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Dissociation between facial and bodily expressions in emotion recognition: A case study

Samanta Leiva[a], Laura Margulis[a,b], Andrea Micciulli[b] and Aldo Ferreres[a,b]

[a]Facultad de Psicología, Universidad de Buenos Aires, Buenos Aires, Argentina; [b]Unidad de Neuropsicología, Hospital Interzonal General de Agudos "Eva Perón", Buenos Aires, Argentina

ABSTRACT

Objective: Existing single-case studies have reported deficit in recognizing basic emotions through facial expression and unaffected performance with body expressions, but not the opposite pattern. The aim of this paper is to present a case study with impaired emotion recognition through body expressions and intact performance with facial expressions. **Methods:** In this single-case study we assessed a 30-year-old patient with autism spectrum disorder, without intellectual disability, and a healthy control group ($n = 30$) with four tasks of basic and complex emotion recognition through face and body movements, and two non-emotional control tasks. To analyze the dissociation between facial and body expressions, we used Crawford and Garthwaite's operational criteria, and we compared the patient and the control group performance with a modified one-tailed *t*-test designed specifically for single-case studies. **Results:** There were no statistically significant differences between the patient's and the control group's performances on the non-emotional body movement task or the facial perception task. For both kinds of emotions (basic and complex) when the patient's performance was compared to the control group's, statistically significant differences were only observed for the recognition of body expressions. There were no significant differences between the patient's and the control group's correct answers for emotional facial stimuli. **Conclusions:** Our results showed a profile of impaired emotion recognition through body expressions and intact performance with facial expressions. This is the first case study that describes the existence of this kind of dissociation pattern between facial and body expressions of basic and complex emotions.

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Introduction

The ability to recognize emotions in other people through non-verbal signs is a basic skill for functioning in society. To date, most studies have focused on facial expressions and only a few have concentrated on whole-body expressions even though emotions can be recognized using nothing but body language (Atkinson, Dittrich, Gemmell, & Young, 2004; Aviezer, Trope, & Todorov, 2012; Martinez, Falvello, Aviezer, & Todorov, 2016; Van den Stock, Righart, & de Gelder, 2007). Facial and body expressions seem to provide different information (de

CONTACT Samanta Leiva leivasamanta@psi.uba.ar

Gelder, 2013): bodily expressions tell us not only about the emotional state of the individual but also about the actions they are carrying out in connection to the emotion (de Gelder, 2006). For example, a body expression of fear may be accompanied by an action to protect the person's body (e.g. covering their face to protect themselves and moving away from danger), information that cannot be obtained from facial expressions. The functional differences between these two types of emotional stimuli are supported by studies of healthy populations using functional brain imaging. These studies have provided evidence that suggests that we process facial and bodily expressions differently (Atkinson, Vuong, & Smithson, 2012; Kret, Pichon, Grèzes, & de Gelder, 2011; Prochnow et al., 2013).

In groups of patients with neurological pathologies, there is solid evidence of deficits in recognizing emotions through different non-verbal cues in cases of traumatic brain injuries (Rosenberg, McDonald, Dethier, Kessels, & Westbrook, 2014), localized brain damage (Yuvaraj, Murugappan, Norlinah, Sundaraj, & Khairiyah, 2013), dementia (Van den Stock et al., 2015), multiple sclerosis (Berneiser et al., 2014), epilepsy (Benuzzi et al., 2014), autism (Golan, Sinai-Gavrilov, & Baron-Cohen, 2015), and schizophrenia (Weisgerber et al., 2015). However, most of these studies have not examined the dissociation between patients' recognition of facial and whole-body stimuli. The discovery of classical and double dissociations between processes are fundamental in cognitive neuropsychology. A classical dissociation is defined as occurring when a patient's performance of task *X* is affected but their performance of task *Y* is normal (Ellis & Young, 1992). When there is another patient with the opposite pattern (normal performance of task *X*, but task *Y* is affected), this is an evidence of a double dissociation. This kind of neuropsychological evidence suggests that the cognitive processes used to solve these tasks are functionally independent (Fellows, 2013). Demonstrating a dissociation between the recognition of emotions expressed through the face and the body would constitute evidence that is consistent with the results of functional imaging-based studies that reveal differential processing of these two types of emotional stimuli. Single-case studies of neuropsychological patients are a key tool for substantiating these dissociations.

