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Psychological and psychobiological stress in the relationship between basic cognitive function and school performance

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Título: El estrés psicológico y psicobiológico en la relación entre funcionamiento cognitivo básico y rendimiento académico.
Resumen: Este estudio analiza el papel desempeñado por el estrés cotidiano, evaluado a través de auto-informe y de los niveles psicobiológicos, en relación con la función cognitiva básica a la hora de predecir el rendimiento académico. La muestra está compuesta por 100 alumnos (55 niñas y niños de 45, con un rango de edad de 8 a 11 años) de una escuela pública de Málaga capital (España). El estrés diario se evaluó mediante el Inventario de estresores cotidianos en niños (IIEC; Trianes et al, 2009). El estrés psicobiológico se midió a través de la ratio cortisol / DHEA, derivado de varias muestras de saliva tomadas por la mañana en dos días consecutivos. Las habilidades cognitivas básicas se evaluaron por medio del sistema de evaluación cognitiva computarizada (batería CDR; Wesnes et al, 2003, 2000). Por último, el rendimiento académico se evaluó a través del valor medio de las calificaciones finales registradas en el informe de la escuela del niño. Además de los análisis estadísticos descriptivos y correlacionales, se realizaron análisis de regresión múltiple con el fin de evaluar el modelo. Los resultados muestran que el estrés diario autopercibido por los niños, actúa pronosticando el rendimiento académico con mayor peso que el funcionamiento cognitivo básico. Por lo tanto, a fin de lograr el buen rendimiento escolar, un alumno no sólo requiere una buena función cognitiva básica, sino que también debe presentar bajos niveles de estrés cotidiano autopercibido. Estos hallazgos sugieren una nueva forma de explicar y predecir el fracaso escolar.
Palabras clave: Funcionamiento cognitivo básico; rendimiento académico; estrés cotidiano; ratio cortisol/dheas; infancia.

Abstract: This study analyses the role played by daily stress, assessed through self-report and at the psychobiological level, in relation to basic cognitive function when predicting school performance. The sample comprised 100 schoolchildren (55 girls and 45 boys, age range 8 to 11 years) from a state school in the city of Malaga (Spain). Daily stress was assessed through the Children's Daily Stress Inventory (IIEC in Spanish; Trianes et al., 2009). Psychobiological stress was measured through the cortisol/DHEAS ratio, derived from saliva samples taken in the morning on two consecutive days. Basic cognitive skills were assessed by means of the Computerized Cognitive Assessment System (CDR battery; Wesnes et al., 2003, 2000). Finally, the measure of school performance was the mean value of the final grades recorded in the child's school report. In addition to descriptive and correlational statistical analyses, multiple regression analyses were conducted in order to assess the model. The results show that children's daily stress self-reported contributes to predict school performance, and has proven to be more influential than basic cognitive function when it comes to predict school performance. Therefore, in order to achieve good school performance, a pupil not only requires good basic cognitive function, but must also present low levels of self-reported daily stress. These findings suggest a new way of explaining and predicting school failure.
Key words: Basic cognitive function; school performance; daily stress; cortisol/dheas ratio; children.

Introduction

School performance is a variable of great interest to both the teaching community and the media. School failure affects 18% of European primary school children (García, 2010), and it is therefore essential to reduce its incidence so as to produce societies with the high levels of knowledge and technology that are required to ensure employment and social welfare. In the context of current research aimed at reducing school failure the purpose of the present study was to describe new variables that may help explain poor school performance, thereby suggesting ways of improving prevention and reducing the impact of this problem.

School performance is, by definition, a complex variable that may depend on a variety of factors, even though it is based on tasks that are mainly cognitive (Fragoso & Alcántara, 2003; Gutiérrez, 1996). However, recent research has also considered the role played by emotional variables such as anxiety (Ezpeleta et al., 2005; Margalit & Shulman, 1996), school stress or daily stress (Lindau et al., 2007) and academic motivation (Baker, 2003; Kaminski et al., 1999) in relation to children's academic grades.

The relationship between basic cognitive function, composed of attention and memory variables, and children's basic learning in primary school has been well documented (Echevarry, Godoy & Olaz, 2007; Wesnes et al., 2009; Wesnes, Pincock, Richardson, Helm & Halis, 2003; Wesnes, Ward, McGinty & Petrini, 2000). However, although the direct relationship between cognition and performance is now widely accepted, research has yet to elucidate fully the variables that affect this relationship and which mediate or modify the effect of cognitive skills on school performance. The present research assesses the role played by daily stress in relation to school performance, both directly and in terms of its influence on the relationship between basic cognitive function and school performance.

