

## Sympathetic reactivity to experimentally induced stress in alexithymia

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**Título:** Reactividad simpática al estrés inducido experimentalmente en la alexitimia.

**Abstract:** Alexithymia refers to a specific disturbance in emotional processing that is manifested through difficulties in identifying and verbalizing feelings. The main objective of this research has been the study the relationship between sympathetic reactivity patterns, measured by electrodermal activity, and the alexithymia level, in a stressful laboratory situation. The subjects were high- or low-alexithymic young females (separated by TAS-20). The experiment involved six phases and the sympathetic reactivity was assessed in each one of them, using the Palmar Sweat Index (PSI), a sensitive indicator of the number of active sweat glands. The results show that both alexithymic and non-alexithymic subjects showed significant increases in PSI during stress phases and systematic decreases in all relaxation phases. We also obtained significant differences between TAS-20 low and high scores and between aggregated experimental phases, but no evidence of interaction TAS-20 x experimental phases. The results provide little support with the hypothesis that alexithymic subjects are more physiologically reactive to stress.

**Key Words:** Emotion; alexithymia; stress; palmar sweat index.

**Resumen:** La alexitimia describe un trastorno específico del procesamiento emocional que se manifiesta mediante una marcada dificultad para identificar y expresar emociones. El objetivo principal de este trabajo ha sido valorar la relación entre los patrones de activación simpática, medidos mediante la actividad electrodermal, y el nivel de alexitimia, en una situación de estrés inducido experimentalmente en el laboratorio. Se emplearon mujeres jóvenes con niveles altos y bajos de alexitimia, clasificadas mediante las puntuaciones que obtuvieron en el TAS-20. El experimento comprendió seis fases, en las que se evaluó su reactividad simpática en cada una de ellas mediante el empleo del Índice de Sudoración Palmar, un indicador sensible al número de glándulas ecrinas activas. Los resultados mostraron que en ambos grupos se produjeron incrementos significativos en el número de glándulas sudoríparas activas durante las fases de estrés, así como reducciones en las fases de relajación. Se obtuvieron también diferencias significativas en los que obtuvieron puntuaciones altas y bajas en el TAS-20 durante las distintas fases experimentales, pero no se apreciaron evidencias de interacción entre las fases y los niveles de alexitimia. Los resultados proveen un moderado apoyo a la hipótesis que sostiene que los alexitímicos son más reactivos fisiológicamente al estrés.

**Palabras clave:** Emoción; alexitimia; estrés; índice de sudoración palmar.

### Introduction

The term Alexithymia (literally from Greek: lack of words for emotions), refers to a specific disturbance in affective-emotional processing that is manifested through the following salient features: 1) difficulty in identifying and describing feelings and emotions verbally, 2) difficulty in distinguishing between feelings and somatic sensations that accompany emotional arousal, and 3) externally-oriented thinking and impaired symbolic activity (Taylor, 2000; Taylor, Bagby, & Parker, 1997). The most recent research has stressed the point that in alexithymia there is not only a difficulty in expressing emotions verbally but also a deficit in the cognitive processing of emotions (Berenbaum & Prince, 1994; Jessimer & Markham, 1997; Lars-Gunnar & Simonsson-Sarnecki, 2002; Parker, Taylor, & Bagby, 1993; Roedema & Simons, 1999; Suslow, 1998; Suslow & Junghanns, 2002); as a consequence, emotions remain undifferentiated and poorly regulated (Taylor, Bagby, & Parker, 1991).

Experimental studies have supported the hypothesis that alexithymia might be associated with variations in brain activity (Franz, Schaefer, Schneider, Sitte, & Bachor, 2004; Richter et al. 2006). Kano et al. (2003) found differences in brain responses (mainly observed in the cortex areas, but not in the subcortical regions) to facial expressions between people with and without alexithymia. These results suggest that people with alexithymia process differently from people

without alexithymia, and that this difference may account for the disorder of affect regulation and consequent peculiar behaviour in people with alexithymia.

These characteristics are conceptualized both as an affect-deficit disorder and a continuous personality trait (Martínez-Sánchez, Ato, Córcoles, Huedo, & Selva, 1998; Martínez-Sánchez, Ato, & Ortiz, 2003) that correlates positively with neuroticism (Pandey & Mandal, 1996), depression (Hendryx, Haviland, & Shaw, 1991) and anxiety (Bagby, Taylor, & Atkinson, 1988). Some authors (Horton, Gewirtz, & Kreutter, 1992) argue that alexithymia could be considered also as a state consequent to depression and/or anxiety (Hendryx, Haviland, Shaw, & Henry, 1994), as well as the effect of some chronic psychopathologic and somatic disorders.