There are only three neuropsychological case studies in the literature which report body–face dissociation in emotional recognition and all three show the same pattern: alterations in the recognition of facial stimuli, while that of whole-body expressions was unaffected. Atkinson, Heberlein, and Adolphs (2007) assessed two patients with bilateral amygdala lesions caused by Urbach–Wiethe disease. Both patients had difficulty recognizing fear through facial expressions but not through bodily expressions. However, the study in question did not include a specific methodology for studying dissociation that directly compares the two patients' performances with the two types of stimuli (face and body). Instead, the patients' abilities to recognize facial and body expressions were reported separately and were not compared directly (Adolphs, Tranel, Damasio, & Damasio, 1994, 1995; Adolphs et al., 1999; Atkinson et al., 2007).

The third existing case study is of a patient with limbic encephalitis with lesions that affected the right-hemisphere insular cortex and medial temporal areas, including the amygdala (Sprengelmeyer et al., 2010). The results showed that the patient's recognition of facial expressions of fear and disgust were affected. However, his recognition of bodily expressions of the six basic emotions that were tested was unchanged. One limitation of this interesting study is that the patient's performance of tasks with facial and bodily stimuli was compared with different control groups, one for each task, rather than a single control group for both.

Single-case studies are becoming increasingly rigorous and now use case-control designs and specific statistical analysis that allows researchers to demonstrate dissociation more exhaustively (Crawford & Garthwaite, 2012; McIntosh & Brooks, 2011). However, this methodology is rarely used for patients who are described as having emotion recognition deficits and in which group studies throw up contradictory results. For example, in patients with autism spectrum disorder (for a review, see Uljarevic & Hamilton, 2013), some studies have reported alterations in subjects' abilities to recognize facial and bodily expressions (Atkinson, 2009; Bal et al., 2010; Nackaerts et al., 2012; Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013; Wallace et al., 2011; Walsh, Creighton, & Rutherford, 2016). Others, however, have not found any differences in the performances of patients and subjects with typical development in emotion recognition, using the same non-verbal cues (Adolphs, Sears, & Piven, 2001; Jones et al., 2011; Libero, Stevens, & Kana, 2014; Rutherford & Towns, 2008). Nor have there been any direct studies of the dissociation between the two types of stimuli in the recognition of basic and complex emotions. As a result, the aim of this paper is to report a single-case study of a 30-year-old patient with autism spectrum disorder (ASD) who showed a classical dissociation between these kinds of stimuli.

Methods and procedures

The patient was evaluated using a battery of standard neuropsychological tests and an experimental battery of tests for the recognition of facial and bodily expressions. The experimental battery was also used with a control group to obtain normative data.

Participants

Patient MM

MM is a 30-year-old Argentinian man with 12 years of schooling who sought help from the neurological department at the Eva Perón Hospital in San Martín, Buenos Aires, Argentina, due to his difficulties in handling social situations. The patient had been diagnosed with ASD, according to the DSM-5 diagnostic criteria (American Psychiatric Association, 2013) and had no intellectual disability (Wechsler Adult Intelligence Scale III: full-scale IQ = 88). As the patient had never had formal neurological tests done at any point in his history and given that he had experienced one episode of what were assumed to have been febrile convulsions in his early infancy, the neurologist who admitted him to the hospital decided that it was necessary to rule out the presence of any other pathologies using computed tomography and electroencephalography. These tests were carried out a month before he was referred to our neuropsychology unit and the results were normal.

MM was born full-term with an Apgar score of 8/9, a low birth weight for his gestational age, and with benzodiazepine withdrawal symptoms due to his mother's consumption of the drug. During his development, the patient experienced slight delays in reaching maturity milestones and underwent speech and language therapy until the age of 11 due to a delay in language acquisition. At school, he had difficulties integrating with his peers and teachers, and he changed school twice due to these difficulties. He repeated eighth grade and finished his schooling in an adult education program. With help from his family, he found a job as a municipal administrative employee, which he held for four years until he was made redundant due to personnel reductions. MM was referred to our neuropsychology unit because he had been unable to find work for two years due to his difficulties in handling social interactions (for example, behaving inappropriately during job interviews and problems in starting interactions with other people and communicating with them, among others). He claimed to have no social life, friends, or girlfriend (he had never been in a relationship), and had verbal communication difficulties which reduced his social interactions even though he had no language problems (there were no problems in his fluency, phonology, and syntax during the interviews). Given that the patient presented complaints about different aspects of his social functioning, including his ability to process emotions, we decided to evaluate him with a series of experimental tasks to assess the recognition of emotions from visual cues (face and body), as part of his neuropsychological assessment.

