# Chapter #23

# EXAMINING HOW POSITIVE AND NEGATIVE EMOTIONS INFLUENCE COGNITIVE PERFORMANCE IN SECONDARY SCHOOLS

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**ABSTRACT**
Few studies have examined the impact of emotions on cognitive (not only academic) performance among adolescents and this is the objective of our research. After ethic committee agreement and parents' authorization, we asked 158 adolescents in secondary schools to respond to the French version of Differential Emotion Scale adapted for school context and to nineteen syllogisms which evaluated cognitive nonacademic performances. As results, we expected that negative emotions related to academic achievement would reduce performance in reasoning and positive emotions would improve it. Our hypotheses were partially validated. The impacts of the results as well as perspectives of future researches in relation with self-esteem, psychological disengagement, dropping out of school were discussed.

*Keywords:* emotions, cognitive performance, deductive reasoning, early- and mid-adolescence, secondary school.

## 1. INTRODUCTION

How emotions could play on cognitive performance in secondary schools? It is still too little known about their influence on cognitive performances at the crucial period of early- and mid-adolescence when many psychological and physical changes take place in a short time (Braconnier & Marcelli, 1998). In the literature concerning the adults, the results can be contradictory and contingent upon the perceived specific emotion. The affective state is however likely to influence cognitive performances (Blanchette & Richards, 2010; Oaksford, Morris, Grainger, & Williams, 1996; Tricard, Maintenant, & Pennequin, 2018).

### 1.1. Age and cognitive performances

The transition from childhood to adulthood is marked by an increasing in cognitive performances in many domains (Roalf et al., 2014). In the study of age change in cognition the most commonly studied cognitive processes are various forms of reasoning (Byrnes, 2008). Reasoning skills appear early and are developed with advancing age with the exception of elderly people when we observe a progressive decrease in performance in reasoning tasks (De Neys & Van Gelder, 2009). This improving of performance with age is therefore observed for the different type of reasoning: deductive reasoning (De Neys & Van Gelder, 2009; Hawkins, Pea, Glick, & Scribner, 1984), inductive reasoning (Csapó, 1997; Galotti, Komatsu, & Voelz, 1997) or quantitative reasoning (Chiesi, Gronchi, & Primi, 2008; Denison, Reed & Xu, 2013).

Reasoning performances are often measured by syllogisms, for example, Premise 1: Four legged animals walk / Premise 2: Tigers are four legged animals / Conclusion: Tigers walk. In this example, the conclusion is valid because it follows logically from the premises, and also credible because it is consistent with the established knowledge. The syllogisms reflect mainly the level of deductive reasoning, which corresponds to the use of general laws to draw a conclusion on a particular case (Tricard et al., 2018). The deductive reasoning would be possible from age of 4 years but under certain conditions (Hawkins et al., 1984): when the syllogisms are plausible (valid and credible) rather than imaginary and when there is a correspondence between the formulation and the validity. That is to say when it comes to answering "yes" this syllogism is valid for the syllogisms formulated positively and "no" this syllogism is not valid for the syllogisms formulated negatively. This correspondence would help young children (4 years old) to succeed without using logical reasoning (Markovits, Schleifer, & Fortier, 1989). Then, we could situate from age of 9 years the possibility of understanding the difference between valid and invalid conclusion about imaginary syllogisms (Galotti et al., 1997). But we could observe a full understanding of the relationship between the premises and the conclusion at age of 11 years (Markovits et al., 1989). During early adolescence, individuals show marked improvements in deductive reasoning (Steinberg, 2005) and the development of deductive reasoning skills would continue until the age of 17-18 years old.

## 1.2. Emotions and cognitive performances

The cognitive performances are not only improved with age. They may also be influenced by other factors and since many decades emotions are mentioned in particular (e.g. Channon & Baker, 1994; Oaksford et al., 1996; Melton, 1995; Radenhausen & Anker, 1988). Huntsinger, Isbell, and Clore (2014) remind that affective feelings have an important feedback and an adaptive function and provide information for many cognitive processing outcomes. Schwarz (2012) underlines that affects could influence our cognitive processing by informing us about our psychological environment: for example, negative affect flags the presence of a problem and positive affect notifies a favorable and safe environment. Blanchette (2006) points out that research on psychopathologies with important affective components showed an effect on reasoning as well as the research on cognition, in positive or in negative mood condition, with non-clinical samples. But in which way exactly negative and positive emotions could influence cognitive performances?