Children's daily stress is understood here as the sum of small daily hassles, a form of low-intensity but high-frequency stress that is produced by unexpected changes, events or everyday problems which a child feels cannot be resolved by using his/her usual resources (Kanner et al., 1981; Lazarus, 1981, 1984). Daily stress has been shown to have an emotional impact on school performance (Fragoso et al., 2003; Lindau et al., 2007), reducing it among primary

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school children (Mirowsky & Ross, 2007). In this context, it is now widely accepted that a child's experience of daily stressors can be revealed through self-reports (Grant et al., 2004, 2006; Kouzma & Kennedy, 2002), even with children as young as six (Gerbot & Barumandzadeh, 2005). The present research chose to use the self-report method to assess the frequency with which children suffer daily problems that cause them emotional disturbance, or even lead to psychopathology or maladjustment (Baker, 2006; Chamberlain et al., 1990; Compas et al., 1993; Fierro, 2002; Ingram & Luxton, 2005; Kanner et al., 1981; Lazarus, 1984; Wolf et al., 1989).

The stress response is expressed cognitively and emotionally, as well as through a series of hormonal changes (Carvajal, 2005; Nacer, 2004; Nater & Rohleder, 2009; Pinel, 2001; Rohleder & Nater, 2009). In addition to the emotional changes reported by children themselves, recent research on children's stress has included the non-invasive assessment of endocrine changes associated with this response (Carvajal, 2005; Nacer, 2004; Pinel, 2001). In this context, dehydroepiandrosterone sulphate (DHEAS), an androgen secreted from the reticular layer of the adrenal cortex and which can be detected in saliva samples, has been shown to play a role in the stress mechanisms of both adults and children (Kellner et al., 2009; Załuska & Janota, 2009). Specifically, DHEAS levels tend to diminish in stressed subjects (Jollin et al., 2009; Katsumata, Hirata, Inagaki, Hirata & Kawada, 2009), in contrast to the levels of cortisol (a steroid hormone synthesized in the fascicular layer of the adrenal cortex), which are raised in such subjects (Wright et al., 2005). As a result, the use and measurement of the cortisol/DHEAS ratio derived from morning saliva samples has been argued to be a more reliable and precise stress indicator than either of the two methods in isolation (Michael, Jenaway, Paykel & Herbert, 2000; Parker, 1999; Van Niekerk, Huppert & Herbert, 2001). In this regard, several recent studies have reported an increase of this ratio (an increase in the concentration of cortisol in relation to the concentration of DHEAS) in participants suffering from high levels of stress which did not reach clinical intensity (Michael, Jenaway, Paykel & Herbert, 2000; Parker, 1999; Van Niekerk, Huppert & Herbert, 2001). However, comparable research with children remains scarce (Steptoe, 2007).

Given the above, the aim of the present study was to analyse the predictive role of basic cognitive function (attention and memory), subjective daily stress and hormonal changes (cortisol/DHEAS ratio) as regards school performance. Specifically, we sought to isolate an optimal subset of variables in order to develop a predictive model of school performance. The approach used is based on certain models that enabled us to analyse not only direct relationships between variables but also more complex relationships that may include the presence of moderating variables (Allison, 1977; Baron & Kenny, 1986; Stone & Hollenbeck, 1989). More specifically, multiple regression was applied to predict school performance on the basis of basic cognitive function, while introducing the degree of self-reported daily stress and the cortisol/DHEAS ratio as potential effect modifiers. The specific aims of the study can be summarized as follows: (1) to examine and describe the relationship between this physiological indicator and the cognitive and emotional aspects studied, while controlling for the effect of differences in sex, age and body mass index (*BMI*), where applicable; and (2) to explore the extent to which children's daily stress (assessed through a subjective and/or physiological response) mediates the predictive value of basic cognitive function with respect to school performance.

Method

Participants

The sample, drawn from a non-clinical population, comprised 100 primary school children recruited from a randomly-selected state school in the city of Malaga (Spain). Parental and school consent were obtained. Incidental sampling was carried out to complete the sample, which included 55 girls and 45 boys, aged 8-11 (41% aged 8; 16% aged 9; 23% aged 10; and 20% aged 11). Their mean age was 9.21 years (SD = 1.22) and they were drawn from primary years 3, 4, 5 and 6. The sample did not include students with the following diagnoses: learning difficulties, a deficient I.Q. and a low SES. This was achieved by means of a personal history test and the psychological evaluations given by the school; as well as by administering the TRF test (Achenbach, 2001) to sample children prior to the study in order to obtain information about psychopathological symptoms. Additionally, parents were asked their level of study, occupation and monthly income in order to find out their socioeconomic level.

Psychological assessment instruments

Daily stress was assessed by the Children's Daily Stress Inventory (IIEC in Spanish; Trianes et al., 2009). This is a self-report instrument that focuses on children's subjective experience of a problem or difficulty that worries them. This subjective aspect is the most important when it comes to defining the experience of stress (Lazarus & Folkman, 1984-1986), given that different children may experience the same stressor in different ways (Gerbot & Barumandzadeh, 2005).