It has been hypothesized that the limited emotional awareness and cognitive processing of affects lead to prolonged and amplifies the physiological arousal and neurovegetative reactivity to stress (Infrasca, 1997; Martin & Pihl, 1986b; Papiak, Feurstein, & Spiegel, 1985) potentially disturbing the autonomic, pituitary-adrenal, and immune system. These dysregulated physiological responses over many years may result in untoward health effects (Li & Sinha, 2006; Lumley, Stettner, & Wehmer, 1996; Lumley, Tomakowsky, & Torosian, 1997).

Several reports reveal a higher prevalence of alexithymic characteristics among patients with stress-related disorders in comparison with other patients and normal controls (Fukunishi, Tsuruta, Hirabayashi, & Asukai, 2001; Kohn, Gurevich, Pickering, & McDonald, 1994; Krystal, Giller, & Cicchetti, 1986; Zeitlin, McNally, & Cassidy, 1993); however, the relationship between alexithymia and stress-related illness

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is more complex than a simple co-occurrence (Martin & Pihl, 1985).

Several studies have examined autonomic activity associated with alexithymia, both at rest and in response to stressors. The hyperarousal model poses that alexithymia is related to higher tonic levels of sympathetic activity and/or exaggerated sympathetic reactivity (and possibly parasympathetic withdrawal) to emotional stressors. There is some evidence of tonic physiological hyperarousal in association with alexithymia (Gündel et al. 2002; Newton & Contrada, 1994; Papciack, Feurestein, & Spiegel, 1985; Rabavilas, 1987; Stone & Nielson, 2001). In contrast, the hypoarousal theory of alexithymia predicts that, under conditions of comparable emotional provocation, there is less physiological activation in individuals with alexithymic tendencies; there is no evidence that alexithymia leads to an excessive reactivity to stressors; indeed, most studies found either no alexithymia effect, or that alexithymia was related to less reactivity (Hyer, Woods, & Boudewyns, 1990; Linden, Lenz, & Stossel, 1996; Nemiah, Sifneos, & Apfel-Savitz, 1977; Wehmer, Brejnak, Lumley, & Stettner, 1995). In support of the hypoarousal model, four studies (i.e., Neumann, Sollers, Thayer, & Waldstein, 2004; Linden, Lenz, & Stossel, 1996; Newton and Contrada, 1994; Brejnak, Lumley, & Stettner, 1995) found that alexithymic men and women displayed attenuated heart rate responses to emotion-provoking tasks.

Because the studies using the SSPS and MMPI-based alexithymia scales are now considered to possess insufficient reliability and validity it was considered possible that the opposite results might be a function of different alexithymia measures.

Martin & Pihl (1986a) argued that alexithymic subjects are not necessarily more physiologically reactive to stress *per se*, but their subjective stress responses tend to be “decoupled” from their autonomic responses. Experimental evidence for a decoupling of HR and the subjective report of tension was found in alexithymics (Martin & Pihl, 1986a; Näring & van der Staak, 1995; Papciack, Feurestein, & Spiegel, 1985). In a previous work (Martínez-Sánchez, Ortiz & Ato, 2001) we carried out a study to evaluate this “decoupling hypothesis”; results do not show significant correlations (high versus low alexithymia scores) between the subjective self-perception of activation and the autonomous reactivity.

The purpose of the present study was to evaluate the relationship between autonomic physiological reactivity patterns to stressful laboratory situations in college students with high versus low alexithymia scores. To produce emotional arousal in our subjects, we designed a laboratory stress task with four different experimental conditions: baseline (adaptation), relaxation and two conditions of stress, cognitive and visual stimuli.

## Method

### Subjects

Eighty five female undergraduates psychology students, aged between 18 and 22 ( $\bar{x} = 19.38$ ;  $S_x = 1.94$ ) participated in this experiment. They were all randomly selected from students enrolled in the “Psychology of Emotion” course at the University of Murcia who scored in the upper or lower quartile of the distribution of scores on the TAS-20. Subjects were divided into two groups according to their alexithymia scores which were based on quartile criteria, 20 in the lower 25 percentile, 23 in the upper 25 percentile. All subjects reported being in good health and none were taking medication at the time of the study that might have influenced either physiological responses or the perception of bodily sensations. Subjects were asked not to ingest alcohol, caffeine, or nicotine 2 hours prior to the experimental study. They all got an academic credit in return for their cooperation.