Control group (CG)

The control group was made up of 30 healthy adult subjects (11 males and 19 females) with no history of neurological and/or psychiatric problems of a similar age to the patient ($M = 33.9$; SD = 13.2; $t = -.291$, $p = .773$, $z_{cc} = -.3$) and with a similar number of years of schooling ($M = 12.7$; SD = 2.2; $t = -.293$, $p = .771$, $z_{cc} = -.3$). Participants were recruited from among the relatives or caregivers of patients of the Neuropsychological Unit at Eva Perón Hospital in San Martín, Buenos Aires, Argentina. Inclusion/exclusion criteria were: (1) Age between 18 and 55 with at least seven years of formal schooling; (2) no neurological, psychiatric, or clinical pathologies that affect cognition (for example, hypothyroidism); (3) no current use of psychotropic drugs; and (4) Spanish as a native language. Each participant was asked to participate in this study and then took part in an individual structured interview with us to ensure that they fulfilled the inclusion/exclusion criteria. All participants provided written informed consent in accordance with the Helsinki Declaration.

Materials and procedure

Neuropsychological and functional assessment

The patient was evaluated at the Neuropsychological Unit at Eva Perón Hospital in San Martín, Buenos Aires, Argentina, using a neuropsychological battery that included assessments of attention, executive functions, memory, visuoconstruction, and social cognition through the following tests: Digit Span subtest (forward and backward) and Visual Memory Span subtest (tapping forward and backward) from the Wechsler Memory Scale-Revised (Wechsler, 1987); D2 Test of Attention (Brickenkamp, 2004); Trail Making Test A and B (TMT – AITB, 1944); Wisconsin Card Sorting Test (WCST – Heaton, Chelune, Talley, Kay, & Curtiss, 1993); Tower of London Drexel University (ToL ^{DX} – Culbertson & Zillmer, 2001); Rey Complex Figure Test (RCFT – Meyers & Meyers, 1995); Rey Auditory Verbal Learning Test (RAVLT – Rey, 1964; Spanish version from Miranda & Valencia, 1997); Phonemic Fluency FAS-Test (taken from Strauss, Sherman, & Spreen, 2006); Faux Pas Test (Stone, Baron-Cohen, & Knight, 1998; adult version for Buenos Aires from Zubizarreta Hospital); and two pictures with first- and second-order false belief stories (based on Baron-Cohen, Leslie, & Frith,1985; Stone et al., 1998). The patient's performance was compared with normative data provided in each manual for the D2 Test of Attention, WCST, ToL ^{DX}, and RCFT. For the RAVLT and Phonemic Fluency FAS-Test, we used the normative data provided in Strauss et al. (2006). Finally, we used normative data from Buenos Aires samples for the Faux Pas Test (taken from Butman, 2008), TMT, and Digit and Visual Memory Span subtests (Margulis & Ferreres, 2017). Table 1 shows the scores

Table 1. Scores obtained by patient MM in his neuropsychological assessment.

Tests	Patient's score	*Z* score
Attention and executive functions		
Digit span forward	6	−.2
Digit span backward	4	−.7
Tapping forward	4*	−1.6
Tapping backward	5	−.4
D2 test of attention		
Total correctly processed (TOT CORR)	332	−1.3
Errors of omission (O ERR)	17	.2
Errors of commission (C ERR)	3	−1
Trail making test. Part A (time in seconds)	38″	.7
Trail making test. Part B (time in seconds)	105″	.9
Phonemic Fluency FAS-Test	29	−1.1
Wisconsin Card Sorting Test		
# of Categories completed (percentile >16)	6	
Perseverative errors	8	.4
Percent conceptual level responses	78	.1
Tower of London ^{DX}		
Total correct score	4	−.2
Total move score	30	−.3
Total time	334	−1.4
Total rule violations	1*	−1.5
Memory		
Rey auditory verbal learning test		
Immediate recall	15	1.6
Delayed recall	15	1.5
Recognition	15	.9
Rey complex figure test		
Immediate recall	17	−1.4
Delayed recall	16*	−1.7
Recognition	20	−.8
Visuoconstruction		
Copy of Rey complex figure test	28*	−2.8
Social cognition		
Faux Pas test (ToM index ≥.9 = normal)	.6*	
False belief tasks		
First-order false belief task (3 = normal)	3/3	
Second-order false belief task (3 = normal)	3/3	

*Indicate scores above average (*Z* score ≤ −1.5).

obtained by the patient in each test. The results showed reduced visuospatial attention span, minor difficulties in following rules on an executive function test, difficulties copying a complex figure, difficulties in the retrieval process with visual material during long-term memory assessments, and a deficit in interpreting inappropriate social situations and assigning mental states in stories with social content. As part of MM's neuropsychological assessment, he was also referred to a specialist service for neurodevelopmental disorders, where he was assessed using ADOS-2, module 4, which gave a positive result (Social and Communication Behaviors = 15; Restricted and Repetitive Behavior = 1; combined domain total = 16). Finally, the functional assessment revealed independence in the activities of daily living (Barthel scale: 100/100) and the instrumental activities of daily living (Lawton and Brody instrumental activities of daily living scale: 24/24).

