DOWN SYNDROME AND AUTOMATIC PROCESSING OF FAMILIAR AND UNFAMILIAR EMOTIONAL FACES

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Participants with Down syndrome (DS) were required to participate in a face recognition experiment to recognize familiar (DS faces) and unfamiliar emotional faces (non DS faces), by using an affective priming paradigm. Pairs of emotional facial stimuli were presented (one face after another) with a short Stimulus Onset Asynchrony of 300 milliseconds and Inter stimulus Interval ISI set up to 50 milliseconds. The goal was to test the hypothesis that recognition deficits on negative information reported by academic literature on this population does not apply to automatic emotional processing specially to meaningful negative information (familiar faces). Results showed that not all of the participants have a recognition deficit on negative stimuli and interestingly, positive familiar faces could not be primed by other valenced facial stimuli. However, positive familiar faces were recognized faster than neutral faces. Educational and clinical implications are discussed at the end of the paper.

Research on mental retardation is a key component in understanding the relation between cognitive and emotional development (Sroufe, 1998). One of the most relevant genetic conditions to explore this relation is the Down syndrome (DS) for several reasons. For instance, DS is one of the most common genetic conditions related to the mental retardation whose etiology is known (Wishart & Pitcairn, 2000; Pitcairn & Wishart, 2000). On the other hand, people with DS are characterized as highly emotional (Smith & Walden, 1998). This behavior may be related to a dysfunctional neural architecture. Specifically, frontal lobe deficits (Jeringan, Bellugi & Sowell, 1993; Raz, Torres & Briggs, 1995), a reduced size of the brain stem (Benda, 1971), cortical limbic neural pathways anomalies (Jeringan et al., 1993) and a reduced size of the hippocampus (Raz et al., 1995). Although, it is known that all of these neural structures are related to the amygdala, which is a neural strata involved on emotional information processing and emotional regulation, the consequences from these dysfunctional neural characteristics on the cognitive emotional architecture remains at large unknown.

Initial cognitive research has pointed out cognitive deficits on people with DS, specifically they are unable to recognize emotional negative faces (Wishart & Pitcairn, 2000; Pitcairn & Wishart, 2000). However little is known about the cognitive mechanisms underlying this kind of deficit. A valuable way to approach this will be by studying the DS emotional appraisal mechanisms over facial expression.

Recently, a stream of cognitive models have emerged that open the possibility for emotional valence to be recognized by automatic information processing. For instance, Bargh’s (1999) seminal model on controlled and automatic information processing proposes that environment events are automatically evaluated by three interconnected systems (Perceptual, evaluative and motivational). Automatic awakening of this systems influence our perception and interpretation of environment events as well as our behavior for adaptation and survival. For instance, death or live situations activate reactive survival behavior related to fear as fast as 250 ms with no time for controlled processing. These are the very same emotional mechanisms that influence other kind of behaviors. For example, in academic settings a wide range of student´s attitudes to a professor are related to non controlled emotional information processing related to fear, hate or empathy to this professor. As it will be suggested at the end of this document, DS learning might be related to a non common way to process emotional information during training. Persons with DS have specific cognitive bias to emotional settings due to deficits to recognize negative facial information. This might prevent them to take on opportunities to establish relevant social relationships in their emotional world. Educative and clinical intervention can be benefited by determining the nature of DS particular cognitive emotional system.

An important stream of academic research designed to explore relevant cognitive mechanisms to process emotional information goes under the affective priming paradigm (Musch & Klauer, 2003). This approach has been used to investigate how automatic cognitive mechanisms evaluate emotional information in humans. Specifically, this robust set of experimental settings to study emotional appraisal (first proposed by Fazio in 1995) were designed to study how the emotional valence of a stimulus (prime) affects the recognition of emotional valence of other stimulus (target). By controlling properties related to the emotional prime and target, the relation between the prime and the target as well as the time of stimulus presentation, a valuable empirical database has emerged from the last 15 years on this research field on the nature of the human emotional appraisal system. Examples of this kind of research are manipulations on word and non words primes (De Houwer, Hermans & Eelen, 1998), object transparency (Hermans, De Houwer & Eelen, 1994), drawings and photos (Banse, 2001), positive and negative odor primes (Hermans, Bayens & Eelen, 1998; Musch & Klauer, 2003).

