence coefficient is higher than the bodily-kinesthetic intelligence coefficient; therefore, it has a greater role in predicting the innovation component of creativity. According to the obtained R2, intelligence profile, selective attention, and switching predict (in sum) 46% of the variance of the elaboration component.

According to the beta coefficients in Table 8, among the predictor variables, logical-mathematical intelligence (P<0.05), body-kinetic intelligence (P<0.01), intrapersonal intelligence (P<0.001), and switching (P<0.05), significantly predict the overall score of creativity. The share of logical-mathematical intelligence, physical-kinetic intelligence, intrapersonal intelligence is positive, and the share of reaction time in the switching test in predicting the overall score of creativity is negative. Therefore, it plays the most important role in predicting creativity. Based on the obtained R2, IQ, predictive attention, and switching predict a total of 55% of the creativity variance.

#### 4. Discussion

The present study aimed to analyze the role of intelligence profile and executive functions (selective attention

Table 3. Intelligence profile, selective attention, and switching correlations with creativity subscales

| Variables                         | Fluency | Flexibility | Originality | Elaboration | Creativity |
|-----------------------------------|---------|-------------|-------------|-------------|------------|
| Mathematical-logical intelligence | 0.34*   | 0.53*       | 0.41*       | 0.51*       | 0.55*      |
| Special-visual intelligence       | 0.21*   | 0.32*       | 0.45*       | 0.43*       | 0.45*      |
| Bodily-kinesthetic intelligence   | 0.07    | 0.22*       | 0.42*       | 0.32*       | 0.28*      |
| Interpersonal intelligence        | 0.14    | 0.35*       | 0.37*       | 0.39*       | 0.42*      |
| Intrapersonal intelligence        | 0.38*   | 0.44*       | 0.42*       | 0.50*       | 0.55*      |
| Musical intelligence              | 0.08    | 0.35*       | 0.33*       | 0.30*       | 0.36*      |
| Naturalist intelligence           | 0.22*   | 0.50*       | 0.53*       | 0.51*       | 0.52*      |
| Linguistic intelligence           | 0.28*   | 0.39*       | 0.32*       | 0.39*       | 0.46*      |
| Reaction time Selective attention | -0.29*  | -0.23*      | -0.08       | -0.09       | -0.26*     |
| Reaction time Switching           | -0.15** | -0.28*      | -0.25*      | -0.27*      | 0.36*      |

P<0.01 \*; P<0.05 \*\*

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**Table 4.** The results of multiple regression of fluency component based on intelligence profile, selective attention, and switching

| Model                                 | B      | Standard Error | Beta  | t    | Sig.  | R    | R <sup>2</sup> |
|---------------------------------------|--------|----------------|-------|------|-------|------|----------------|
| Model 1                               |        |                |       |      |       | 0.52 | 0.27           |
| Mathematical-logical intelligence     | 0.09   | 0.06           | 0.13  | 1.42 | 0.15  |      |                |
| Special-visual intelligence           | 0.10   | 0.08           | 0.12  | 1.30 | 0.19  |      |                |
| Bodily-kinesthetic intelligence       | -0.01  | 0.08           | -0.01 | 0.19 | 0.84  |      |                |
| Interpersonal intelligence            | -0.03  | 0.07           | -0.04 | 0.53 | 0.59  |      |                |
| Intrapersonal intelligence            | 0.22   | 0.07           | 0.31  | 3.11 | 0.002 |      |                |
| Musical intelligence                  | -0.07  | 0.07           | -0.12 | 1.08 | 0.28  |      |                |
| Naturalist intelligence               | -0.01  | 0.10           | -0.02 | 0.18 | 0.85  |      |                |
| Linguistic intelligence               | 0.06   | 0.06           | 0.09  | 0.95 | 0.34  |      |                |
| Reaction time for selective attention | -0.004 | 0.001          | -0.28 | 3.51 | 0.001 |      |                |
| Reaction time for switching           | 0.001  | 0.001          | 0.05  | 0.70 | 0.48  |      |                |

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and switching) in predicting creativity components. For this purpose, multiple regression analysis of intelligence profile, selective attention, and switching in relation to the creativity components was performed and the results were given in this section.