Evaluation of body expressions

Three experimental tests with whole-body stimuli were used: two for recognizing bodily expressions of emotions (basic and complex emotions, respectively) and one non-emotional control task that involved recognizing movements of locomotion and instrumental movements. These tasks and those used for facial expressions were experimental and were designed in the context of doctoral research conducted by the first author into emotion recognition from body movements in neuropsychological patients. The patient was assessed using these experimental tests as there is no tool for evaluating the ability to recognize basic and complex emotions through movement that has been specifically designed and/or adapted for Argentina. The importance of using emotional stimuli that have been adapted to each culture has been stressed by multiple studies that reported cultural differences in the recognition of emotional expressions using the face and the body (Crivelli, Jarillo, Russell, & Fernández-Dols, 2016; Engelmann & Pogosyan, 2013; Gendron, Roberson, van der Vyver, & Barrett, 2014; Hess, Blaison, & Kafetsios, 2016; Kleinsmith, De Silva, & Bianchi-Berthouze, 2006; Matsumoto, 1992; Matsumoto & Kudoh, 1987; Zhu, Ho, & Bonanno, 2013). All the stimuli used in this study were validated using healthy participants (Leiva, 2015; in press) and have been previously used in other case studies of adult patients with neurological pathologies (Leiva, Margulis, Micciulli, & Ferreres, 2016, 2017).

Body expressions of basic emotions. This test consisted of 42 videos (Figure 1(a)) lasting approximately five seconds each which showed whole-body images of a person with a pixelated face expressing one of the following basic emotions: fear, disgust, surprise, sadness,

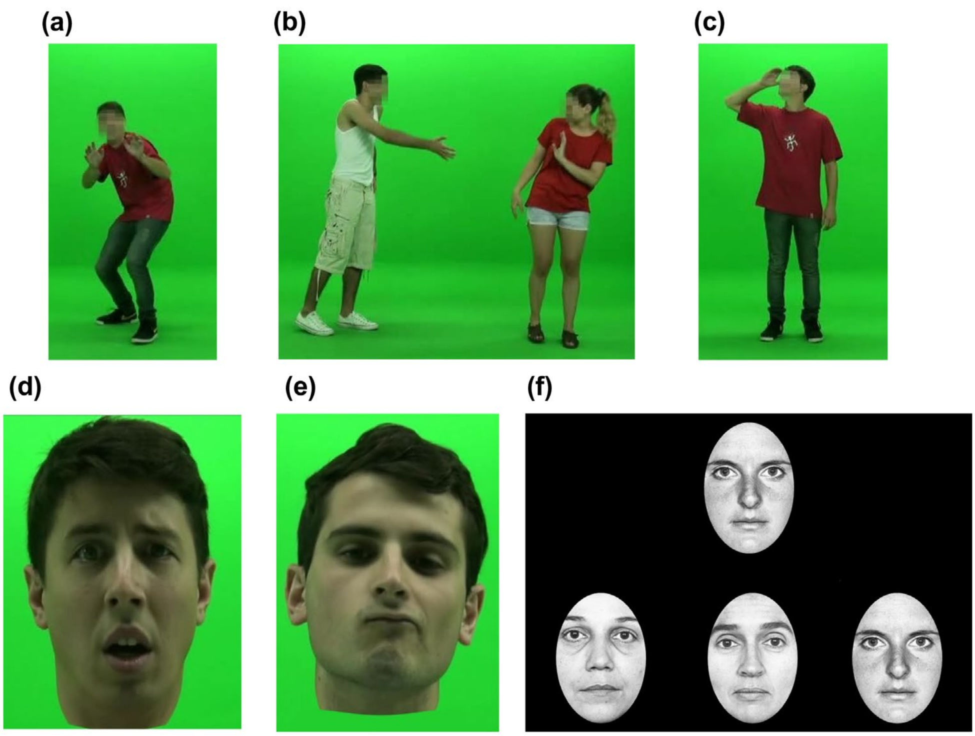

Figure 1. Screen capture examples of the experimental tasks (a) body expressions of basic emotions (fear); (b) body expressions of complex emotions (contempt); (c) non-emotional body movements (drinking from a glass); (d) facial expressions of basic emotions (fear); (e) facial expressions of complex emotions (arrogance); (f) facial perception.

happiness, anger, or a neutral expression. The stimuli were presented one-by-one on a computer screen and the subjects were asked to identify the emotion that the person in the video was feeling by focusing only on their body movements. After each stimulus was presented, the screen showed a written list of six options from which the participants had to pick the one that they thought was correct. In all cases, the options included four basic emotions, 'neutral,' and 'other' for when participants did not think any of the previous options were correct. We included six options in all tasks with video stimuli (this task and those described below) in order to balance out the number of options in all tasks, since there were different numbers of emotions (basic and complex) or non-emotional movements across tasks. In this and all subsequent tasks, the options included in each trial were selected based on a pilot study performed with healthy participants (Leiva, 2015) and there was no time limit for responding. The stimuli used in this and all subsequent tasks did not include any sound (they were only visual stimuli) and could be repeated once at the participants' request.