The children's basic cognitive function was assessed by means of the Cognitive Drug Research (CDR) battery (Wesnes et al., 2003, 2000), a computerized assessment system that includes neuropsychological tests of attention and memory (Wesnes, Pincock, Richardson, Helm & Halis, 2003; Wesnes, Ward, McGinty & Petrini, 2000).

The measure of school performance was derived from children's school reports. The procedure used, i.e. taking the mean value of their final grades, is acknowledged to be reliable, as grades are public and validated by the school system. It is also one of the most widely used ways of assessing school performance (Fragoso & Alcántara, 2003; Gómez, 1976; Gutiérrez, 1996).

Specifically, the tests and variables employed in this study were as follows:

- The *Children's Daily Stress Inventory* (IIEC in Spanish; Trianes et al., 2009). This self-report inventory comprises 25 dichotomous items organized into three dimensions: 1) Health (12 items), for example, "I get frightened easily" or "My parents often take me to the doctor"; 2) School (7 items), for example, "I usually get bad grades" or "My teachers are very strict with me"; and 3) Family (7 items), for example, "My parents ask me to do more things than I feel able to" or "I spend a lot of time home alone".

  Responses are dichotomous and the total score is obtained by summing the frequency of the annoying, upsetting and irritating events that the child has experienced over the last few months (i.e. the sum of all affirmative responses). High scores on this inventory therefore indicate high levels of self-reported daily stress in childhood. Far from constituting an objective piece of information, the frequency of the stressor estimated by the child refers to the subjective importance that the boy or girl gives the stressor. The instrument has an internal consistency (Cronbach's α) of 0.81 and its psychometric properties are reported in Trianes et al. (2011). The instrument correlates with the scores reported by parents in intra- and extra-family stressors (FILE) at r = 0.55; and with health problems reported by parents at r =0.23; as well as with other variables.
- The *CDR Computerized Assessment System* (Wesnes et al., 2003, 2000). Participants' basic cognitive function (attention and memory) was evaluated by means of the Cognitive Drug Research (CDR) battery (Wesnes, Pincock, Richardson, Helm & Halis, 2003; Wesnes, Ward, McGinty & Petrini, 2000), a specialized system that provides a computerized assessment of cognitive function (Haskell, Kennedy, Wesnes & Scholey, 2005; Kennedy, Haskell, Wesnes & Scholey, 2004; Scholey & Kennedy, 2004; Wesnes et al., 2000). This battery has previously been used in research with children and has shown excellent reliability (Wesnes et al., 2003) when measuring variables such as attention and episodic working memory (Wesnes et al., 2009).

  The version of the CDR battery used here consists of 11 tasks administered in the following order: word presentation, immediate word recall, picture presentation, simple reaction time, digit vigilance, choice reaction time, spatial working memory, numerical working memory, delayed word recall, word recognition and picture recognition (Wesnes, Ward, McGinty & Petrini, 2000). The functions of attention, working memory and episodic memory are CDR-specific, with attention and working memory being the instrument's main measures (Keith, Stanislav & Wesnes, 1998: Wesnes, Ward, McGinty & Petrini, 2000). The battery has a keyboard command connected to a laptop, allowing participants to respond via YES/NO buttons to the information presented on the screen. All the tests and instructions were presented here in Spanish. Between 25 and 45 minutes are required per person to complete the battery (Ingwersen, Defeyter, Kennedy, Wesnes & Scholey, 2007), although this will depend on the individual's speed in responding to the items presented on the CDR screen. The present study used a single variable derived from summing the scores obtained on the attention and memory tests included in the CDR battery.
- *Academic grades obtained via the pupil's school report.* In order to obtain a measure of school performance we calculated the mean grade for the main subjects (environmental studies, art, Spanish, English and mathematics) featured in each pupil's school report at the end of the first semester of the academic year.