### 1.2.1. Deleterious effect of negative emotions

According to Tricard et al. (2018) the deductive reasoning of young people is influenced by emotions. These researchers examined the influence of inducing joy and sadness emotional states on deductive reasoning performances, measured by syllogisms, of children aged from 9–10 years old. They founded a negative effect of sadness on the scores of correct answers to syllogisms compared to joy. Fartoukh, Chanquoy and Piolat (2014) also examined the effect of a mood induction but on phonological working memory capacity in fourth and fifth graders. Their results showed a decreasing of phonological working memory performances in the case of negative mood induction procedure. Tricard and her colleagues (2018) as well as Fartoukh et al. (2014) specify that a negative affective experience will lead to a poor cognitive performance. Thus, experiencing a negative affective state should weaken the performance of pupils in cognitive tasks like reasoning task.

### 1.2.2. Facilitative effect of positive emotions

According to Bryan and Bryan (1991) a positive emotional state about school and learning promotes success and speed in solving reasoning problems. They randomly assigned children (third to fifth grades) and students in junior high and high school to a positive-mood induction condition or a no-treatment control condition. The objective was to assess the impact of positive moods on students' feelings of self-efficacy and math performance. The results showed that children in the positive-mood condition completed significantly more problems accurately than children in the no-treatment control condition. They also showed that students (in junior high and high school) in the positive-mood induction condition expressed greater self-efficacy for math than students in the control condition. Thus, feeling positive emotions towards learning and college would encourage better results in logical reasoning on a task. For Caparos and Blanchette (2015) positive emotions would indeed have a facilitating effect during a cognitive task. Giroux, Blanchette and Gosselin (2014) confirm that subjects with the induction of a positive emotional state perform better on a reasoning task with syllogisms. The objective of this study was to explore the influence of music-induced joy and sadness on deductive reasoning. The reasoning performance in a music-induced joy condition was much more higher compared to inducing sadness and the absence of emotional induction.

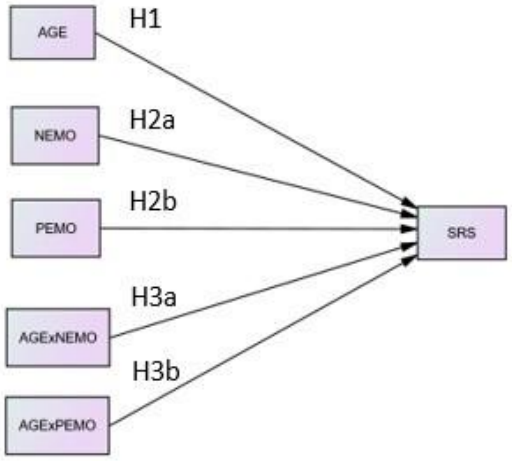
## 1.3. Objectives

The overall conclusions of all the studies in the "Emotions and cognitive performances" section were that there is a deleterious effect of negative emotions as well as a facilitative effect of positive emotions on cognitive performances. These studies were also done with a public of adults or young children. However, few studies have concretely examined the influence of affective state on cognitive and not only academic performance among adolescents. The objective of our research is to bring more information about that topic. As mentioned previously, cognitive performances are influenced by emotions and are improved with age. However, it could exist a differential effect of emotions on cognitive performances. Early adolescents could be more sensitive to emotions because of a poorer development of emotional regulation (Ahmed, Bittencourt-Hewitt, & Sebastian, 2015). Thus, we also wanted to explore the interaction effect of emotion and age on reasoning at this stage of early- and mid-adolescence which are marked by several changes in a short time.