Due to the appointed neural characteristics in DS condition, a research opportunity is presented to analyze emotional appraisal mechanisms constrained by a deficit on negative information processing. Automatic and controlled appraisal mechanisms could be modified in order to compensate for this limitation in ways that we are not aware of. For example, it is unknown if automatic and controlled appraisal mechanisms for negative information are the same in this population or if these appraisal mechanisms are similar to those of a typical individual.

Initial research to deal with this interest was presented by Morales (2004) and Morales and Lopez (2005, 2006). Here, participants with DS were required to recognize emotional faces in a set of affective priming experiments. Basically, they showed a tendency to eliminate negative emotional facial information whenever the Stimulus Onset Asynchrony between the prime (negative face) and the target (another negative face) was 250 ms. Interestingly enough, two female participants did indeed recognized negative facial information and showed affective priming on negatively related faces at this level of automatic processing. This automatic processing behavior points out to a different cognitive behavior pattern from that initial research imposing controlled processing information tasks by explicit reports. These findings open the possibility of a complex emotional processing system revealing itself in different ways depending on DS frame.

Additional research can be introduced to explore if this cognitive deficit covers all negative stimuli spectra and to produce insight about the way a genetically constrained emotional system works. Meaningful facial stimuli can be used for this purpose. For example, DS faces have features that distinguish them from other individuals. It might be the case that emotional facial information has special relevance for this population even on negative facial information. This will speak in favor of an emotional tuned system to process only relevant information for this population. Since facial information has proven to have ecological validity to explore appraisal processes over emotional information (Fiedler, 2003; Musch & Klauer, 2003), there is a chance to experimentally explore if DS´s cognitive deficit on negative information affects even the evaluation of information that typifies them, that is, their own facial configuration. Facial recognition research suggests the possibility for a familiar vs. non familiar face recognition system (Lund, 2001; Parkin, 1999; Doubis, Roosin, Schiltz, Boardt, Bruyer & Crommelinck, 1999). If indeed DS emotional processing system proves to behave differently depending on the kind of facial information is processed, the results could be integrated from a familiar vs. none familiar model approach. However, intriguing research guidelines might arise about what *familiarity* means for the DS emotional system. The following study was implemented to test this familiarity effect.

Method

A facial recognition experiment using the affective priming paradigm was implemented to test if familiar emotional DS faces are recognized by participants with DS differently from a control group. The affective priming paradigm began as an experimental technique presented by Fazio (1995) to study how the emotional valence of a stimulus (prime) affects the recognition of other valenced stimuli (target), (e.g. Musch & Klauer, 2003). Facial stimuli are relevant because visual stimuli produce robust affective priming (Fiedler, 2003; Gutierrez, 2006; Öhman & Mineka, 2001) and allow ecological validity since faces are natural communicators of emotional information (Harwood, Hall, Schinkfield &

Alison, 1999). Here, the hypothesis is that DS emotional familiar faces provide information that is only relevant to individuals with DS.

Participants
The study sample consisted of 16 persons with DS whose reading skills and attention capacities were excellent. All participants were taken from a special training group diagnosed by a private University as cognitive capable to take advance reading comprehension courses as well as computer skills training. All of them went through several courses in order to reach the current cognitive development. On the other hand the control group consisted of 15 young people from Monterrey Mexico (typical population) who agreed to voluntarily participate in the study. Both groups ranged between 20 and 28 years old. This sample was intentionally selected from an advance DS training program affiliated to a Mexican University.
Debriefing about the experiment was provided to the participants' parents. Moreover, written consents from parents were obtained.

Instruments and materials
Face stimuli was implemented using guidelines from Ekman, Friesen and Hager´s (2002) Face Action Coding System (FACS). Facial stimuli are relevant for the present study since produce robust affective priming (Fiedler, 2003; Gutierrez, 2006; Öhman & Mineka, 2001) and allow ecological validity since faces are natural communicators of emotional information (Harwood, Hall, Schinkfield, Alison, 1999). Figure 1 shows some of the positive, negative and neutral real faces for a trained group of bachelor psychology students and simulated faces persons with DS (Morales, Lopez & Hedlefs, in press).