Determination of salivary cortisol and DHEAS levels

Four saliva samples were collected from each child in order to determine the salivary cortisol/DHEAS ratio. This strategy improves the reliability and accuracy of the initial indicator (cortisol). The dehydroepiandrosterone-sulfate (DHEA) is an androgen produced by the reticular layer of the adrenal cortex. It has proven to be influential in stress mechanisms both in adulthood and childhood (Kellner et al., 2009; Załuska and Janota, 2009). It shows a circadian rhythm similar to that of cortisol (Parker, 1999). DHEAs levels are usually low in individuals who are subject to stress (Jollin et al., 2009; Katsumata, Hirata, Inagaki, Hirata, Kawada, 2009). In this sense, the morning salivary cortisol/DHEAS ratio has proven to be a reliable and accurate indicator of stress in healthy individuals, as a number of research studies have observed an increase of such ratio (an increase in the cortisol concentration/decrease in the DHEAS concentration) in participants with high levels of stress which did not reach clinical intensity (Michael, Jenaway, Paykel and Herbert, 2000; Parker, 1999; Van Niekerk, Huppert and Herbert, 2001). The first was collected upon waking and the second 30 minutes later, the same procedure being repeated the following day. This procedure attempts to capture the increase in cortisol levels that occurs during the first half an hour after waking; these levels then decrease over the following 30 minutes and continue to fall as the day progresses (Steptoe, 2007; Wright & Steptoe, 2005). Therefore, we carried out four different determinations on the same hormone.

In order to improve the reliability of this salivary marker we also analysed DHEAS levels in the second saliva sample from the first day (Goodyear et al., 2001; Jollin et al., 2009; Katsumata, Hirata, Inagaki, Hirata & Kawada, 2009; Kellner et al., 2009; Załuska & Janota, 2009), thereby enabling us to calculate a cortisol/DHEAS ratio.

Samples were thawed and centrifuged at 3000 rpm for 5 minutes in order to obtain a clear and watery supernatant of low viscosity. Free cortisol levels were determined by using 20 μl of saliva in a chemiluminiscence immunoassay with temporal resolution (Test Elecsys for Cortisol). The lower detection limit of this assay was 0.5 nmol/L, with inter-assay coefficients and intra-assay variation coefficients of less than 10%. To determine DHEAS levels, 50 µl of saliva was used in an ELISA immunoassay (DeMeditec®). The analytic sensitivity of this assay was 2.186 pg/ml, with intra-assay variation coefficients of less than 7% across the whole of the expected range of DHEAS levels. Values for the cortisol/DHEAS ratio are expressed in nmol/L.

Procedure

After contacting the randomly-selected primary school and obtaining the relevant written approval from teachers and families, we proceeded to collect the data. Confidentiality was ensured at all times and the pupils' rights were always protected.

The IIEC (Trianes et al., 2011) was applied during the usual class timetable in a room equipped for such a purpose. Children were asked to think of potential stressors during a school term, then their school performance during that term was taken for analysis. Children aged 9 and over took the test as a group, whereas those aged 8 did so in small groups of 2-3 pupils. The CDR battery (Wesnes et al., 2003) was administered individually, with each pupil taking approximately 40 minutes to complete it. This was done in the afore-mentioned room.

The CDR battery was administered individually. To do so, an assessor sat with each child in front of a computer, and an answer-sheet was collected from each child.

As regards saliva sampling, parents or relatives were first given detailed instructions about the procedure and their role in it. They were told that they had to supervise the saliva sampling protocol to be followed by their children, and were given the necessary materials to do so, namely: four 10 ml sterile sample tubes, labelled by date and time, a document in which the saliva sampling protocol was explained in detail, and a questionnaire designed to increase the reliability of the cortisol/DHEAS ratio. The questionnaire – which included questions related to the control of saliva samples - required them to record the exact times at which samples were taken, the time at which their children went to bed on the two nights prior to the sampling, what they had for supper that night, what time they got up, whether they had slept well or not, how they were feeling when they got up, and the quality of their sleep. These additional control variables were taken into account in order to increase the reliability of the collection of saliva samples.

The specific saliva sampling procedure was as follows: children, supervised by a parent who had previously been instructed by the research staff, placed their saliva sample in the corresponding tube, firstly upon waking up and then again 30 minutes later. This procedure was then repeated the following day. Such procedure was strictly controlled by means of registering the exact hour and minute the samples were taken. Additionally, there were multiple telephone and written reminders, in order to exhaustively control parents who were responsible for the correct collection of saliva samples and who voluntarily committed to do so. On both days they were required to respect and follow the instructions given, i.e. they were not to eat, drink (except for water) or brush their teeth throughout the entire process of saliva sampling, which was not complete until the second sample had been collected. The children's samples were handed in upon arrival at school and were immediately placed in a freezer at -20 ºC, before being sent to a specialist laboratory for analysis.

Finally, and as mentioned above, school performance was measured according to the mean value of the grades recorded in each pupil's school report at the end of the first semester of the academic year.

Risk factors were controlled as explained above, in the section where the sample is described. This was done in order for such factors not to affect the endocrine regulation, and to ensure the data was valid and reliable.

Statistical analysis

Several statistical analyses were performed in order to meet the objectives of the present study: a) a descriptive and exploratory analysis in order to determine the sample characteristics and distribution with respect to the different study variables; b) a bivariate analysis of the relationships between variables, by means of Pearson's r coefficient; and c) multiple regression, in order to construct models and analyse the relationships among constructs.