## 1.4. Hypotheses

As our first hypothesis, we made the assumption that there was a significant correlation and a significant effect of the age on the cognitive performances: the cognitive performances should increase with age (H1). Second, we expected a significant correlation and a significant effect between the emotions about school and the cognitive performances: more the emotions about school are negative the lower should be the cognitive performances (H2a); more the emotions are positive the higher should be the cognitive performances (H2b). Finally, we expected a significant interaction effect between the age and the emotions about school on the cognitive performances: more the emotions about school are negative and more the age is low the lower should be the cognitive performances (H3a); more the emotions are positive and more the age is high the higher should be the cognitive performances (H3b). All the hypotheses are summarized in Figure 1.

*Figure 1.*
*Hypotheses.*




*Legend: NEMO = Negative emotions; PEMO = Positive emotions; SRS = Syllogism reasoning score as a measure of Cognitive performances; AGExNEMO = interaction between Age and NEMO; AGExPEMO = interaction between Age and PEMO.*

## 2. METHODS

### 2.1. Participants

158 students in secondary school (83 boys and 75 girls) participated in our research. They were 12 years-old on average (11-14 years, *SD* = 0.78). The most of them were in 6th (11-12 years old) and in 5th class (12-13 years old); two participants were in 4th (13-14 years old) and two others in 3th class (14-15 years old). 92% of the participants were French native speakers and the others were speaking French since more than five years. It is important to precise that we did not finish our data collection because of the Covid-19 crisis and we chose to include all the participants that we met. That is why we have only four participants in total for 4th (13-14 years old) and 3th class (14-15 years old).

### 2.2. Procedure

We obtained an ethic committee agreement for our study. We asked first school principals a permission to realize our study in their establishment and then we sent an authorization form to the parents to obtain a permission for the participation of their children. All participants also completed a consent statement and responded to the questionnaires at school, in group.

### 2.3. Measures

Our study contains as measures two questionnaires.

To measure negative (e.g., “Do you have any regrets, do you feel guilty for something that you have done?”) and positive emotions (e.g., “Do you feel happy?”) related to academic situations, participants completed the 36 items of the French validation of the

Differential Emotion Scale (DES) proposed by Ricard-St-Aubin, Philippe, Beaulieu-Pelletier and Lecours (2010) adapted firstly to the school context by Galand and Philippot (2005). Items were rated on a 5-point Likert scale ranging from 1 (Rarely or never) to 5 (Very often). The Cronbach's alpha coefficients for both groups of items measuring positive emotion ($\alpha = 0.65$) or negative emotions ($\alpha = 0.92$) were high and so we could construct two composite variables: positives emotions and negative emotions.

To measure cognitive nonacademic performances, we proposed 19 syllogisms, staying in line with previous studies which used this type of measurement rather than others. We counted the total number of right answers for every participant. She or he needed to choose the fine answer between four different propositions of a possible conclusion of every syllogism (example):

*"We tell to the aliens: "All printers need ink"*
*We also say to them: "My pen needs ink"*
*What conclusion would the aliens have made?*

*o My pen is a printer*
*o My pen is not a printer*
*o My pen is a felt*
*o The aliens could not have concluded"*

Our syllogisms had neutral emotional content and they were pretested about this in Tricard (2018). The emotionality of the experiment's content has an effect on the cognitive performances (Blanchette & Richards, 2004; Gosselin & Blanchette, 2018) and that is why we chose to include this type of syllogisms.

## 2.4. Statistical analysis

We analyzed our data within a Network (see Fonseca-Pedrero, 2018; Hevey, 2018) and SEM approaches framework. The Network analysis allowed us to explore the partial correlations and links between our different variables. The SEM analysis permitted us to test the impact of emotions on cognitive performances. More precisely the later was a path analysis with a maximum likelihood estimation and we applied bias-corrected percentile bootstrap confidence intervals to test the significance of the different effects. In order to assess the fit of the models, the following indices were used: the ratio $\chi^2/df$ (chi-square/degree of freedom), the p value, the CFI (Comparative Fit Index), the GFI (Goodness-of-Fit Index), the AGFI (Adjusted Goodness-of-Fit Index), the RMSEA (Root Mean Square Error of Approximation) including the associated 90% confidence interval (CI) and the RMR (Root Mean Square Residual). The fit of a model is considered excellent for a value of the ratio $\chi^2/df$ less than 2 and a non-significant p value (Kline, 2011), for CFI, GFI and AGFI coefficient values greater than 0.90 (Mokhtarian & Ory, 2009), for RMSEA values less than 0.07 (MacCallum, Browne & Sugawara, 1996) and a maximum upper bound of the 90% CI of 0.10 (Browne & Cudek, 1993) and for RMR values less than 0.08 (Gana & Broc, 2018).

