CESPU
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GANDRA-BARTA NA AVALIAÇÃO DO RECONHECIMENTO EMOCIONAL DE FACES NA LESÃO CEREBRAL ADQUIRIDA

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Dissertação de Mestrado em Psicologia da Saúde e Neuropsicologia

Gandra, janeiro de 2017

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Dissertação apresentada no

Instituto Universitário de Ciências da Saúde

para cumprimentos dos requisitos necessários para a

obtenção de Grau de Mestre em

Psicologia da Saúde e Neuropsicologia

Orientador: Prof. Doutor Bruno Peixoto

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Agradecimentos

O caminho percorrido não o concretizei sozinha, por isso deixo aqui os meus sinceros agradecimentos especiais a quem de uma forma ou de outra me acompanhou durante este percurso.

Ao **Prof. Dr. Bruno Peixoto**, pelo acompanhamento constante durante todas as etapas da dissertação, pela orientação exemplar, pelo profissionalismo, por todo o conhecimento e sabedoria e por toda a disponibilidade.

Ao **Prof. Dr. José Maranhão**, por todas as palavras, por todos os conselhos, pela ajuda constante ao longo do percurso, pelo exemplo de profissional e pessoal que se tornou para mim durante estes anos.

A **todos os professores** pela formação de excelência transmitida ao longo destes 5 anos, por contribuírem com todo o seu conhecimento para a melhoria do meu futuro profissional.

Ao **Centro de Reabilitação Profissional de Gaia**, em especial à **Prof. Dra. Sandra Guerreiro** e à **Prof. Dra. Isabel Almeida**, pela colaboração e disponibilidade que ofereceram para a realização da investigação e pelos seus contributos de conhecimento e experiência.

A todos os **pacientes com lesão cerebral adquirida** que aceitaram participar neste projeto contribuindo assim para a sua realização e por permitirem adquirir maiores conhecimentos nesta área no sentido de um futuro melhor.

Aos **meus pais** por tudo, porque nunca existirão palavras suficientes para agradecer tudo o que fizeram por mim ao longo da minha vida, por acreditarem em mim, por não me deixarem desistir, por me acompanharem sempre, por todos os sacrifícios que sei que fazem para me dar um futuro melhor e essencialmente pelo amor incondicional que me fazem sentir todos os segundos da minha vida, não teria alcançado o que alcancei, nem seria a mulher que sou hoje se não fossem vocês. Obrigada **mãe**, pela força da natureza que és, por seres uma mulher tão forte e por me dares esse exemplo, por me relembrares sempre que sou o teu maior amor e a tua prioridade. Obrigada **pai**, por seres tão trabalhador, por me protegeres, por toda a dedicação, por todas as vezes que deixaste o que querias fazer

para me levares onde precisava, por seres um grande exemplo de empenho e trabalho, por todo o carinho.

Aos **meus avós**, por serem tão dedicados e por me apoiarem sempre. À minha **avó Filomena**, por todas as refeições feitas com amor, pelo carinho e preocupação constante, por torcer sempre por mim, por todo o mimo, por gostar tanto de mim. Ao meu **avô Magalhães** por me ter mostrado que para ser família não é preciso ser de sangue, por ter ao longo destes anos ter tido o papel de meu avô sem pensar duas vezes, por estar sempre lá para me apoiar, por todo o carinho.

Aos **meus tios Catarina e Tiago,** por me acompanharem, por toda a força que me dão, por quererem sempre os meus conselhos "como psicóloga", por me ajudarem no que conseguem, por se interessarem sempre e por todo o afeto.

Ao meu **afilhado Francisco**, pelo amor que me transmite, por me ensinar a ter mais paciência, por querer sempre "*brincar mais um bocadinho*", por todo o miminho que me dá.

À minha **bisavó,** mesmo já não estando presente fisicamente, por ser o meu anjinho da guarda desde o dia que partiu.

Ao **Carlos**, por ter aparecido na minha vida e a ter tornado melhor e mais feliz, pela paciência e carinho nos momentos mais difíceis, por me mostrar sempre o lado positivo, por toda a felicidade que me transmite e me faz sentir, por acreditar sempre em mim e nas minhas capacidades, por todo o amor que me dá.

À **Tânia**, por ser a minha melhor amiga e levar esse papel a sério sempre, por estar comigo nos bons, médios e maus momentos, por estar sempre, por todas as aventuras, pela constante presença na minha vida, pela importância que tem para mim, pela amizade.

À **Rita**, por ter sempre um espaço na vida dela para mim, por todas as conversas, pelas palavras, pela amizade, pelo carinho.

Ao **meu grupo de amigos**, por à maneira deles me apoiarem sempre e serem uma espécie de claque pessoal que eu tenho, por toda diversão que acrescentam à minha vida e por terem uma presença constante ao longo da minha vida.

Resumo

Na comunicação interpessoal, o reconhecimento emocional de faces demonstra um papel de grande relevância, visto que apresenta influência na adequação da interação social. Após a lesão cerebral adquirida são apresentadas dificuldades na interação social relacionadas com o comprometimento do reconhecimento emocional de faces.

O manuscrito intitulado de "Gandra-BARTA na Avaliação do Reconhecimento Emocional de Faces na Lesão Cerebral Adquirida", centra-se em testar a validade discriminativa do Gandra-BARTA às alterações no reconhecimento emocional de faces após a lesão cerebral adquirida e perceber a sua ligação com o funcionamento cognitivo geral, funcionamento executivo e outras variáveis associadas à lesão cerebral adquirida. O instrumento Gandra-BARTA, consiste num teste para a avaliação do reconhecimento emocional de faces constituído por 59 fotografias a cores com as expressões emocionais universais (alegria, tristeza, medo, raiva, nojo, surpresa e expressões neutras).