According to study results, there were significant positive relationships between intrapersonal intelligence and fluency component, as well as, between the logical-mathematical intelligence and flexibility component. The results also showed a significant positive relationship between bodily-kinesthetic intelligence and naturalist intelligence with the originality component. The results also showed positive and significant relationships between logical-mathematical, bodily-kinesthetic, intrapersonal, and naturalist intelligence with elaboration component, as well as, between the selective attention and the fluency component and the total score of creativity. The logical-mathematical intelligence, body-kinetic intelligence, intrapersonal intelligence, and switching positively predict the overall score of creativity.

The results of this study agree with the findings of Ghodrati, Afrooz, Sharifi Daramadi, and Hooman (2001) studies [3] and are also similar to the results of the studies of Batey et al. (2010) and Nusbaum and Silvia (2011) which indicated a significant relationship between intelligence and creativity [6, 20]. The results of this study do not correspond with the findings of the study by Furnham and Bachtar (2008) which reported that in-

telligence is unable to predict creativity. The results of this study are similar to the findings of Walsh, which showed that flexibility, originality, and elaboration components can highly affect intelligence [27].

The results of the present study are similar to the findings of the study by Piaw (2014) which indicated that intelligence can predict creativity. Although in Piaw study (2014), four kinds of interpersonal, naturalist, musical, and special-visual intelligence were able to predict creativity, in the present study, it was demonstrated that musical and special-visual intelligence cannot solely predict any creativity component [18]. Experience and cultural and historical backgrounds other than genetics can affect intelligence and creativity [28]. Therefore, the difference between the results of the present study with those of the mentioned study can be explained by considering the cultural differences of the samples of the two studies. The samples in Piaw study were the principals of elementary and intermediate schools in Malaysia whereas the samples of the present study were Iranian 13 to 15 years old students.

Also, considering the evolution process of creativity, the differences between the results of the present study with those of Piaw research (2014) can be justified [18]. About the evolution of creativity, Runko (1999) believed that creativity slowly changes as humans grow up, and based on their different experiences in different ages, it increases or decreases during the time [29]. Smith and Carlsson (1985) reported that creativity decreases at the



**Table 5.** The results of multiple regression analysis of flexibility component based on intelligence profile, selective attention, and switching

| Model                                 | B      | Standard Error | Beta  | t    | Sig.  | R    | R <sup>2</sup> |
|---------------------------------------|--------|----------------|-------|------|-------|------|----------------|
| Model 1                               |        |                |       |      |       | 0.62 | 0.41           |
| Mathematical-logical intelligence     | 0.16   | 0.05           | 0.27  | 3.14 | 0.002 |      |                |
| Special-visual intelligence           | 0.005  | 0.07           | 0.006 | 0.06 | 0.94  |      |                |
| Bodily-kinesthetic intelligence       | 0.09   | 0.07           | 0.10  | 1.28 | 0.20  |      |                |
| Interpersonal intelligence            | 0.06   | 0.05           | 0.08  | 1.01 | 0.31  |      |                |
| Intrapersonal intelligence            | 0.10   | 0.06           | 0.15  | 1.65 | 0.10  |      |                |
| Musical intelligence                  | 0.01   | 0.06           | 0.03  | 0.31 | 0.75  |      |                |
| Naturalist intelligence               | 0.10   | 0.08           | 0.14  | 1.24 | 0.21  |      |                |
| Linguistic intelligence               | 0.01   | 0.05           | 0.02  | 0.24 | 0.80  |      |                |
| Reaction time for selective attention | -0.002 | 0.001          | -0.11 | 1.66 | 0.09  |      |                |
| Reaction time for switching           | -0.001 | 0.001          | -0.07 | 1.02 | 0.30  |      |                |

**JMR**

**Table 6.** The results of multiple regression analysis of originality component based on intelligence profile, selective attention, and switching