### Materials and measures

The experiment was conducted in a laboratory with controlled temperature and illumination. Electrodermal activity was assessed using the Palmar Sweat Index (PSI); palmar sweat gland activity is a very sensitive indicator of autonomic reactivity (Fernández Castro *et al.*, 1991; Freedman *et al.*, 1994; Köhler, Weber, & Vögele, 1990; Turpin & Clements, 1993). PSI was assessed using the plastic impression technique, with fingerprints being obtained at 2,5-min intervals from the left index finger. PSI provides a direct measure of the number of sweat glands using a solution of 3% polyvinyl formal, 1% butylphthalate as a plasticizer, and the remainder ethylene dichloride. Toronto Alexithymia Scale, TAS-20 (Bagby, Parker & Taylor, 1994), Spanish version (Martínez-Sánchez, 1996) was used. The TAS-20 is a 20-item self-report measure of the alexithymic construct with good internal consistency, high test-retest reliability and construct and criterion validity (Bagby, Taylor, & Parker, 1994; Taylor, Bagby, & Luminet, 2000). A three-factor structure is theoretically congruent with the alexithymia construct: (F. I.) difficulty to identify feelings and to distinguish between feelings and somatic sensations of emotional arousal; (F. II.) difficulty in describing feelings to others; and (F. III.) externally-oriented thinking. A Spanish version of TAS-20 was accomplished by Spanish psychologists fluent in both English and Spanish, using back-translation methodology; this version showed good internal consistency ( $\alpha = .78$ ) and test-retest reliability ( $r = .71$ ,  $p < .001$ ) over a 19-week interval. These results are comparable to those obtained with the English version of the scale.

The stability and replicability of this factor structure were demonstrated with both clinical and non-clinical populations by the use of confirmatory factor analysis (Bagby, Parker, & Taylor, 1994; Parker, Bagby, Taylor, Endler, & Schmitz, 1993).

**Experimental tasks and procedure**

The experiment protocol (i.e. baseline definition, data reduction recovery periods, etc.) follows the standard designs used in several studies (Fernández Castro, Martínez-Sánchez, & Ortiz, 1999; Köhler, Weber, & Vögele, 1990; Köhler & Troester, 1991; Köhler & Schuschel, 1994; Martínez-Sánchez, Ortiz, & Fernández, 1998).

Participants attended individually the laboratory session. After orientation, the subject was greeted by the experimenter and given a written explanation of the experiment and consent form. After completion of the consent form, the subject sat quietly for 20 minutes. The experiment itself started with a 10 min adaptation phase during which the subjects had to relax and get used to the measurement procedures, especially the taking of the fingerprints (adaptation phase). This was followed by another 7,5 min of relaxation (from min 10 to 17,5), after which there was an instruction phase I lasting 1,5 min; from min 19 to 26,5 (stress I, mental arithmetic), the subjects has to count backward by step of seven as quickly as possible, starting from 2007, which was followed by another resting phase of 7,5 min duration (relaxation II from 26,5 to 34 min). The second part of the experiment followed the same scheme: 34-35 instruction phase II; 35-42,5 (stress II) during this phase the subjects had to watch a distressing film about surgery. Thereafter the subjects were told to relax again (III-relaxation from 42,5-50 min). All except 5 students completed the experimental protocol.

**Results**

Due to the high *heterogeneity* between groups variance observed in almost all phases of the experiment, we carried out Barlett's homogeneity of variance tests for scores obtained in each phase (see Table 1). A transformation log of observed electrodermal activity (PSI scores) was applied in order to get homogeneous groups.