Body expressions of complex emotions. This test consisted of 31 videos (Figure 1(b)) lasting approximately 10 s which showed whole-body expressions of the following complex emotions: arrogance, admiration, jealousy, compassion, flirtation, contempt, gratitude, or shame. As in the basic emotions task, the videos showed whole-body images of people with pixelated faces. Unlike the previous test, however, these videos showed two people interacting but only one of them, who was wearing a red T-shirt, was expressing the target emotion. Participants were asked to observe the entire scene but only to identify what the person in the red T-shirt was feeling. After each video was presented on a computer screen, the subjects had to pick one of six response options which were also shown on the screen, which included four complex emotional states, 'neutral' and 'other.'

Non-emotional body movements. This test was made up of 27 short videos (Figure 1(c)) which showed a person carrying out one of the following body movements: walking, running, jumping, drinking from a glass, sweeping, hammering, combing their hair, swinging a tennis racket, and kicking a ball. In the case of instrumental gestures, only the movement was shown, without the objects. After each video was presented on a computer screen, participants were asked to pick one of six response options which were also shown on the screen. As with the emotional tests, 'other' was always included as a possible answer in case they did not think any of the others were correct.

Evaluation of facial expressions

Three experimental tests using facial stimuli were given: two emotional recognition tasks (for basic and complex emotions) and one control task involving the perception of structural facial features.

Facial expressions of basic emotions. In this test, the participants were shown 35 videos (Figure 1(d)) lasting approximately five seconds. Each was of a person's face expressing one of the following basic emotions: fear, disgust, surprise, sadness, happiness, anger, or a neutral expression. The videos were shown on a computer screen and the participants were asked to identify the emotion that the person in the video was feeling. After each video, the subjects were asked to pick which of a list of six options shown on the screen they thought was correct. The response options included four basic emotions, 'neutral,' and 'other.'

Facial expressions of complex emotions. This test was made up of 30 videos (Figure 1(e)) lasting approximately five seconds. Each showed a person's face expressing one of the following emotions: admiration, arrogance, compassion, flirtation, contempt, or shame. As with the previous tests, the videos were shown on a computer screen and after watching each, the subjects were asked to pick one of six response options which were shown on the same screen. The response options included four complex emotions, 'neutral,' and 'other.'

Facial perception. As a control test, a visual matching task was used to evaluate the subjects' perception of structural facial features (Figure 1(f)). The test consisted of 30 items in which one face is shown in the top half of a computer screen (the target stimulus) with three faces arrayed below it, only one of which is the correct answer. The participants needed to point out which of the three faces shown was the same as the target stimulus. These facial photographs were taken from the Pictures of Facial Affect set (Ekman & Friesen, 1976) and only neutral images that did not show emotional expressions were used.

In all the tests, the answer was considered correct if the subject picked the target option and incorrect if they chose any other option.

All the participants were set the six tasks in the following order: (1) Non-emotional body movements; (2) Bodily expressions of basic emotions; (3) Bodily expressions of complex emotions; (4) Facial perception; (5) Facial expressions of basic emotions; and (6) Facial expressions of complex emotions. The healthy participants were assessed on all tasks in one 90-min session. On the assumption that patient MM, like others with ASD, would have difficulties performing some of the emotional processing tasks, he was evaluated over two sessions lasting a maximum of one hour each, between which the tasks were divided. The assessment was planned in this way to minimize the effect of fatigue and frustration that the patient's difficulties could potentially cause. Likewise, to balance out the effect of external factors that might affect one session more than the other, both took place on the same day of the week (two Tuesdays a week apart) at the same time (from 10 am to 11 am), under similar sleep and dietary conditions, and both were carried out by the same assessor.

Data analysis

First, for each of the six tests, we calculated the percentage of MM's correct answers, the average percentage of correct answers, and the standard deviation for the control group. Since the control group included both male and female participants, we analyzed possible differences between their performance of the six tasks using the Mann–Whitney *U* Test for the two non-emotional tasks (due to the strong asymmetry in data distribution) and the independent samples *t*-test for the emotional tasks.