Results

The descriptive analyses (based on means and standard deviations) showed that the sample was normative, as the means reached approximately the halfway point of the interval between the highest and lowest scores, excluding extreme values for the means and *SD* of the variables included: basic cognitive function, self-reported and hormonal daily stress, and school performance (Table 1).

Table 1. Descriptive statistics of children's daily stress, basic cognitive function, global school performance and morning salivary cortisol/DHEAS

Variable	Min – max	*M*	*SD*
Daily stress	0 – 17	6.35	3.87
Cognitive function	38.25 – 208.96	108.73	31.98
School performance	4.00 – 9.00	6.48	1.23
Salivary cortisol/DHEAS	0.01 – 0.67	0.12	0.12

Correlation analyses of these variables revealed an inverse and statistically significant relationship between basic cognitive skills and both self-reported daily stress levels (r = -.25; $p < .01$) and hormonal stress markers (r = -.22; $p < .03$). There was also a direct correlation between basic cognitive skills and school performance (r = .40; $p < .000$). By contrast, self-reported daily stress showed an inverse relationship with school performance (r = -.29; p < .003) (Table 2). As required in order to assess the correlations with the cortisol/DHEAS ratio we controlled for the effect of gender, age and body mass index (*BMI*) in each pupil by means of partial correlations.

Table 2. Pearson's correlation coefficients and level of significance among the studied variables.

Control variables		IIEC	Cortisol/ DHEAS	CDR	School performance
BMI, gender & age	IIEC	1			
	Cortisol/DHEAS	.19 .06	1		
	CDR	-.25 .01**	-.22 .03*	1	
	School performance	-.29 .003**	-.07 .47	.40 .000**	1

** Correlation is significant at the .01 level (bilateral)
* Correlation is significant at the .05 level (bilateral)

Taking all the selected variables, the Bayesian information criterion (BIC) was used to select the model that best predicted academic performance, with multiple logistic regression analysis being applied to identify the model with the lowest BIC value among all the possible regression models (including interactions). The best model was the one based on self-reported daily stress, basic cognitive function and age-adjusted gender. This model, obtained by means of the ENTER method, had an adjusted coefficient of determination of .22. Basic cognitive function showed a direct and significant association with academic performance *(r = .02, p* < .001), whereas the interaction of daily stress was indirectly related with academic performance (r = -.07, p = .02), the goodness of fit being 17.3%.

The analysis of the other models, which included the cortisol/DHEAS ratio, showed that this variable did not have any statistically significant effects.

As a result, daily stress contributes to predict school performance, in relation to which an inverse relationship can be observed: high levels of daily stress predict a low school performance. Therefore, daily stress has proven to be more influential than basic cognitive function when it comes to predict school performance.

Discussion and conclusions

The present research has tested a new model for the prediction of school performance. This model involves predicting performance based not only on cognitive variables (basic cognitive function) but also in relation to daily stress. The results indicate that the suggested predictive variables are successful in predicting performance, although they play different roles. The most relevant predictive variable is basic cognitive function, which correlated significantly with performance (.40) and, to a lesser degree, with both self-reported stress (-.25) and psychophysiological stress (-.22). In relation to the latter two variables, self-reported stress predicts academic performance (-.29), while the cortisol/DHEA ratio does not correlate. However, the psychophysiological stress variable correlated with basic cognitive function (-.22). The role of both stress variables is enhanced and their effects are linked in the interaction between both variables.

The resulting model includes basic cognitive function, gender, age and daily stress in the prediction of school performance. This means that in order to perform well at school, a pupil not only requires good basic cognitive function, but must also present low levels of daily stress. This is relevant in terms of explaining school failure in those pupils who, despite having a good cognitive level, obtain poor grades. One could demonstrate in these cases that the pupils in question are exposed to high levels of daily stress.

The observed interaction between the variables studied indicates that this is an interesting model for the prediction of school performance, not least because research to date has not studied the relationship between stress and cognitive variables when it comes to predicting such performance (Kaplan, Liu & Kaplan, 2005; Lupien & Maheu, 2007; Sandberg, 2007). There are many studies which could be considered as providing a background to the present findings, since they have shown that basic cognitive variables (attention and memory) can predict performance (Echevarry, Godoy & Olaz, 2007; Wesnes et al., 2009; Wesnes, Pincock, Richardson, Helm & Halis, 2003; Wesnes, Ward, McGinty & Petrini, 2000). However, there is very little research relating psychological and psychophysiological stress to school performance (Lupien & Maheu, 2007; Sandberg, 2007; Steptoe, 2007). The present study has attempted to fill this gap by including psychological and psychophysiological stress in the analysis, together with basic cognitive function, in order to predict performance. It should be noted, however, that this psychophysiological variable did not have a statistically significant effect, a fact that proves the need for a higher number of biological measurements to be applied along a future longitudinal study.