**Table 1:** Barlett's homogeneity of variances tests of all phases, before and after log transformation.

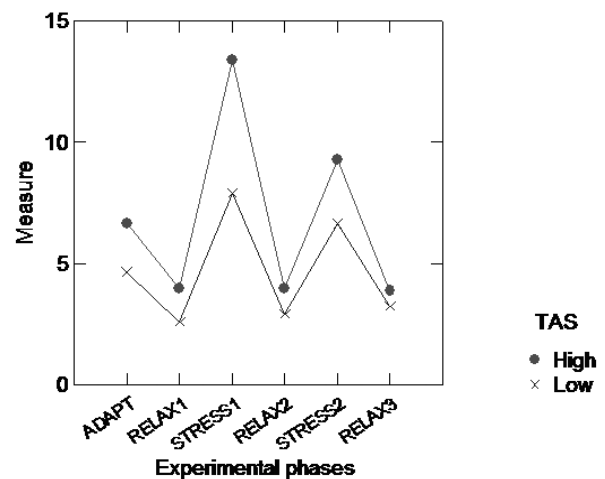
Phases	Before transformation		After transformation	
	Barlett K <sup>2</sup>	P	Barlett K <sup>2</sup>	P
Adaptation	2.99	.084	.28	.598
Relaxation 1	8.45	.004	.38	.537
Stress 1	6.85	.009	.14	.705
Relaxation 2	0.10	.752	.30	.584
Stress 2	8.04	.005	.46	.499
Relaxation 3	1.16	.281	.19	.660

To cope with the resulting 2 (TAS classes: Low and High Alexithymia) x 3 (Phases: Adaptation, Relaxation and Stress) mixed design with repeated measures in the second variable, we used a mixed model approach (Keselman, Algina, & Kowalchuk, 2001). This analytical strategy unifies many common statistical approaches, including standard repeated measures, in a general likelihood-based procedure called general linear mixed models (Pinheiro & Bates, 2000; Verbeke & Mollenberghs, 1997). It basically consists of a conventional linear model to test repeated measures hypotheses combined with a flexible specification of the most appropriate covariance structure. Modelling the correct covariance structure of the data should normally result in more powerful tests of fixed-effect parameters (Littell, Pendergast, & Natarajan, 2000).

Mean values of all experimental phases with original PSI measure show a clear trend to a systematic increase of the dependent measure in all stress phases, and systematic decreasing in all relaxation phases, but no evidence of interaction in function of TAS scores (see Table 2 and Figure 1). The same pattern was observed when all stress and relaxation phases were aggregated (see Table 3 and Figure 2).

**Table 2:** Observed means of all experimental phases by TAS scores

TAS score	Experimental phases					
	Adaptation	1-Relax.	1-Stress	2-Relax.	2-Stress	3-Relax.
Low	4.635	2.587	7.890	2.912	6.634	3.239
High	6.646	3.971	13.383	3.980	9.294	3.882



**Figure 1.** Means of all experimental phases

**Table 3:** Observed means of aggregated experimental phases.

TAS score	Adaptation	Relaxation	Stress
Low	4.635	2.913	7.262
High	6.646	3.945	11.338

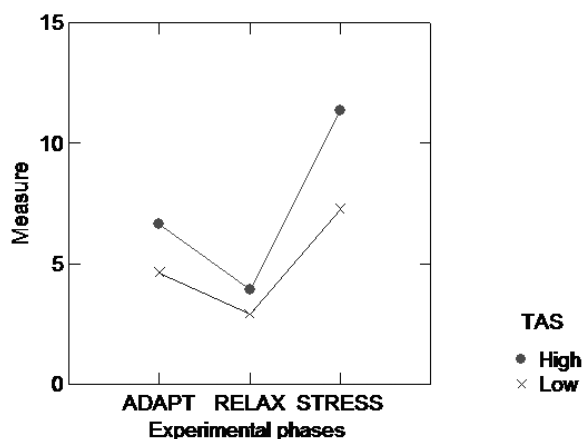


Figure 2: Means of aggregated experimental phases.

We used PROC MIXED procedure in SAS version 8 (SAS Institute, 1996) to estimate fixed effect parameters. In order to compare models with the same fixed effects we tried different covariance structures with our data. The best covariance structure, in terms of both indexes of relative goodness-of-fit Akaike Information (AIC) and Schwarz's Bayesian Criterion (SBC), was compound symmetry (see Table 4). *Models with closer to zero AIC and SBC criteria indicate a better fit.*

Table 4: Values of Akaike and Schwarz criteria on 7 covariance structures

Covariance structure	Akaike's criterion	Schwarz's criterion
Compound symmetry	-229.1	-230.8
Toeplitz	-229.2	-234.2
Huynh-Feldt	-229.9	-235.6
Homogeneous		
compound symmetry	-231.9	-237.6
Unstructured	-232.0	-249.2
Autoregressive (1)	-240.7	-242.3
Variance components	-259.8	-260.6

Using type 3 Sum of Squares for fixed effects, we obtained significant differences between TAS Low and High scores:  $F_{1,36} = 4.63$ ;  $P = .0382$  and between aggregated experimental phases:  $F_{2,74} = 79.54$ ;  $P < .0001$ , but no evidence of interaction TAS x experimental phases.