We compared the patient's performance at the two non-emotional tasks with those of the control group using the Mann–Whitney *U* Test, due to the asymmetry in the distribution. For this and all subsequent comparisons, we used .05 as the critical *p*-value.

To analyze the dissociation between facial and bodily expressions, we used Crawford and Garthwaite's (2005) operational criteria. According to the authors, a patient has a classical dissociation between two tasks if the following criteria are met: (1) the patient's performance of task *X* is significantly lower ($p \leq .05$) than that of the control group; (2) there is no difference ($p > .05$) between the patient's performance of task *Y* and that of the control group; and (3) the difference observed between tasks *X* and *Y* for the patient is statistically different ($p \leq .05$) to the difference observed in the control group for the same tasks.

To verify each of the criteria, we used the statistics suggested by the authors. We tested for compliance with criteria 1 and 2 using a modified one-tailed *t*-test designed specifically for single-case studies (Crawford & Howell, 1998). This compares the patient's performance with that of a control group made up of a small sample ($n < 50$). To test compliance with criterion 3, we used the Revised Standardized Difference Test (RSDT), which compares the discrepancy between tasks for the patient and the control group, taking the correlation between these into account (Crawford & Garthwaite, 2005). We also estimated the percentage of the control population that would perform worse than the patient (Crawford & Garthwaite, 2002). Finally, the size of the effect (z_{cc}) was reported for all these comparisons, as suggested by Crawford, Garthwaite, and Porter (2010). The software used to carry out these analyses was *Dissocs_ES* and *Singlims_ES*, both of which are available for free download from Professor Crawford's personal website.

Dissociation analyses were carried out for the recognition tasks for basic emotions (body vs. face) and complex emotions (body vs. face).

Results

In the control group there were no statistically significant differences between males' and females' performances at non-emotional tasks (Facial perception: $M_{males} = 99.7$, SD = 1.01, $M_{females} = 99.5$, SD = 1.3, $U = 97.5$, $p = .609$; Non-emotional body movements: $M_{males} = 98.9$, SD = 1.7, $M_{females} = 98.6$, SD = 2.5, $U = 102.5$, $p = .911$), or emotional tasks (Bodily expressions of basic emotions: $M_{males} = 75.5$, SD = 12.3, $M_{females} = 82.8$, SD = 9.8, $t = 1.789$, $p = .084$; Facial expressions of basic emotions: $M_{males} = 80.3$, SD = 7.6, $M_{females} = 85.3$, SD = 11.2, $t = 1.456$, $p = .157$; Bodily expressions of complex emotions: $M_{males} = 74.5$, SD = 13.9, $M_{females} = 76.4$, SD = 15.6, $t = .337$, $p = .739$; Facial expressions of complex emotions: $M_{males} = 80$, SD = 9.6, $M_{females} = 86.1$, SD = 11.8, $t = 1.47$, $p = .153$).

Non-emotional tests: patient vs. control group

Some 96.3% of the patient's answers were correct for the test for recognizing non-emotional body movements (26/27) and 100% were correct for the facial perception test (30/30). There were no significant differences between the patient's and the control group's performances on the non-emotional body movement test ($M_{CG} = 98.76$, $SD_{CG} = 2.25$; $U = 2.00$, $p = .068$) or the facial perception task ($M_{CG} = 99.6$, $SD_{CG} = 1.15$; $U = 13.00$, $p = .700$).

Dissociation of facial and bodily expressions

Basic emotions

In the recognition tests for basic emotions, 60% of the patient's answers were correct for whole-body stimuli (25/42) and 91% were correct for facial stimuli (32/35). When the patient's performance was compared to that of the control group, statistically significant differences were only observed in the recognition of bodily expressions ($t = -1.777$, $p = .043$, Table 2). An effect-size analysis revealed that the patient's performance differed by 1.8 standard deviations from the control group's performance. There were no significant differences between

Table 2. Results of comparison between patient MM's percentage of correct answers and the performance of the control group in the four emotional tasks.

Type of emotion	Type of stimuli	Control group			MM	Significance test[a]		Estimated percentage of the control population obtaining a lower score than MM[b]		Estimated effect size (z_{cc})[c]	
		n	Mean	SD	MM	*T*	*p*	Point	(95% CI)	Point	(95% CI)
Basic	Face	30	83.43	10.16	96	.733	.235	76.53	(63.1 to 87.4)	.745	(.334 to 1.146)
	Body	30	80.16	11.16	60	−1.777	.043	4.30	(.85 to 11.21)	−1.806	(−2.385 to −1.216)
Complex	Face	30	83.89	11.25	83	−.078	.469	46.92	(33.11 to 61.02)	−.079	(−.437 to .280)
	Body	30	75.70	14.76	48	−1.846	.037	3.75	(.67 to 10.18)	−1.877	(−2.470 to −1.271)

[a]Crawford and Howell (1998), the results are for a one-tailed test.
[b]Crawford and Garthwaite (2002).
[c]Crawford et al. (2010).

the patient's percentage of correct answers and that of the control group for the facial stimuli test ($t = .733$, $p = .235$).