These results make sense intuitively, in that it seems plausible that good school performance requires not only good cognitive skills, but also peace of mind and a lack of daily stress. The next step will be to test the present model in a larger sample, although it is worth noting that the current sample size is acceptable, as it refers to a study where saliva samples were taken for hormonal analysis (Li & Gleeson, 2004; Nater, Rohleder, Schlotz, Ehlert & Kirschbaum, 2007; Rohleder, Nater, Wolf, Ehlert & Kirschbaum, 2004), something which is inherently difficult. The present study suggests that future research should also consider the possibility of a longitudinal analysis, with repeated measurements of daily stress and stress biological markers, which would enable estimates to be made of the differences due to children's development, and also help to define more precisely the role played by the model's variables. Likewise, it would be interesting to study this relationship in selected groups with different types of difficulties, for example, problems with reading and writing, in order to determine whether these circumstances modify the model obtained here with pupils without particular difficulties.

In conclusion, the present study demonstrates that stress, measured by means of the IIEC, interacts inversely with basic cognitive function, assessed by the CDR system, and with school performance. This result suggests a new way of explaining school failure in those pupils who, despite having good memory and attentional skills, suffer from daily stress. Given that both cognitive factors, such as poor attention and memory, and emotional factors, such as self-reported stress, have an impact on school performance, it would seem necessary for any treatment aimed at helping underachieving pupils to work on improving not only their cognitive skills but also their emotional capabilities, such as coping with daily stress.

References

Achenbach, T. M., & Dumenci, L. (2001). Advances in Empirically Based Assessment: Revised Cross-Information Syndromes and New DSM-Oriented Scales for the CBCL, YSR, and TRF. *Journal of Consulting and Clinical Pychology, 69,* 699-702.

Allison, P. D. (1977). Testing for Interaction in Multiple Regression. *American Journal of Sociology, 83,* 144-253.

Baker, S. R. (2006). Towards an Idiothetic Understanding of the Role of Social Problem Solving in Daily Event, Mood and Health Experiences: a Prospective Daily Diary Approach. *British Journal of Health Psychology, 11*(3), 513-531.

Baron, R. M., & Kenny, D. A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical. Considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.

Carvajal, C. (2005). Estrés y depresión: una mirada desde la clínica a la neurobiología. *Revista Médica de la Clínica Condes, 16* (4), 210-219.

Chamberlain, K., & Zika, D. (1990). The Minor Events Approach to Stress: Support for the Use of Daily Hassles. *British Journal of Psychology, 81*(4), 469-481.

Compas, B. E., Ey, S., & Grant, K. E. (1993). Taxonomy, Assessment, and Diagnostic of Depression during Adolescent. *Psychological Bulletin, 114*, 323-344.

Echavarri, M., Godoy, J. C., & Olaz, F. (2007). Diferencias de género en habilidades cognitivas y rendimiento académico en estudiantes universitarios. *Universitas Psicológicas, 6*(2), 319-329.

Ezpeleta, L. (2005). *Factores de riego en psicopatología del desarrollo*. Barcelona: Masson.

Fierro, A. (2002). *Personalidad, persona, acción. Un tratado de Psicología*. Madrid: Alianza Editorial.

Fragoso, T. C., & Alcántara, M. A. (2003). *Influencia de los factores estresantes en el rendimiento escolar en alumnos de segundo de secundaria.* Psicología. México: Universidad Franco Mexicana.

García, J. (2010, Abr). Los Veintisiete debaten cómo reducir las tasas de fracaso escolar en la UE. Retrieved from http://www.elmundo.es/elmundo/2010/04/13/union_europea/1271153277.html.

Gerbot, E., & Barumandzadeh, T. (2005). Access to University: Stressfull Situation at the Onest Some Dysfunctional Coping Strategies. *Annales Medico-Psychologiques, 163*(7), 561-567.

Gómez Dacal, G. (1976). Evaluación formativa. *Vida Escolar, 177* (78), 6-11.

Goodyear, J., Park, R. J., Netherton, C. M., & Herbet, J. (2001). Possible Role Of Cortisol And Dehydroepiandrosterone And Psychopathology. *British Jouranl of Psychiatry, 179*, 243-249.

Grant, K. E., Compas, B. E., Thurm, A. E. McMahon, S. D., & Gibson, P. Y. (2004). Stressors and Child and Adolescent Psychopatology: Measurement Issues and Prospective Effects. *Journal of Clinical Child and Adolescent Psychology, 33*(2), 412-425.