## Discussion

The main objective of this study has been to evaluate the autonomic reactivity to experimentally induced stress in alexithymic subjects. The results show that both alexithymic and nonalexithymic subjects showed significant increases in PSI during the stress phases; mean values of all experimental phases with original PSI measure show a clear trend to a systematic increase of dependent measure in all stress phases, and systematic decreasing in all relaxation phases, but no

evidence of interaction in function of TAS-20 scores; the same pattern was observed when all stress and relaxation phases were aggregated. Also, we obtained significant differences between TAS-20 low and high scores and between aggregated experimental phases, but no evidence of interaction TAS-20 x experimental phases.

High alexithymics showed an increase of electrodermal activity as an expression of autonomous arousal during stress phase. These results provide little support to the hypothesis that alexithymic subjects are more physiologically reactive to stress, evaluated with the Palmar Sweat Index.

The association between alexithymia and higher sympathetic vegetative reactivity (emotional arousal) is still controversial. Our data confirm Papciak et al.'s (1985) findings. They predicted that alexithymic male college students would react autonomically to stress just as normal subjects do; they used a stress quiz to provoke autonomic responses and recorded blood pressure, HR, and frontal electromyogram results, founding that both alexithymic and nonalexithymic subjects showed significant increases in HR and blood pressure during the stress quiz. Stone & Nielson (2001) found that high-alexithymic subjects had a significantly higher electrodermal activity after exposure to an emotionally arousing videotape than that of the low-alexithymic participants, but no differences were found between high and low alexithymics in electrodermal activity under cognitive distress.

With the exception of Waldstein et al. (2002), six studies supporting the hypoarousal model (Linden et al., 1996; Neumann et al., 2004; Nemiah et al., 1997; Newton and Contrada, 1994; Wehmer et al., 1995) consisted of considerably younger participants which may, at least in part, account for the differential reactivity patterns (Neumann et al., 2004). In an investigation of alexithymia and cardiovascular reactivity Linden et al. (1996) found no relationship between alexithymia and blood pressure responses, although heart rate responses were lower in high alexithymia individuals. In a similar study, Friedlander et al. (1997) found no relationship between alexithymia and blood pressure responses to the stressor of viewing disgusting scenes, but women with high alexithymia had a different pattern of heart rate changes than women with low alexithymia.

Only a few studies have provided evidence of sympathetic hyperactivity in alexithymics in response to emotional stimuli. A possible explanation for these different results may be that different types of alexithymia, formed by distinct neural malfunction produce different levels of sympathetic activity (Larsen, Brand, Bermond, & Hijman, 2003). The inconsistent findings may be explained, in part, by the use of different emotion-inducing stimuli and also to the monitoring of different physiological variables.

Regarding changes of PSI during stressful situations, our results replicate findings from previous studies (Köhler, Weber, & Vögele, 1990; Köhler & Troester, 1991; Köhler & Schuschel, 1994; Martínez-Sánchez, Fernández, & Ortiz, 1998; Turpin & Clements, 1993), in accordance with reactions in other psychophysiological variables observed in

some studies: PSI increased significantly from baseline to stress and decreased after its cessation.

There are some limitations in the present study concerning the generalization of results. First, the subjects were women and the applicability of the results for the male population remains to be shown. Second, there may be some limitations in the generalization of the results related with PSI; further studies are needed to replicate changes in PSI during stress, however diverse investigations have demonstrated that PSI displays essentially the same behaviour as electrodermal variables (Clements & Turpin,

1996); the physiologic basis of the electrodermic response has been identified as the activity of the sudoriferous glands, which are innervated by the sympathetic branch, thus making this neurovegetative parameter reliable for measuring arousal. Another problem is the intrusiveness of method, because the subject perceives clearly the application of the drop, its removal and the social interactions involved.

In conclusion, it must be concluded that our data provides little support with the hypothesis that alexithymic are more physiologically reactive to experimentally induced stress.