The comparison of the discrepancy between the patient's test results for facial and bodily expressions and the discrepancy of the control group's revealed statistically significant differences ($t = 2.897$, $p = .007$). Using the RSDT, it was estimated that only .35% of the control population would show a greater discrepancy between the two tests (body vs. face) than was observed in the patient.

Complex emotions

In the recognition tests for complex emotions, 48% of the patient's answers were correct for whole-body stimuli (15/31) and 83% were correct for facial stimuli (25/30). As was observed with the basic emotion recognition test, when the patient's performance was compared to the control group's, statistically significant differences were only observed for the recognition of body expressions ($t = -1.846$, $p = .037$, Table 2). An effect-size analysis revealed that the patient's performance differed from that of the control group by 1.9 standard deviations. There were no statistically significant differences between the patient's percentage of correct answers and that of the control group on the facial stimuli test ($t = -.078$, $p = .469$).

The comparison of the discrepancy between the patient's test results for facial and body expressions and the discrepancy of the control group's revealed statistically significant differences ($t = 2.079$, $p = .046$). Using the RSDT, it was estimated that only 2.33% of the control population would show a greater discrepancy between the two tests (body vs. face) than was observed in the patient.

Discussion

The aim of this paper was to present a dissociation between the recognition of facial expressions and the recognition of body expressions in an adult patient (MM) with ASD.

In comparison to the control group, the patient performed worse at both emotional recognition tasks using whole-body stimuli (for basic and complex emotions). The patient's performance did not differ from that of the control group on either of the two facial expression tasks (for basic and complex emotions). The discrepancy between the patient's performance at bodily and facial recognition tasks was high in comparison with the discrepancy between the control group's performance at these tasks. Patient MM thus, met Crawford and Garthwaite's (2005) criteria for classical dissociation as his recognition of both basic and complex emotions was only impaired when looking at whole-body emotional stimuli—his recognition of the same emotions based on facial expressions was unaffected.

MM's performance is consistent with studies that have reported alterations in the ability to identify emotions based on bodily expressions in groups of patients with autism (Atkinson, 2009; Nackaerts et al., 2012). MM showed no difficulties in recognizing facial expressions, which is consistent with studies that reported no differences between patients with autism and subjects with typical development, on emotional recognition using cues of this type (Adolphs et al., 2001; Jones et al., 2011; Rutherford & Towns, 2008). The fact that the behavioral results did not differ between patients and control subjects for facial recognition of emotions does not rule out the possibility that patients with ASD process these stimuli differently. In fact, some studies showed abnormal eye gaze patterns in patients with autism even though they achieve similar scores to participants with typical development (for a review, see Harms, Martin, & Wallace, 2010). As the evaluation of patient MM only recorded the number of correct answers, there is no other available information (for example, from eye-tracking or electrophysiological and brain imaging studies) that would allow the way he processes this sort of emotional stimuli to be described.

MM's difficulty in recognizing emotions based on body movements cannot be explained by a deficit in his processing of general movements of this sort because his performance at a similar task with no emotional content (the recognition of movements of locomotion and instrumental actions) was similar to that of the control group. However, one limitation of our study is that the body control task we used for the assessment seems to have been easier than the two emotional body tasks. The use of appropriate control tasks is a challenge in emotional assessment. For example, the authors of a recent review of emotion recognition in neuropsychological patients criticized the fact that most of the studies in question did not include any control tasks (Yuvaraj et al., 2013). In the case of patients with autism, this issue is particularly relevant because deficits in processing biological motion have been described regardless of whether the stimuli used were emotional or not (Atkinson, 2009), something that should be taken into account in future studies.