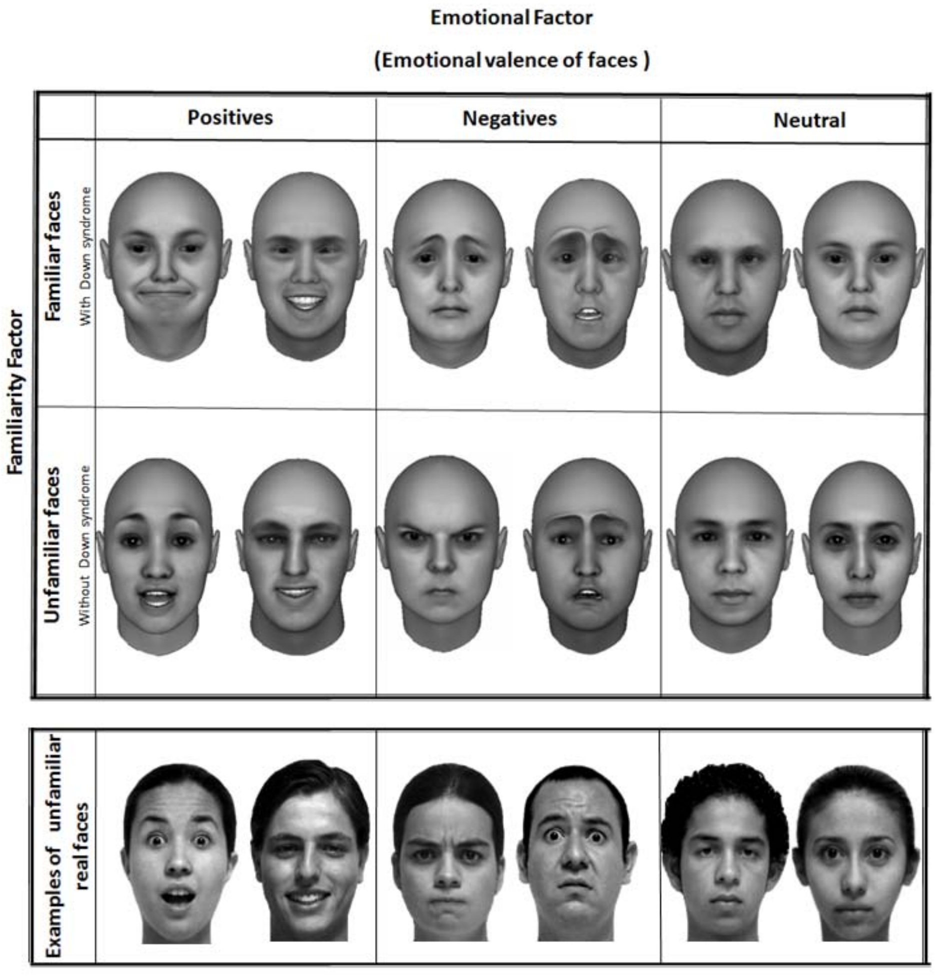

Figure 1.
Shows some of the positive, negative and neutral real faces for a trained group of psychology students as well as simulated faces. It also shows the experimental factors included in the study.

Persons with DS could not be trained to emulate emotional faces. Therefore, only neutral faces were obtained for female and male individuals with DS. Then, these faces were entered into computer software that allows simulation of emotional faces based on neutral faces photos. Figure 1 shows the obtained stimuli set for DS faces.

Note from Figure 1 that some controls were applied over the faces, like taking out the hair, normalization, etc, (e.g. Calder, Young, Rowland, Perrett, Hodges & Etcoff, 1996). In order to apply the same controls to the first facial stimuli set non DS faces were also entered into the computer face simulation system to produce emotional faces. Figure 1 shows the obtained stimuli for these individuals. Experimental stimuli included combinations for emotional congruent pairs (Positive/Positive, Negative/Negative, and Neutral/Neutral) and emotional incongruent pairs (Negative/Positive, Positive/Neutral, Negative/Neutral, and Neutral/Positive). Considering female and male faces with or without DS characteristics a set of 408 experimental trials were obtained. A computer system named SUPER LAB-PRO was used to present experimental trails. These trials share a particular experimental sequence that is described over the experimental procedure section of the paper.