## References

- Bagby, R.M., Parker, J.D., & Taylor, G.J. (1994). The twenty-item Toronto Alexithymia Scale-I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research, 38*(1), 23-32.
- Bagby, R.M., Taylor, G.J., & Atkinson, L. (1988). Alexithymia: a comparative study of three self-report measures. *Journal of Psychosomatic Research, 32*, 107-116.
- Bagby, R.M., Taylor, G.J., & Parker, J.D. (1994). The twenty-item Toronto Alexithymia Scale-II. Convergent, discriminant, and concurrent validity. *Journal of Psychosomatic Research, 38*(1), 33-40.
- Berenbaum, H., & Prince, J.D. (1994). Alexithymia and the interpretation of emotion-relevant information. *Emotion and Cognition, 8*(3), 231-244.
- Clements, K., & Turpin, G. (1996). Physiological effects of public speaking assessed using a measure of palmar sweating. *Journal of Psychophysiology, 10*, 283-290.
- Fernández Castro, J., Köhler, Th., Limonero, J.T., Prieto, L., & Edo, E. (1991). Un método casi desconocido para medir la actividad de las glándulas sudoríparas. *Cuadernos de Medicina Psicosomática, 19*, 28-31.
- Fernández Castro, J., Martínez-Sánchez, F., & Ortiz Soria, B. (1999). Efecto modulador de la competencia personal percibida sobre la reactividad fisiológica al estrés inducido experimentalmente. *Revista de Psicología Contemporánea, 6*(1), 82-89.
- Franz, M., Schaefer, R., Schneider, C., Sitte, W., & Bachor, J. (2004). Visual event-related potentials in subjects with alexithymia: modified processing of emotional aversive information? *American Journal of Psychiatry, 161*, 728-735.
- Freedman, L.W., Scerbo, A.S., Dawson, M.E., Raine, A., McClure, W.O., & Venables, P.H. (1994). The relationship of sweat glands count to electrodermal activity. *Psychophysiology, 31*, 196-200.
- Friedlander, L., Lumley, M. A., Farchione, T., & Doyal, G. (1997). Testing the alexithymia hypothesis: Physiological and subjective responses during relaxation and stress. *Journal of Nervous and Mental Diseases, 185*, 233-239.
- Fukunishi, I., Sei, H., Morita, Y., & Rahe, R.H. (1999). Sympathetic activity in alexithymics with mother's low care. *Journal of Psychosomatic Research, 46*, 579-589.
- Fukunishi, I., Tsuruta, T., Hirabayashi, N., & Asukai, N. (2001). Association of alexithymic characteristics and posttraumatic stress responses following medical treatment for children with refractory hematological diseases. *Psychological Report, 89*(3), 527-534.
- Gündel, H., Greiner, A., Ceballos-Baumann, A.O., von Rad, M., Förstl, H., & Jahn, T. (2002). Erhöhte sympathische Grundaktivität bei hoch- versus niedrig-alexithymen Patienten mit spasmodischem Tortikollis. *Psychotherapie Psychosomatik und Medizinische Psychologie, 52*, 461-468.
- Hendryx, M.S., Haviland, M.G., & Shaw, D.G. (1991). Dimensions of alexithymia and their relationships to anxiety and depression. *Journal of Personality Assessment, 56*(2), 227-237.
- Hendryx, M.S., Haviland, M.G., Shaw, D.G., & Henry, J. (1994). Alexithymia in women and men hospitalized for psychoactive substance dependence. *Comprehensive Psychiatry, 35*(2), 124-128.
- Horton, P.C., Gewirtz, H., & Kreutter, K.J. (1989). Alexithymia and solace. *Psychotherapy and Psychosomatics, 51*(2), 91-95.