Descriptive Statistics and Network analysis were done with JASP software (JASP Team, 2019) and SEM analysis was realized with AMOS software (Arbuckle, 2014).

## 3. RESULTS

Descriptive statistics and the zero-order correlation matrix are presented in Table 1 and Table 2. The correlation matrix indicated that there were only two significant correlations between the variables of our interest: a positive relation between Positives emotions and Cognitive performances ($r$ = .22, p < .01) as well as a negative relation between Positives emotions and Age ($r$ = -.17, p < .05). This was not a surprise then when we integrated our hypotheses in a model to test with SEM analysis and the fit of the model was very poor ($\chi^2/df$ = 228; p = 0.000; *CFI* = 0.343; *GFI* = 0.662; *AGFI* = -0.589; *RMSEA* = 1.200, 90% CI [1.142 – 1.260]) and the path coefficient weren't significant except the effect of positive emotions on cognitive performance. As a next step in our analysis we put the three variables from the two significant correlations from Table 2 to a network analysis (Figure 2). This time three partial correlations were significant: the relation between Age and Cognitive performances (H1), between Positives emotions and Age, and, between Positives emotions and Cognitive performances (H2b). Age and Cognitive performances were also negatively connected via Positives emotions. Thus we transposed this model in SEM framework by orienting the effects of the variables in accordance with our hypotheses (e.g. a direct effect from Positives emotions and Cognitive performances, etc.). We obtained a good model fit ($\chi^2/df$ = 1.247; p = 0.274; *CFI* = 0.998; *GFI* = 0.995; *AGFI* = 0.979; *RMSEA* = 0.010, 90% CI [0.000 – 0.060]) but the effect of Age on Cognitive performances wasn't significant ($\beta$ = 0.06, p = .34, 95% CI [-0.119 – 0.251]). We redid the analysis by omitting this link of the tested model (Figure 3) and the fit was very good ($\chi^2/df$ = 0. 745; p = 0.338; *CFI* = 1.00; *GFI* = 0.997; *AGFI* = 0.981; *RMSEA* = 0.000, 90% CI [0.000 – 0.020]). The direct effect from Age to Positive emotions was significant and negative ($\beta$ = -0.17, p < .05, 95% CI [-0.308 – -0.017]), with $R^2$ = 0.03 for Positive emotions. The direct effect from Positive emotions to Cognitive performances was significant and positive ($\beta$ = 0.22, p < .05, 95% CI [0.045 – 0.381]), with $R^2$ = 0.05 for Cognitive performances. The indirect effect from Age to Cognitive performances was also significant but negative ($\beta$ = -0.04, p < .05, 95% CI [-0.104 – -0.003]).

*Table 1.*
*Descriptive statistics.*

| | Sexe | Classe | Age | SRS | NEMO | PEMO |
|---|---|---|---|---|---|---|
| **Mean** | | | 11.873 | 8.595 | 2.063 | 3.177 |
| **Median** | | | 12.000 | 8.000 | 1.963 | 3.194 |
| **Std. Deviation** | | | 0.780 | 2.481 | 0.617 | 0.565 |
| **Skewness** | 0.102 | -0.813 | 0.552 | 0.578 | 0.749 | -0.038 |
| **Kurtosis** | -2.015 | 1.742 | -0.243 | 1.570 | 0.631 | 0.117 |
| **Shapiro-Wilk** | 0.635 | 0.694 | 0.824 | 0.960 | 0.962 | 0.993 |
| **P-value of Shapiro-Wilk** | < .001 | < .001 | < .001 | < .001 | < .001 | 0.703 |
| **Minimum** | | | 11.000 | 3.000 | 1.037 | 1.667 |
| **Maximum** | | | 14.000 | 18.000 | 4.370 | 4.889 |
| **25th percentile** | | | 11.000 | 7.000 | 1.593 | 2.889 |
| **50th percentile** | | | 12.000 | 8.000 | 1.963 | 3.194 |
| **75th percentile** | | | 12.000 | 10.000 | 2.426 | 3.556 |