| Model                                 | B      | Standard Error | Beta  | t    | Sig.  | R    | R <sup>2</sup> |
|---------------------------------------|--------|----------------|-------|------|-------|------|----------------|
| Model 1                               |        |                |       |      |       | 0.68 | 0.46           |
| Mathematical-logical intelligence     | 0.04   | 0.05           | 0.07  | 0.88 | 0.38  |      |                |
| Special-visual intelligence           | 0.09   | 0.07           | 0.10  | 1.28 | 0.20  |      |                |
| Bodily-kinesthetic intelligence       | 0.28   | 0.07           | 0.28  | 3.78 | 0.001 |      |                |
| Interpersonal intelligence            | 0.03   | 0.06           | 0.03  | 0.49 | 0.61  |      |                |
| Intrapersonal intelligence            | 0.09   | 0.06           | 0.12  | 1.46 | 0.14  |      |                |
| Musical intelligence                  | -0.09  | 0.06           | -0.15 | 1.48 | 0.14  |      |                |
| Naturalist intelligence               | 0.33   | 0.09           | 0.42  | 3.70 | 0.001 |      |                |
| Linguistic intelligence               | -0.008 | 0.05           | -0.01 | 1.14 | 0.88  |      |                |
| Reaction time for selective attention | 0.001  | 0.001          | 0.04  | 0.61 | 0.54  |      |                |
| Reaction time for switching           | -0.001 | 0.001          | 0.10  | 1.47 | 0.14  |      |                |

**JMR**

age of seven to eight and the period between ten and eleven is the peak of creativity. Then, at the age of 12, it starts to decrease again, and this decrease is even more than that between the age of seven to eight. After the age of 12, gradual but even increase in creativity can be seen and this growth again peaks at the age of 16. Smith and

Carlsson considered the age from 10-12 as the first real stage of creativity [30].

Camp stated that at the age of (about) 12, creativity increases and it starts to decrease at the age of 15. He believed that the environment is vital for the creativity of kids. Bredekamp and Copple also stated that creativity

**Table 7.** The results of multiple regression analysis of elaboration component based on intelligence profile, selective attention, and switching

| Model                                 | B      | Standard error | Beta  | t    | Sig. | R    | R <sup>2</sup> |
|---------------------------------------|--------|----------------|-------|------|------|------|----------------|
| Model 1                               |        |                |       |      |      | 0.68 | 0.46           |
| Mathematical-logical intelligence     | 0.11   | 0.04           | 0.21  | 2.61 | 0.01 |      |                |
| Special-visual intelligence           | 0.08   | 0.05           | 0.12  | 1.54 | 0.12 |      |                |
| Bodily-kinesthetic intelligence       | 0.12   | 0.06           | 0.15  | 2.07 | 0.04 |      |                |
| Interpersonal intelligence            | 0.03   | 0.04           | 0.05  | 0.73 | 0.46 |      |                |
| Intrapersonal intelligence            | 0.11   | 0.05           | 0.20  | 2.35 | 0.02 |      |                |
| Musical intelligence                  | -0.06  | 0.05           | -0.13 | 1.36 | 0.17 |      |                |
| Naturalist intelligence               | 0.17   | 0.07           | 0.27  | 2.39 | 0.01 |      |                |
| Linguistic intelligence               | 0.007  | 0.04           | 0.01  | 0.15 | 0.87 |      |                |
| Reaction time for selective attention | 0.001  | 0.001          | 0.03  | 0.43 | 0.66 |      |                |
| Reaction time for switching           | -0.001 | 0.000          | -0.08 | 1.28 | 0.20 |      |                |

JMR

**Table 8.** Multiple regression results of total creativity score based on intelligence profile, selective attention, and switching

| Model                             | B     | Standard Error | Beta  | t     | Sig.  | R    | R <sup>2</sup> |
|-----------------------------------|-------|----------------|-------|-------|-------|------|----------------|
| Model 1                           |       |                |       |       |       | 0.74 | 0.55           |
| Mathematical-logical intelligence | 0.40  | 0.14           | 0.21  | 2.77  | 0.05  |      |                |
| Special-visual intelligence       | 0.22  | 0.19           | 0.08  | 1.15  | 0.24  |      |                |
| Bodily-kinesthetic intelligence   | 0.55  | 0.20           | 0.18  | 2.73  | 0.01  |      |                |
| Interpersonal intelligence        | 0.19  | 0.16           | 0.08  | 1.18  | 0.24  |      |                |
| Intrapersonal intelligence        | 0.52  | 0.16           | 0.24  | 3.30  | 0.001 |      |                |
| Musical intelligence              | -0.11 | 0.16           | -0.06 | -0.66 | 0.51  |      |                |
| Naturalist intelligence           | 0.34  | 0.24           | 0.15  | 1.40  | 0.16  |      |                |
| Linguistic intelligence           | 0.14  | 0.15           | 0.07  | 0.93  | 0.35  |      |                |
| Selective attention               | -0.01 | 0              | -0.10 | -1.65 | 0.10  |      |                |
| Switching                         | -0.01 | 0              | -0.13 | -2.14 | 0.03  |      |                |

JMR

decreases as age increases [3]. Considering the relationship between age and creativity and the effects of different experiences on creativity and intelligence profile [28], the differences seen in the predictability of different intelligence profiles in creativity in the two studies can be related to the age differences of the samples of the two studies.