- Hyer, L.A., Woods, M.G., & Boudewyns, C. (1990). Alexithymia among Vietnam veterans with posttraumatic stress disorder. *Journal of Clinical Psychiatry, 51*, 243-247.
- Infrasca, R. (1997). Alexithymia, neurovegetative arousal and neuroticism. An experimental study. *Psychotherapy and Psychosomatics, 66*, 276-280.
- Jessimer, M., & Markham, R. (1997). Alexithymia: a right hemisphere dysfunction specific to recognition of certain facial expressions?. *Brain and Cognition, 34*, 246-258.
- Kano, M., Fukudo, S., Gyoba J., Karachi, M., Tagawa, M., Mochizuki, H., Itoh, M., Hongo, M. & Yanai K. (2003). Specific brain processing of facial expressions in people with alexithymia: an H<sub>2</sub><sup>15</sup>O-PET study. *Brain, 126*(6), 1474 - 1484.
- Keselman, H.J., Algina, J., & Kowalchuk, R.K. (2001). The analysis of repeated measures design: a review. *British Journal of Mathematical and Statistical Psychology, 54*(1), 1-20.
- Köhler, Th., & Schuschel, I. (1994). Changes in the number of active sweat glands (palmar sweat index, PSI) during a distressing film. *Biological Psychology, 37*, 133-145.
- Köhler, Th., & Troester, U. (1991). Changes in the palmar sweat index during mental arithmetic. *Biological Psychology, 32*, 143-154.
- Köhler, Th., Weber, D., & Vögele, C. (1990). The behaviour of the PSI (palmar sweat index) during two stressful situations. *Journal of Psychophysiology, 4*, 281-287.
- Kohn, P.M. Gurevich, M., Pickering, D.I., & McDonald, E. (1994). Alexithymia, reactivity, and the adverse impact of hassles-based stress. *Personality and Individual Differences, 16*(6), 805-812.
- Krystal, J.H., Giller, E.L., & Cicchetti, D.V. (1986). Assessment of alexithymia in posttraumatic stress disorder and somatic illness: Introduction of a reliable measure. *Psychosomatic Medicine, 48*, 84-94.
- Lars-Gunnar, L., & Simonsson-Sarnecki, M. (2002). Alexithymia and cognitive bias for emotional information. *Personality and Individual Differences, 32*, 1063-1075.
- Larsen, J.K., Branda, N., Bermond, B. y Hijmanc, R. (2003). Cognitive and emotional characteristics of alexitimia. A review of neurobiological studies. *Journal of Psychosomatic Research, 54*, 533- 541.
- Li, C.S. & Sinha, R. (2006). Alexithymia and stress-induced brain activation in cocaine-dependent men and women. *Journal of Psychiatry and Neuroscience 31*(2), 115-121.
- Linden, W., Lenz, J.W., & Stossel, C. (1996). Alexithymia, defensiveness and cardiovascular reactivity to stress. *Journal of Psychosomatic Research, 41*(6), 575-583.
- Littell, R.C., Pendergast, J., & Natarajan, R. (2000). Modelling covariance structure in the analysis of repeated measures data. *Statistics in Medicine, 19*, 1793-1819.
- Lumley, M.A., Stettner, L., & Wehmer, F. (1996). How are alexithymia and physical illness linked? A review and critique of pathways. *Journal of Psychosomatic Research, 41*(6), 505-518.
- Lumley, M.A., Tomakowsky, J., & Torosian, T. (1997). The relationship of alexithymia to subjective and biomedical measures of disease. *Psychosomatics, 38*, 497-502.
- Martin, J. B., & Pihl, R.O. (1985). The stress-alexithymia hypothesis: theoretical and empirical considerations. *Psychotherapy and Psychosomatics, 43*, 169-176.
- Martin, J.B., & Pihl, R.O. (1986a). Influence of alexithymic characteristics on