Procedure

Each subject attended to a 120 minutes individual session with a trained cognitive psychologist. Each sat in front of a computer and instructions were provided until they understood the experimental cognitive task very well. The task was explained until they could say they understood the task.

The experimental trails were as follows. First, a point at the center of the computer screen appeared to allocate participant's gaze at the center of the computer screen. Then, either a DS or non DS face with or without emotion appeared for 250 milliseconds followed by a white interval of 50 milliseconds. Finally, another DS face or non DS face with or without emotion appeared and stayed at the computer screen until the participant decided if this last face was emotional or neutral. The computer user had to press the *Z* computer key that had a red paper on it with the word *YES* written on it to indicate the face was emotional or to press the letter *M* that had a green paper that had the word *NO* if the presented face had no emotion.

After instructions, a practice session was required. Only after subjects declared full understanding of the experimental task then experimental trials were presented. The whole study takes approximately 120 minutes. The total number of stimuli as well as factor randomization of emotional stimuli will ensure statistical parameter estimation for this kind of small groups (Anderson, 2001).

Results

A mixed ANOVA analysis was carried out over correct answers. All control subjects were included since they provided more than 90% correct latencies. However, as expected, most of the experimental subjects provided wrong responses to experimental conditions where the target included negative faces. Interestingly, five experimental subjects showed evidence for at least 30% or more recognition to negative facial targets (they were not to suppose to do this, according to most of the literature research). These subjects were not included in the ANOVA analysis. Therefore, a mixed 2 x 6 mixed ANOVA analysis was carried over since experimental conditions with negative targets were not considered. A statistically significant main effect for group performance $F (1, 24) = 13{,}700$, $p= 0.001$. Here, the experimental group tested significantly slower than the control to all experimental conditions.

No main effect was obtained for familiarity $F (5, 120) =1{,}6$, $p=0.14$. However, additional information is obtained by testing the interaction among familiarity, group and type of emotional relation among stimuli as it is illustrated on Figure 2.

Notice from Figure 2 that control subjects performances were almost identical for familiar and non familiar faces. However, participants with DS performance to positive familiar faces contrasted to their latencies for positive non familiar faces. This behavior was responsible for a marginal significant interaction $F (5,120) = 1{,}990$, $p =0.08$. Interestingly, no affective priming could be obtained to familiar positive targets. This was not the case to other targets. One analytical comparison was carried over to compare trails with positive familiar face targets against trails with familiar neutral faces for participants with DS. The goal was to check for significative recognition facilitation to positive familiar faces. However, no effect was obtained to this comparison $F (5, 50) =1{,}4$, $p=0.22$