Based on the results of the present study, the intelligence profile can predict creativity and its components. These findings can be considered similar to Gardner's definition of intelligence who defined it as the ability or

psychological-biological capability for processing the information which becomes active in a cultural environment, or in creating products that are valuable in culture. These findings are similar to the results of Carroll (1993) who indicated that creativity and intelligence concepts do not refer to a single concept; yet, creativity requires a part of mental abilities [19].

All people have each of the eight kinds of intelligence in part, yet intelligence profiles of every person are different from those of others. As Gardner and Armstrong

believed, other than genetics, experience, and historical background affect intelligence. Therefore, education can highly affect the intelligence profile, and nurturing the eight kinds of intelligence is the most important and effective factor in fostering the creativity of kids [28].

Creative people have specific lifestyles and thinking methods which lead to their improvement in specific areas. As stated by Gardner, creativity is a character of those people whose innovations are initially novel and uncommon, but eventually accepted by the community as a proper product for society [28]. Intelligence profile refers to the suitability aspect of creativity concerning the fact that people go through different processes to acquire the specific information and these different processes result from different kinds of intelligence. People with different intelligence profiles process information differently and such differences may result in greater differences in their values. In this aspect of creativity, intrapersonal and interpersonal intelligence are of special importance.

These two kinds of intelligence may directly engage with the main purpose of creativity which is the change of mind. A creative product affects the thinking processes of other people through reflection and communication. Creativity has a crucial role in the culture and eventually results in cultural changes. Therefore, creativity can change the values of different kinds of intelligence in culture by changing the nature of existing information, their values, and the purposes for which this information is used. Accordingly, the transaction between multiple kinds of intelligence and creativity is mutual [31].

Because different intelligence profiles can produce different innovative products, an intelligence profile emphasizes a new dimension of creativity. Intrapersonal intelligence highly affects creativity by helping self-regulation and self-direction. Creativity naturally accompanies change and transformation. Here, the resistance of powerful and influential practitioners in the related area is a normal problem that creative people usually face and in such conditions having a powerful intrapersonal intelligence not only is important for organizing other kinds of intelligence but also has a greater role in maintaining personal motivation for creating a novel product [31].

People with higher intrapersonal intelligence can understand and express their own emotions and try to perceive their inner feelings, dreams, strengths and weaknesses, and relationships with other people. This intelligence helps the people to know themselves and their abilities in making the relationship with themselves [32]. Creative people tend to stay in touch with their own

emotions and can express their feelings by creating innovative products. These people should know themselves and control their own emotions to express and transfer their feelings to other people by creating innovative products that are different from the accepted norms of their society. Therefore, these people may have higher intrapersonal and even interpersonal intelligence, and based on the multiple intelligence theory, creativity may have a relationship with an intelligence profile [28].

Mathematical-logical intelligence has a relationship with mathematical science and reasoning. It means the ability to recognize patterns, to perceive and use logic, symbols, numerical functions, to recognize patterns, phrases, and functions by inductive reasoning or logical comparisons. This ability is evident among the scholars of logic, scientists, and mathematicians. These people are curious and possess powerful reasoning. In this kind of intelligence, the elements of creativity, including observation, perseverance, and attention to relationships can be seen [31].

Bodily-kinesesthetic intelligence can perform physical activities connected to the mental activities which include adjusting physical movements and using the body to express thoughts and emotions. It can be seen in athletes, actors, and dancers [31]. Activities related to this intelligence stimulate learning by direct physical experiences and it can develop the components of risk-taking, experimentation and prediction, observation, and positive look upon the errors in innovations. Harmonious movements are a kind of powerful and unique expression. It is a language for making communications with the minimum number of mediators through abstract thinking and conceptualization. It is a way of perceiving human experiences [33].

Perceiving human experiences refers to the fact that the brain lies in a body that lives a social and physical environment. Dewey detected the deep routes of relationships with cognition in which body and mind converge with each other and are interwoven. Learning by bodily-kinesesthetic intelligence means perception with both body and mind which can be effective in the growth of creativity [33].