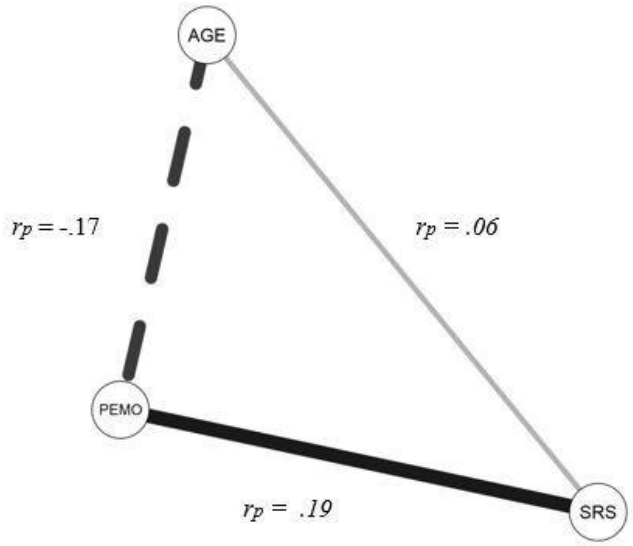
*Legend: NEMO = Negative emotions; PEMO = Positive emotions; SRS = Syllogism reasoning score as a measure of Cognitive performances.*

*Table 2.*
*Correlation matrix.*

| | Gender | Class | Age | SRS | NEMO | PEMO |
|---|---|---|---|---|---|---|
| **Gender** | — | | | | | |
| **Class** | 0.209 ** | — | | | | |
| **Age** | -0.188* | -0.800*** | — | | | |
| **SRD** | 0.038 | -0.049 | 0.029 | — | | |
| **NEMO** | 0.122 | -0.085 | 0.084 | -0.035 | — | |
| **PEMO** | -0.039 | 0.099 | -0.167* | 0.220** | 0.068 | — |
| * p < .05, ** p < .01, *** p < .001 | | | | | | |

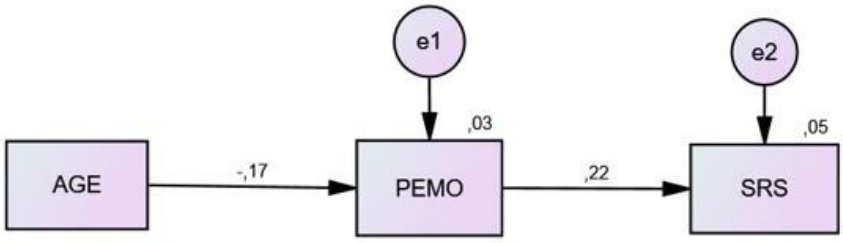
*Legend: NEMO = Negative emotions; PEMO = Positive emotions; SRS = Syllogism reasoning score as a measure of Cognitive performances.*

*Figure 2.*
*Network analysis.*




*Legend: NEMO = Negative emotions; PEMO = Positive emotions; SRS = Syllogism reasoning score as a measure of Cognitive performances. Solid lines correspond to positive links; dashed lines correspond to negative links. The broader and darker the line, the stronger the link.*

*Figure 3.*
*Path analysis and synthese of the different effects.*




*Legend: PEMO = Positive emotions; SRS = Syllogism reasoning score as a measure of Cognitive performances; e1 =residual variance of PEMO ; e2 = residual variance of SRS.*

## 4. DISCUSSION

Our hypotheses were partially validated. Concerning our first hypothesis, the age didn't directly affect the cognitive performances in our sample. The problem is that the majority of our participants was only 11-12 years old and this is not what we wished. It will be necessary to include more participants who are older (13-14 years old) for the next stage of our research. Thus we can investigate if there is a difference, at least, between the group of 11-12 years old and the group of 13-14 years old pupils. The age had also a partial positive correlation and an indirect negative relation on the cognitive performances via the positive emotions in a network analysis. This negative indirect relation might have a suppression effect on the positive one and may explain why we didn't obtain a significant direct effect. These results give us an insight that the relationship between age and cognitive performance isn't probably unequivocal.