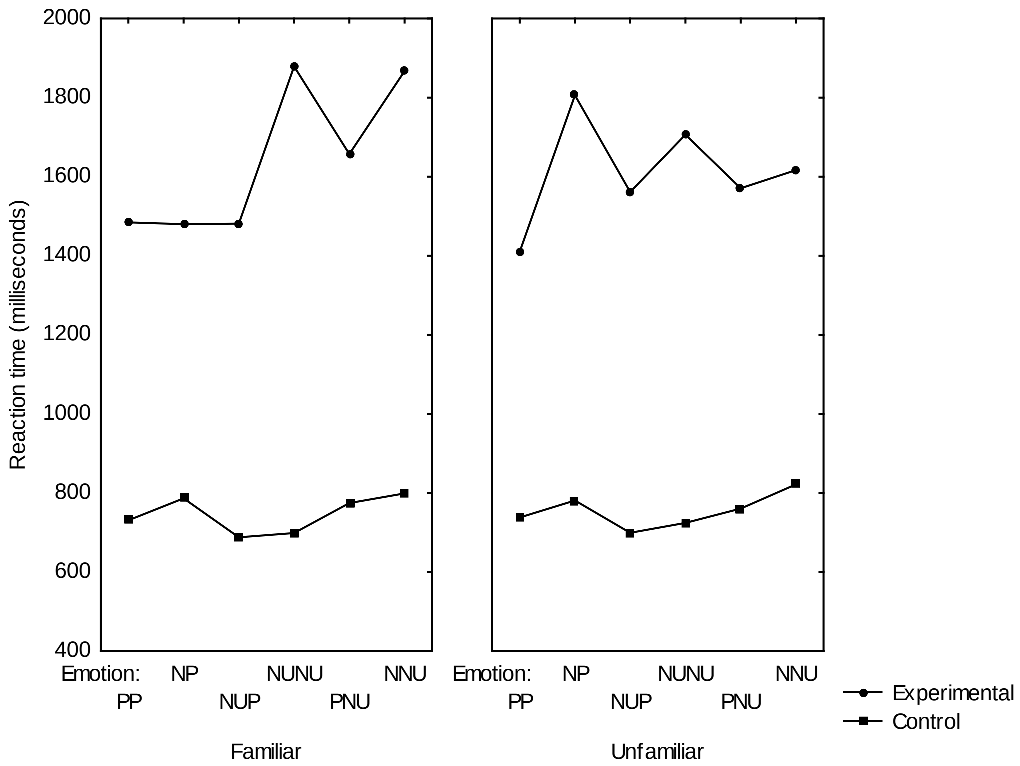

Figure 2.
A marginally significant interaction for the three main factors (Emotional congruency level, Facial familiarity and Groups) emerges from considering experimental trials with positive targets to familiar vs. non familiar faces on DS individual.

In general, results showed slower latencies for participants with DS than the control group through all experimental conditions, an automatic processing recognition deficit on negative information for many participants but not all of them and a cognitive bias to recognize positive familiar faces. It is argued next that these results points out to a DS emotional reality that is different from the concept of a simple emotional deficit.

Discussion
No evidence for a familiarity effect was obtained. Remember that no significant main effect was obtained for familiarity through experimental conditions. This was contrary to the wide empirical evidence supporting facial recognition familiarity effects on typical subjects (Stevenage, Lee & Donnelly, 2005). It might be the case that using simulated faces interfers with recognition of familiar faces. However, participants with DS showed a tendency to recognize faster positive target faces except for incongruent none familiar faces (recognition differences since 200 ms up to 400 ms from neutral faces). Therefore, some facial discrimination due to stimuli occurred. Moreover, whenever a DS face appeared on the computer screen, participants with DS behaved in a different way than control subjects. For example, they use to smile and say *Look!!…people like me*. We sincerely think that DS variability was responsible for the no familiarity effect. Controlling for genetic condition (types of DS) or perhaps sample size might reduce variability. If something could be learned from the data is that different cognitive emotional profiles might typify persons with DS. Thus more experimental efforts must be conducted to establish cognitive emotional styles related to the DS.

Implications for educational and clinical practice could be derived from this kind of research. First, the researcher noticed that DS interventions by punishment conditioning might not be effective since explicit negative stimuli tend to cognitively be filtered. Here, affective priming facial recognition studies as the one used in the current study can be used as a cognitive diagnostic to see if pre attentive or implicit punishment conditioning is available. Second, positive approaches by familiar people might have stronger intervention effects on persons with DS. Specifically, the establishment of a strong positive relationship of familiar person like a well known teacher is better for intervention results than someone unknown. Since individuals with DS seems to be recognizing positive familiar information faster than other emotional stimuli.

The concept for a cognitive deficit to process negative information seemed too short to describe the cognitive constrained emotional architecture of persons with DS. In other words, a picture emerged for a completely different emotional world where negative codification was not an impediment for individuals with Down syndrome to still feel anger, happiness or love. They actually do feel negative emotions but for most of them negative coding seems not to belong to their emotional system.

On the other hand, negative appraisal deficits did not typify all members of this population (remember some experimental group individuals, indeed recognized negative information). A possible emotional style might have arised depending on DS condition. Interestingly, faster recognition to familiar positive faces might be more than a coincidence. First, DS positive faces could not be affected by any other emotional context since no affective priming could be obtained for these positive facial stimuli. Second, this positive bias was only present to recognized members of their own kind. DS positive faces must contain something relevant for them.