People with higher naturalist intelligence are interested in the fields of botany and zoology and they have good skills in the classifications of plants, animals. Nature, ecotourism, and colors affect creativity. Due to their relationship with the components of creativity, even a little existence of each kind of intelligence can provoke creativity [33].

In another interpretation, the relationship between creativity and intelligence can be related to the neurophysiol-

ogy of intelligence. The effectiveness of neural structures of intelligence may justify a part of the variance of creativity scores. Timed tests are usually used for measuring creativity. In such conditions, the effective neural system can result in the improvement of performance in creativity tests [4]. However, the results of studies in this area indicated that the neural effectiveness alone is not enough for interpreting the creative output. Carroll's (1993) meta-analysis demonstrated that alongside intellectual abilities, some other features can interpret the variance of creativity scores [19]. The predictability of different kinds of intelligence for creativity components can also be verified for the multidimensional creativity theory. This theory states that like multiple intelligences, there are eight kinds of creativity. In such an interpretation, the four components of creativity and their combinations can be studied from multiple creativity perspectives.

Other findings of the present study indicated that selective attention negatively predicts the fluency component and switching did not have any role in predicting any creativity component. In other words, the increase in the reaction time in the tests of selective attention indicates a decrease in the creativity of the subjects. These findings are similar to the findings of Bott et al. (2014) which reported the existence of a relationship between selective attention and creativity, and also, the absence of any relationship between creativity and switching [5]. Also, the findings of this study are similar to the results of the research by Dorfman, Matinda, Gassimova, and Vartanian (2008) which depicted the relationship between creativity and reaction time [34].

The findings of this study are similar to the results of the study of Benedek, Jauk, Sommer, Arendasy, and Neubauer (2014) which showed that creativity has a relationship with selective attention and inhibition, but not with switching [8]. The findings of this study are different from the results of the research by Groborz and Necka (2003) in which a relationship was reported between cognitive control and the originality component of creativity [17]. The results of this study verified the previous findings indicating the relationship of creativity to the changes in focused attention and elaboration of attention extent [34].

In interpreting the obtained results, it can be said that most of the researchers consider creativity as the ability to create relationships between unrelated concepts and since combining or relating two or more concepts requires them to be at the center of attention, the produced changes at the center of attention can have direct effects on the ability to create such combinations. How-

ever, Vartabian stated that such a perspective towards creativity that easily accompanies it with the extension of attention may be unable to express all the realities and the ability to apply extended attention at the first stage of problem-solving and focused attention at the next stage can properly explain the creativity process. In other words, researchers state this approach to indicate that creativity requires a change in the area of attention.

The results of this study regarding the predictability of selective attention for creativity and unpredictability of switching support Martindale's theory which is based on the idea that the attention of creative people is a changing state and depends on task requirements. He demonstrated that creative people show an increase in their performances in tasks related to attention that includes a few cognitive interventions (such as naming color and reading words and naming color-word) whereas they show a decrease in their performances in tasks with many interventions. The findings of the present study indicated that switching cannot predict creativity. Based on this finding, it can be realized that high-level executive performances have a weaker relationship with creativity [5]. Many creativity theories assume that producing innovative ideas require proper recombination of unrelated semantic concepts. By indicating that selective attention can predict creativity, it seems that the findings of this study verify this theory. Selective attention that happens with inhibition depicts the ability to suppress intervention resulted from close semantic concepts and accordingly allows far semantic concepts [8].

This study, like most other studies, had some limitations. It was conducted on 13 to 15 years old students which made it difficult to generalize the results to other age groups. In this study, other effective factors such as personal characters were not included, therefore it is suggested that such factors be included in future studies. The findings of this study can be used for educational plans in schools. Considering the predictive role of kids' selective attention and intelligence profile in creativity and its effects on learning and training and success in their daily lives, parents and educational system are suggested to pay attention to these two important factors to achieve the desired growth in tutoring processes of kids.

## 5. Conclusion

In sum, the findings of this study assert the effective role of intelligence profile features and selective attention in predicting the creativity components.

## Ethical Considerations

### Compliance with ethical guidelines

All ethical principles were considered in this article. The participants were informed about the purpose of the research and its implementation stages; they were also assured about the confidentiality of their information; Moreover, They were allowed to leave the study whenever they wish, and if desired, the results of the research would be available to them.

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### Authors' contributions

All authors contributed in preparing this article.

### Conflict of interest

The authors declared no conflict of interest.

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