Grant, K. E., Compas, B. E., Thurm, A. E., McMahon, S. D., Gibson, P. Y., & Campbell, A. J. (2006). Stressors and Child and Adolescent Psychopathology: Evidencing of Moderating and Mediating Effects. *Clinical Psychology Review, 26,* 257-283.

Gutiérrez Calvo, M. (1996). Ansiedad y deterioro cognitivo: incidencia en el rendimiento académico. *Ansiedad y Estrés, 2(*2-3), 173-194.

Haskell, C. F., Kennedy, D. O., Wesnes, K. A., & Scholey, A. B. (2005). Cognitive and Mood Improvements of Caffeine in Habitual Consumers and Habitual Non-Consumers of Caffeine. *Psychopharmacology, 179*, 813–825.

Ingram, R. E., & Luxton, D. D. (2005). Vulnerability-Stress Models. In B. L. Hankin & J. R. Abela (Eds.), *Development of Psychopathology: A Vulnerability-Stress Perspective* (pp. 32-46). CA, US: Sage Publications.

Ingwersen, J., Defeyter, M. A., Kennedy, D. O., Wesnes, K. A., & Scholey A. B. (2007). A Low Glycaemic Index Breakfast Cereal Preferentially Prevents Children's Cognitive Performance from Declining throughout the Morning. *Science Direct Appetite, 49,* 240–244.

Jollin, L., Thomasson, R., Le Panse, B., Baillot, A., Vibarel-Rebot, N., Lecoq, A. M., Amiot, V., De Ceaurriz, J., & Collomp, K. (2009). Saliva DHEA and cortisol responses following short-term corticosteroid intake. *European journal of clinical investigation, 39*(12)*,* 11-14.

Kaminski, K. L. (1999). The Relationships between Students' Perceived Stress and Support Factors and Academic Motivation within Two Disparate Secondary Schools. (Motivation, Adolescents, School Environment). *Dissertation Abstracts International Section A: Humanities and Social Science, 59*(10-A), 37-81.

Kanner, A. D., Coyne, J. C., Schaefer, C., & Lazarus, R. S. (1981). Comparison of Two Models of Stress Measurement: Daily Hassles and Uplifts Versus Major Life Events. *Journal of Behavioural Medicine, 4*(1), 1-39.

Kaplan, D. S., Liu, R. X., & Kaplan, H. B. (2005). School Related Stress in Early Adolescence and Academic Performance Three Years Later: The Conditional Influence of Self Expectations. *Social Psychology of Education, 8*, 3-17.

Katsumata, M., Hirata, K., Inagaki, H., Hirata, Y., & Kawada, T. (2009). Evaluation of new saliva collection device for determination of salivary cotinine, cortisol, dehydroepiandrosterone and testosterone concentrations. *Nippon Eiseigaku Zasshi (Japanese journal of hygiene), 64*(4), 811-6.

Keith, M. S., Stanislav, S. W., & Wesnes, K. A. (1998). Validity of a cognitive computerized assessment system in brain-injured patients. *Brain Injury, 12*(12), 1037-43.

Kellner, M., Muhtz, C., Peter, F., Dunker, S., Wiedemann, K., & Yassouridis, A. (2009). Increased DHEA and DHEA-S plasma levels in patients with post-traumatic stress disorder and a history of childhood abuse. *Journal of Psychiatry Research, 43*(12), 1025-1035.

Kennedy, D. O., Haskell, C. F., Wesnes, K. A., & Scholey, A. B. (2004). Improved Cognitive Performance in Human Volunteers Following Administration of Guarana (Paullinia Cupana) Extract: Comparison And Interaction with Panax Ginseng. *Pharmacology, Biochemistry and Behavior, 79,* 401-411.

Kouzma, N. M., & Kennedy, G. A. (2002). Homework, Stress, and Mood Disturbance in Senior High School Student. *Psychological Reports, 91*, 193-198.

Lazarus R. S. (1984). On the Primacy of Cognition. *American Psychologist, 39,* 124-129.

Lazarus R. S., & Folkman, S. (1986). *Estrés y procesos cognitivos*. Barcelona: Martinez-Roca.

Li, T., & Gleeson, M. (2004). The Effect of Single and Repeated Bouts of Prolonged Cycling and Circadian Variation on Saliva Flow Rate, Immunoglobulin A and Alpha-Amylase Responses. *Journal of Sports Sciences*, *22*, 1015-1024.

Lindau, M., Almkvist, O., & Mohammed, A. H. (2007). Effects of Stress on Learning and Memory. *Encyclopedy of Stress (Second Edition), 2*, 571-577.

Lupien, S. J., & Maheu, F. S. (2007). Memory and Stress. *Encyclopaedic of Stress (Second Edition), 2*, 693-699.

Margalit, M., & Shulman, S. (1996). Autonomy Perceptions and Anxiety Expressions of Learning Disabled Adolescents. *Journal of Learning Disabilities, 19*, 291-293.