Therefore, this research provided evidence suggesting that the well documented deficit to recognize negative information (Wishart & Pitcairn, 2000; Pitcairn & Wishart, 2000; Turk & Cornish, 1998) did not apply to all individuals with DS. Moreover, more experimental manipulation will be needed to understand why affective priming could not be obtained for positive familiar faces. It was clear, people with DS evaluate their own positive faces very differently than the way typical individuals evaluated their own faces. Here, affective priming to positive familiar faces was obtained for typical individuals.

In short, evidence was presented to understand more about the emotional nature of people with DS. Regarding to this, academic literature reporting that individuals of this population have difficulties to keep appropriate physical distance in social settings (Wishart & Pitcairn, 2000), for example individuals with Down syndrome tend to be closer than usual to others when they talk and this was associated to their deficit to recognize that typical individuals impose negative valuation to this kind of social proximity. However, it might be the case that people with DS find this kind of social interaction positive and familiar since they cannot codify negative outcomes. Positive familiar stimuli could not be primed by other emotional contexts. Moreover, not all participants tested as incapable to process negative facial information. Here, consideration for a cognitive emotional style might arise. Different positive and negative percentages to emotionally valuate stimuli can be found through this population. From a point of view of a person with DS, this kind of appraisal processing might impose a different way to enact their emotional world. To reduce DS emotional appraisal processing to negative and positive information as a *deficit* might be inappropriate to explore the possibility of an unknown new emotional style.

Only a minor set of studies have examined face processing in DS, and these have mostly examined emotion recognition through explicit or controlled measures (e.g. Wishart & Pitcairn, 2000; Pitcairn & Wishart, 2000; Turk & Cornish, 1998). Future research using experimental paradigms as the ones shown in this paper might overcome limitations presented by this initial research since automatic emotional appraisal processing of DS can be put under scientific scrutiny. This is not possible by standard testing. Therefore, new theoretical development is now possible to specify the emotional profile of persons with DS.

References

Anderson, N. H. (2001). *Empirical direction in design and analysis: scientific psychology series.* Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Banse, R. (2001). Affective priming with liked and disliked persons: Prime visibility determines congruency and incongruency effects. *Cognition & Emotion*, 15 (4), 501–520.

Bargh, J. A. (1999). The cognitive monster: the case against the controllability of automatic stereotype effects. In S. Chaiken & Y. Trope (Eds.), *Dual process theories in social psychology* (pp. 361-382). New York: Guilford Press.

Benda, C. E. (1971). Mongolism. In J. Minckler (Ed.), *Pathology of the nervous system* (pp. 1361-1371). New York: McGraw-Hill.

Calder, A., Young, A., Rowland, D., Perrett, D., Hodges, J., & Etcoff, N. (1996). Facial Emotion Recognition after Bilateral Amygdala Damage: Differentially Severe Impairment of Fear. *Cognitive Neuropsychology*, 13(5), 699-745.

De Houwer, J., Hermans, D., & Eelen, P. (1998). Affectivity and identity priming with episodically associated stimuli. *Cognition & Emotion*, 12, 145-169.

Dubois, S., Rossion, B., Schiltz, C., Bodart, J. M., Michel, C., Bruyer, R., & Crommelinck, M. (1999). Effect of Familiarity on the Processing of Human Faces. *NeuroImage*, 9, 278-289.