- physiological and objective stress responses in normal individuals. *Psychotherapy and Psychosomatics*, 45, 66-77.
- Martin, J.B., & Pihl, R.O. (1986b). The relevance of alexithymia for research on stress and stress-related disorders. En Humphrey, J.H. (Ed.) *Human Stress, current selected research. Vol. 1* (pp. 99-111). N.Y.: AMS Press, Inc.
- Martínez-Sánchez, F. (1996). Adaptación española de la Escala de Alexitimia de Toronto (TAS-20). *Clínica y Salud*, 7, 19-32.
- Martínez-Sánchez, F., Ato, M., & Ortiz, B. (2003). Alexithymia-state or trait? *The Spanish Journal of Psychology*, 6, 51-59.
- Martínez-Sánchez, F., Ato, M., Córcoles, E., Huedo, T., & Selva, J. (1998). Stability in the alexitimia levels: a longitudinal analysis of temporary series on various emotional answers. *Personality and Individual Differences*, 24, 767-772.
- Martínez-Sánchez, F., Ortiz, B., & Ato, M. (2001). Subjective and autonomic stress responses in alexithymia. *Psicothema*, 13, 63-68.
- Martínez-Sánchez, F., Ortiz, B., & Fernández, J. (1998). El índice de sudoración palmar: un procedimiento de evaluación de la reactividad autónoma en el estudio del estrés inducido experimentalmente. *Ansiedad y Estrés*, 4(2-3), 227-238.
- Näring, G.W.B., & van der Staak, C.P.F. (1995). Perception of heart rate and blood pressure: the role of alexithymia and anxiety. *Psychotherapy and Psychosomatics*, 63, 193-200.
- Nemiah, J.C., Sifneos, P.E., & Apfel-Savitz, R. (1977). A comparison of the oxygen consumption of normal and alexithymic subjects in response to affect-provoking thoughts. *Psychotherapy and Psychosomatics*, 28, 167-171.
- Neumann, S. A., Sollers, J.J., Thayer, F. F. & Waldstein, S.R. (2004). Alexithymia predicts attenuated autonomic reactivity, but prolonged recovery to anger recall in young women. *International Journal of Psychophysiology*, 53(3), 183-195.
- Newton, T.L. & Contrada, R.J. (1994). Alexithymia and repression: contrasting emotion-focused coping styles. *Psychosomatic Medicine*, 56, 457-462.
- Pandey, R., & Mandal, M.K. (1996). Eysenckian personality dimensions and alexithymia: examining the overlap terms of perceived autonomic arousal. *Personality and Individual Differences*, 20(4), 499-504.
- Papciak, A.S., Feuerstein, M., & Spiegel, J.A. (1985). Stress reactivity in alexithymia: decoupling of physiological and cognitive responses. *Journal of Human Stress*, 11, 135-142.
- Parker, J.D., Bagby, R.M., Taylor, G.J., Endler, N.S., & Schmitz, P. (1993). Factorial validity of the 20-item Toronto Alexithymia Scale. *European Journal of Personality*, 7, 221-232.
- Parker, J.D., Taylor, G.J., & Bagby, R.M. (1993). Alexithymia and processing of emotional stimuli: an experimental study. *New Trends in Experimental and Clinical Psychiatry*, IX(1/2), 9-14.
- Pinheiro, J.C., & Baltes, D.M. (2000). *Mixed-effects models in S and S-PLUS*. New York, NY: Springer.
- Rabavilas, A.D. (1987). Electrodermal activity in low and high alexithymia neurotic patients. *Psychotherapy and Psychosomatics*, 47, 101-104.
- Richter, J., Möller, B., Spitzer, C., Letzel, S., Bartols, S., Barnow, S., Freyberger, H. J., & Grabe, H. J. (2006). Transcallosal Inhibition in Patients with and without Alexithymia. *Neuropsychobiology*, 53(2), 101-107.
- Roedema, T.M. & Simons, R.F. (1999). Emotion-processing deficit in alexithymia. *Psychophysiology*, 36, 379-387.
- SAS Institute, Inc. (1999). *SAS/STAT User's Guide, Version 8*. Cary, NC: SAS Institute Inc.
- Stone, L.A., & Nielson, K.A. (2001). Intact physiological response to arousal with impaired emotional recognition in alexithymia. *Psychotherapy and Psychosomatics*, 70(2), 92-102.
- Suslow, T. (1998). Alexithymia and automatic affective processing. *European Journal of Personality*, 12, 433-443.
- Suslow, T., & Junghanns, K. (2002). Impairments of emotion situation priming in alexithymia. *Personality and Individual Differences*, 32, 541-550.
- Taylor, G.J. (2000). Recent developments in alexithymia theory and research. *Canadian Journal of Psychiatry*, 45(2), 134-142.
- Taylor, G.J., Bagby, R.M., & Luminet, O. (2000). Assessment of alexithymia: Self-report and observer-rated measures. In R. Bar-On & J.D.A. Parker (Eds), *The handbook of emotional intelligence*. (pp. 301-319). San Francisco: Jossey-Bass.
- Taylor, G.J., Bagby, R.M., & Parker, J.D. (1991). The alexithymia construct. A potential paradigm for psychosomatic medicine. *Psychosomatics*, 32(2), 153-164.
- Taylor, G.J., Bagby, R.M., & Parker, J.D. (1997). *Disorders of affect regulation. Alexithymia in medical and psychiatric illness*. Cambridge: Cambridge University Press.
- Turpin, G., & Clements, K. (1993). Electrodermal activity and psychopathology: the development of the palmar sweat index (PSI) as an applied measure for use in clinical settings. In J.C. Roy, W. Boucsein, D.C. Fowles & J.H. Gruzelier (eds), *Progress in electrodermal research* (pp. 49-59). New York and London: Plenum Press.
- Verbeke, G., & Mollenberghs, G. (1997). *Linear mixed models in practice: a SAS-oriented approach*. New York, NY: Springer.
- Wehmer, F., Brejnak, C., Lumley, M., & Stettner, L. (1995). Alexithymia and physiological reactivity to emotion-provoking visual scenes. *The Journal of Nervous and Mental Disease*, 183(6), 351-357.
- Zeitlin, S.B., McNally, R.J., & Cassiday, K.L. (1993). Alexithymia in victims of sexual assault: an effect of repeated traumatization? *American Journal of Psychiatry*, 150(4), 661-663.

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