To the authors' knowledge, this is the first case study to document a classical dissociation between the recognition of facial expressions and that of bodily expressions of basic and complex emotions. To date, three cases of dissociation between the recognition of basic emotions based on facial or bodily expressions have been reported on: two patients with bilateral amygdala lesions caused by Urbach–Wiethe disease (Adolphs et al., 1994, 1995, 1999; Atkinson et al., 2007) and one patient with limbic encephalitis whose lesions affected the right insular cortex and right temporal medial areas, including the amygdala (Sprengelmeyer et al., 2010). These three cases showed the same pattern: the patients performed worse at recognizing emotions based on facial stimuli but their performance with body stimuli was unaffected. The patient who is described here, MM, has the opposite dissociation: he performed worse with body stimuli and normally with facial stimuli. Although rigorous methods for documenting the dissociation were only used with MM, the data from all four patients can be taken as initial evidence of the existence of a double dissociation between the ability to recognize emotions through bodily expressions and the ability to recognize emotions through facial expressions. The difference between the pattern observed for patient MM and patients with acquired amygdala lesions is particularly interesting as that area of the brain has been the focus of several studies of patients with ASD. Studies using fMRI showed a reduction in amygdala activity during recognition tasks that use facial emotional stimuli in patients with ASD (for a review, see Harms et al., 2010), although it is not yet known precisely how this brain dysfunction is related to emotional recognition. Furthermore, it has been shown that patients with acquired amygdala lesions have different alteration patterns to those observed in patients with ASD (Paul, Corsello, Tranel, & Adolphs, 2010). Future research would need to contain further evidence of differential deficit patterns in patients with developmental disorders and in patients with acquired brain injuries, to test if this kind of dissociation is observed in other pathologies.

This description of patient MM's case is the first study to directly compare the existence of a dissociation between facial and bodily expressions of complex emotions. In so doing, it discovered the same dissociation as for basic emotions: the patient's performance was only affected for whole-body stimuli. The neuropsychological evidence of differential impairment for the two types of stimuli is coherent with functional imaging (de Borst & de Gelder, 2016; Kret et al., 2011; Peelen, Atkinson, & Vuilleumier, 2010; Van de Riet, Grèzes, & de Gelder, 2009) and behavioral studies of healthy populations (Aviezer et al., 2012; Martinez et al., 2016), which reveal differences in how we process the two types of stimuli. The particular relevance of neuropsychological dissociation studies lies in the fact that they allow us to discriminate between independent processes (Ellis & Young, 1992) that cannot be differentiated, at least at present, through the sole use of behavioral or functional imaging studies.

Despite dissociation data shown in this case study, our work has several limitations that should be taken into account in future studies. First, patient MM had a relatively low IQ score and, although it was within normal ranges, we did not test IQ for the control group. In future research, we plan to test if the dissociation pattern is maintained if we use a control group with a similar IQ to the patient or to test if IQ impacts how participants carry out emotional tasks. On the other hand, patient MM has a reduced visuospatial attention span and his deficits with visual memory processes, as described in his neuropsychological assessment, may influence his performance at emotional tests. However, the selective deficit with bodily emotional stimuli but not with facial expressions or non-emotional movements assessed with similar material, make it unlikely that these slight alterations are the cause of the patient's dissociated performance. As mentioned above, in future studies we would encourage the use of more and better control tasks to control visual perception, visual attention, or other basic cognitive processes that could affect patients' performances. Regarding the evaluation procedure, we emphasize that the patient was evaluated with the emotional tests throughout two different sessions, while the control group was evaluated in one session. Although we control possible influential external factors between sessions, we cannot estimate with exact precision how having two sessions impacted the performance of patient MM. Therefore, the dissociation finding described in this work needs to be replicated by future research. Finally, the use of experimental tests to evaluate emotional recognition is also a limitation when interpreting this data. However, the use of appropriate tests that have been culturally adapted to Latin American populations, including that of Argentina, is a challenge that the region is up against in relation not just to emotional evaluation tests but also in the evaluation of classic cognitive features such as memory, attention, and executive functions (Fernandez, Ferreres, Morlett-Paredes, Rivera, & Arango-Lasprilla, 2016; Ostrosky Shejet & Velez Garcia, 2016).

The clinical implications of the findings of single-case studies such as the one described here are naturally very limited. Greater evidence and studies of groups of patients would be needed to characterize the performance of different pathological populations and reach conclusions that would have a bearing on diagnosis and intervention. We also need to study the relationship between the deficit in the ability to recognize whole-body emotional expressions and other cognitive and/or behavioral aspects that could potentially underlie this performance.

Given the clinical relevance of characterizing impairments to the ability to recognize emotions among a range of pathological populations (those with autism, focal brain lesions, traumatic brain injuries, etc.), we believe that our initial finding of a double dissociation between the recognition of facial and bodily expressions of emotion suggests the need to systematically include body stimuli in studies of impairment patterns during the processing of non-verbal emotional cues. This would allow specific deficits in processing social information among these pathological populations to be described more exhaustively.

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Disclosure statement

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ORCID

Samanta Leiva http://orcid.org/0000-0003-3196-1675

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