Ekman, P., Friesen, W. V., & Hager, J. C. (2002). *Facial Action Coding System: The manual on CD ROM*. USA: Research Nexus division of Network Information Research Corporation.
Fazio, R. H. (1995). Attitudes as object-evaluation associations: Determinants, consequences, and correlates of attitude accessibility. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 247–282). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.
Fiedler, K. (2003). The hidden vicissitudes of the priming paradigm in evaluative research. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 109-137). Mahthaw, NJ: Lawrence Erlbaum Associates, Publishers.
Gutierrez, M. C. (2006). Procesamiento parafovial de información emocional [Parafoveal processing of emotional information]. In E. Gamez & J.M. Diaz (Eds.), *Investigaciones en Psicología Básica ULL*: *Psicolingüística*, *Razonamiento y Emoció*n (pp. 167 – 184). España: Departamento de Psicología Cognitiva, Social y Organizacional ULL.Spain.
Harwood, N. K., Hall, L. J. & Schinkfield, A. J. (1999). Recognition of facial emotional expressions from moving and static displays by individuals with mental retardation. *American Journal on Mental Retardation*, 104(3), 270-278.
Hermans, D., De Houwer, J., & Eelen, P. (1994). The affective priming effect: Automatic activation of evaluative information in memory. Cognition & Emotion, 8, 515-533.
Hermans, D., Baeyens, F., & Eelen, P. (1998). Odours as affective- Processing context for word evaluation: A case of cross- modal affective priming. *Cognition & Emotion*, 12, 601-613.
Jeringan, T. L., Bellugi, U., & Sowell, E. (1993). Cerebral morphological distinctions between William´s and Down´s syndromes. *Archives of Neurology*, 50, 186-191.
Lund, N. (2001). *Attention and pattern recognition*. USA: Taylor and Francis Inc.
Morales, M. G. (2004). Mecanismos cognitivos de reconocimiento de información emocional en personas con síndrome de Down. [Down syndrome and cognitive mechanisms underlying emotional facial recognition]. Unpublished master`s thesis. Universidad Autonoma de Nuevo León, Monterrey, Mexico.
Morales, M. G. E., & Lopez, R. E. O. (2005). Mecanismos cognitivos de reconocimiento de información emocional en personas con síndrome de Down [Down syndrome and cognitive mechanisms underlying recognition of emotional faces]. *Revista Médica Internacional sobre Síndrome de Down*, 9(1), 2-6.
Morales, M. G. E., & López, R. E.O. (2006). *El síndrome de Down y su mundo emocional* [The emotional world and Down syndrome]. Mexico: Trillas.
Morales, M. G. E., López, R. E. O. & Hedlefs, A. M. I. (in press). *La psicología de las emociones: expresión facial, emoción y pensamiento* [Psychology of emotions: facial expression, emotion, and thought].Mexico: Trillas
Musch, J. & Klauer, K. C. (2003). The psychology of evaluation: an introduction. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 1-5). Mahthaw, NJ: Lawrence Erlbaum Associates, Publishers.
Öhman, A., & Mineka, S. (2001). Fear, fobias and preparnedness: toward an evolved module of fear and fear learning. *Psychology review*, 108,483-522.
Parkin, A. (1999). *Exploraciones en Neuropsicología Cognitiva* [Exploration in cognitive neuropsychology]. Madrid, Spain: Medica Panamericana.
Pitcairn, T. K., & Wishart, J. G. (2000). Face processing in children with Down syndrome. In D., Weeks, R. Chua, & D. Elliot (Eds.), Perceptual-Motor behavior in Down syndrome. Edinburgh (pp. pp. 123-147). Champaign, III: Human Kinetics.
Raz, N., Torres, I., & Briggs, S. D. (1995). Selective neuroanatomical abnormalities in Down´s syndrome and their cognitive correlates: Evidence from MRI morphometry. *Neurology*, 45, 356-366.
Smith, M., & Walden, T. A. (1998, August). Emotion Regulation in Children with Down syndrome. Paper presented in The American Psychological Association Annual Convention, San Francisco, CA.
Sroufe, A. (1998). *Desarrollo emocional: la organización de la vida emocional en los primeros años* [Emotional development: the organization of the emocional life in the early years]. Mexico: Oxford University Press.
Stevenage, S. V., Lee, E. A., & Donnelly, N. (2005). The role of familiarity in a face classification task using thatcherized faces. *Quarterly Journal of Experimental Psychology*, 58 (6), 1103-1118.
Turk, J., & Cornish, K. (1998). Face recognition and emotion perception in boys with fragile X syndrome. *Journal of Intellectual Disability Research*, 42, 490-499.
Wishart, J. G., & Pitcairn, T. K. (2000). Recognition of identity and expression in faces by children with Down syndrome. *American Journal on Mental Retardation*,105(6), 466-479.