Concerning our second hypothesis, the positive emotions correlated with the performance on the reasoning test but not the negative ones. Consequently, only positive emotions affected the cognitive performance and in connection with our third hypothesis, this is without an interaction with the age of the participants. This is in line with the results of Radenhausen and Anker (1988) and more recently with the results of Caparos and Blanchette (2015) or Wang, Chen, and Yue (2017) where positive emotions improve cognitive performances. This shows that in a learning situation or in a reasoning assessment it is particularly preferable to foster positive emotions, and the later might be encouraged and privileged to facilitate learning and the best possible conditions for pupils' evaluation. What about negative emotions? Some researchers (e.g. Fiedler, 1990; Forgas, 1995; Royce & Diamond, 1980) explain that reasoning tests are may be less constrained by emotions than other types of tests. It is also possible that pupils entered a state in which feelings do not influence the task performance like the state of flow (Csikszentmihalyi, Abuhamdeh, & Nakamura, 2005). This could be valuable when both positive and negative emotions don't interfere with cognitive performances but, in our case, there were still a significant relation and a significant influence from positive emotions to cognitive performances. Melton (1995) showed that negative emotions could even improve cognitive performance.

In our research, we investigated the emotions on a global level as positive and negatives emotions. It will be interesting to study the link and the effect of emotions on cognitive performances on a specific level. May be some specific negative emotions could improve cognitive performances but other could do the opposite. Thus, this might explain why on global level there was no relation and no effect from negative emotions to cognitive performances. May be there is also an explanation in descriptive statistics terms: the mean of negative emotions in our sample is under the theoretical mean of the composite variable. When we explored more in detail the descriptive statistics, 75% of the participants had a score under this later mean. Which implies that the most of them feels rarely negative emotions about school and thus it is difficult to detect an effect on another variable.

Concerning our third hypothesis, age had a negative indirect effect on cognitive performances mediated by positive emotions. It wasn't in our hypotheses but age had a negative direct effect on positive emotions. These results are in line with these obtained by Galand and Philippot (2005) but on a specific positive emotion level. They founded that reported level of positive emotions decreases with the increase in adolescents'age. Thus decreasing positive emotions would provoke a decreasing in cognitive performances with increasing in age. This statement is opposite on what is generally mentioned in the literature: cognitive performances increase with age (e.g. Brehmer, Li, Müller, von Oertzen, & Lindenberger, 2007; Cromer, Schembri, Harel, & Maruff, 2015; Roalf et al., 2014). As we suggested it earlier, the relationship between age and cognitive performance isn't probably unequivocal at this stage of human development. This is important to take in to account about an eventual decreasing in academic performances and dropping out of school in teenage period. Keating (2012) precise that it is possible that factors other than changes in logical structure with age would be implicated in task performance. May be for some pupils in secondary school this phenomenon of decreasing positive emotions is more present than for others and it would be necessary to learn more about it as well as its link with other variables which could interfere with it.

## 5. FUTURE RESEARCH DIRECTIONS

In future research, we must take also in account specific emotions and not only global emotions. We could also explore the influence of emotions on academic performances. Due to the risk of a vicious cycle between psychological disengagement and academic failure, better understanding of the link of emotions about school and academic performance appear like crucial. The understanding of this phenomenon added to the impact of self-esteem (a factor related to cognitive and academic performances, e.g. Simon & Simon, 1975) on these variables would be important to investigate in order to avoid dropping out of school. It will be also interesting to explore the influence of motivation within a such a theoretical framework. As we know, the motivation is important in school learning (Nicholls & Thorkildsen, 1995). The perception of the school context by the students have an impact on their motivation (Ryan & Patrick, 2001) and emotional experience at school (Galand & Philippot, 2005). Thus, it is plausible that the emotions felt about school and motivation could influence academic performances (e.g. Valiente, Swanson & Eisenberg, 2012).

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