Michael, A., Jenaway, A., Paykel, E.S., & Herbert, J. (2000). Altered Salivary Dehydroepiandrosterone Levels in Major Depression in Adults. *Biological Psychiatry*, *48*, 989-995.

Mirowsky, J., & Ross, C. E. (2007). Education Levels and Stress. *Encyclopedy of Stress (Second Edition), 1*, 888-893.

Nater, U. M. (2004). *The role of salivary alpha-amylase in stress research.* Göttingen: Cuvillier Verlag.

Nater, U. M., & Rohleder, N. (2009). Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system: current state of research. *Psychoneuroendocrinology, 34*(4), 486-96.

Nater, U. M., Rohleder, N., Schlotz, W., Ehlert, U., & Kirschbaum, C. (2007). Determinants of the Diurnal Course of Salivary Alpha-amylase. *Psychoneuroendocrinology, 32*(4), 392-401.

Parker, C. R. (1999). Dehydroepiandrosterone and Dehydroepiandrosterone Sulfate Production in the Human Adrenal during Development and Aging. *Steroids, 64*, 640–647.

Pinel, J. P. (2001). *Biopsicología.* Madrid: Pearson Educación.

Rohleder, N., & Nater, U. M. (2009). Determinants of salivary alpha-amylase in humans and methodological considerations. *Psychoneuroendocrinology, 34*(4), 469-85.

Rohleder, N., Nater, U.M., Wolf, J. M., Ehlert, U., & Kirschbaum, C. (2004). Psychosocial Stress-Induced Activation of Salivary Alpha-Amylase. An Indicator of Sympathetic Activity? *Annals of the New York Academy of Sciences*, *1032*, 258-263.

Sandberg, S. (2007). Childhood Stress. *Encyclopaedic of Stress (Second Edition), 1,* 442-478.

Scholey, A. B., & Kennedy, D. O. (2004). Cognitive and Physiological Effects of an "Energy Drink": an Evaluation of the Whole Drink and of Glucose, Caffeine and Herbal Flavouring Fractions. *Psychopharmacology, 176*, 320–330.

Steptoe, A. (2007). Cortisol Awakening Response. *Encyclopedia of Stress (Second Edition), 1,* 649-653.

Stone, E. F., & Hollenbeck, J. R. (1989). Clarifying Some Controversial Issues Surrounding Statistical Procedures for Detecting Moderator Variables: Empirical Evidence and Related Matters. *Journal of Applied Psychology, 74,* 3-10.

Trianes, M. V., Blanca, M. J., Fernández, F. J., Escobar, M., & Maldonado, E. F. (2011). *IECI. Inventario de Estrés Cotidiano Infantil.* Madrid: TEA Ediciones.

Van Niekerk, J. K., Huppert, F. A., & Herbert, J. (2001). Salivary Cortisol and DHEA: Association with Measures of Cognition and Well-Being in Normal Older Men, and Effects of Three Months of DHEA Supplementation. *Psychoneuroendocrinology*, *26*, 591-612.

Wesnes, K., Annas, P., Edgar, C., Deeprose, C., Karlsten, R., Philipp, A., Kalliomäki, J., & Segerdahl, M. (2009). Nabilone produces marked impairments to cognitive function and changes in subjective state in healthy volunteers. *Journal of Psychopharmacology, 16*(4)*,* 402-408.

Wesnes, K. A., Pincock, C., Richardson, D., Helm, G., & Hails, S. (2003). Breakfast Reduces Declines in Attention and Memory Over the Morning in Schoolchildren. *Appetite, 41*, 329–331.

Wesnes, K. A., Ward, T., McGinty, A., & Petrini, O. (2000). The Memory Enhancing Effects of a Ginkgo Biloba/Panax Ginseng Combination in Healthy Middle-Aged Volunteers. *Psychopharmacology, 152*, 353–361.

Wolf, T. M., Elston, R. C., & Kissling, G. E. (1989). Relationship of Hassles, Uplifts, and Life Event to Psychological Well-Being of Freshman Medical Students. *Journal of Behavioural Medicine, 15*(1), 37-45.

Wrigh, C. E., & Steptoe, A. (2005). Subjective Socioeconomic Position, Gender and Cotisol Responses to Waking in an Eldery Population. *Psychoneuroendocrinology, 30*, 582-590.

Wright, R., Cohen, T., & Cohen, S. (2005). The Impact of Stress on the Development and Expression of Atopy. *Current Opinion in Allergy and Clinical Immunology, 5*, 23-29.

Zaluska, M., & Janota, B. (2009). Dehydroepiandrosteron (DHEA) in the mechanisms of stress and depression. *Psychiatria Polska, 43*(3), 263-74.

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