A amostra é constituída por um grupo de pacientes com lesão cerebral adquirida (n=20) e um grupo de controlo (n = 16), sem história clínica de lesão cerebral adquirida ou qualquer patologia neuropsiquiátrica. O Gandra-BARTA diferenciou os dois grupos, em vários itens como: tempo de resposta, número total de identificações emocionais corretas e na identificação de emoções específicas (nojo, raiva, surpresa e alegria). O número de identificações emocionais corretas mostrou sensibilidade de 81,3% e especificidade de 75%, no ponto de corte de 41. Idade, escolaridade, tempo após lesão e funcionamento executivo relacionam-se com a identificação de algumas das emoções. Este teste demonstra então, ser um instrumento válido no contexto de lesão cerebral adquirida, apresentando valores satisfatórios de sensibilidade e especificidade.

O documento relativo a este trabalho foi desenvolvido em formato de artigo, em conformidade com as regras propostas pela revista científica *Acta Neuropsychologica* e posteriormente submetido à mesma. O *Abstract* foi submetido ao *14th European Conference on Psychological Assessment*.

Palavras-Chave: Reconhecimento Emocional de Faces, Emoções, Traumatismo Crânio Encefálico, Acidente Vascular Cerebral, Gandra-BARTA, Lesão Cerebral Adquirida

Abstract

In interpersonal communication, the emotional recognition of faces demonstrates a role of great relevance, which seems to influence the adequacy of social interaction. After an acquired brain lesion, difficulties in the social interaction related to the emotional recognition of faces are presented.

The manuscript features a dissertation titled "Gandra-BARTA an Assessment of the Emotional Recognition of Faces in Acquired Brain Injury", focuses on testing discriminative validity of Gandra-BARTA and its connection with general cognitive functioning, executive functioning and other associated variables to acquired brain injury. The Gandra-BARTA instrument consists in a test to evaluate the emotional recognition of faces and it is consisted by 59 colored photographs with universal emotional expressions (joy, sadness, fear, anger, disgust, surprise and neutral expressions).

The sample is compounded by a group of patients with acquired brain injury (n = 20) and a control group (n = 16) with no clinical history of acquired brain injury or any neuropsychiatric pathology. Gandra-BARTA differentiated the two groups into several items such as completion time, total number of correct emotional identifications, and an identification of specific emotions (disgust, anger, surprise, and joy). The number of correct emotional identifications showed a sensitivity of 81.3% and specificity of 75% for a cutoff of 41. Age, schooling, time after the injury and functioning of the employee are related to the identification of some of the emotions. Gandra-BARTA is a valid instrument within the context of acquired brain injury, presenting satisfactory values of sensitivity and specificity. The document related to this work was developed in an article format, in accordance with the revisions of the scientific journal Acta Neuropsychologica and subsequently submitted to it. The Abstract was submitted to the 14th European Conference on Psychological Assessment.

Keywords: Emotional Recognition of Faces, Emotions, Trauma Brain Brain, Stroke, Gandra-BARTA, Acquired Brain Injury

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Gandra-BARTA na avaliação do reconhecimento emocional de faces na lesão cerebral adquirida

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Resumo

Background: Pacientes com lesão cerebral adquirida, podem apresentar dificuldades a nível social mais especificamente no reconhecimento emocional de faces. A presente investigação tem como objetivo testar a validade discriminativa do Gandra-BARTA às alterações no reconhecimento emocional de faces após a lesão cerebral adquirida e perceber a sua ligação com o funcionamento cognitivo geral, funcionamento executivo e outras variáveis associadas à lesão cerebral adquirida.

Métodos: A amostra é constituída por dois grupos, o Grupo Clínico (n=20) constituído por indivíduos com lesão cerebral adquirida e o Grupo de Controlo (n=16) constituído por sujeitos saudáveis. Todos os participantes foram sujeitos a avaliação global da capacidade cognitiva através do Montreal Cognitive Assessment (MoCA), a avaliação do funcionamento executivo através do INECO *Frontal Screening* e a avaliação do reconhecimento emocional de faces através do Gandra-BARTA.

Resultados: Os resultados demonstram que o Gandra-BARTA apresenta capacidade discriminativa para a avaliação do reconhecimento emocional de faces em pacientes com lesão cerebral adquirida. É apresentada diferenciação na existência de lesão cerebral adquirida no reconhecimento emocional de faces evidenciando-se a diferença na identificação de raiva, nojo, alegria e surpresa. O estudo também apresenta a existência de um declínio da identificação de emoções ao longo da idade, no reconhecimento da emoção nojo apresenta défice ao nível da idade e funcionamento executivo, e na raiva ao nível da idade e escolaridade. O reconhecimento emocional de faces apresenta melhorias no tempo após lesão. A identificação da expressão neutra demonstra melhoria ao longo do tempo após a lesão.

Conclusão: A capacidade discriminativa do Gandra-BARTA, permite que seja um instrumento a utilizar na avaliação do reconhecimento emocional de faces em pacientes com lesão cerebral adquirida. Os indivíduos com lesão cerebral apresentam dificuldades na identificação de raiva, nojo, alegria e surpresa. O reconhecimento emocional difere no que concerne à idade, funcionamento executivo, escolaridade e tempo pós-lesão.

Palavras-Chave: Emoções, AVC, Traumatismo Crânio Encefálico, Expressões Faciais

Abstract

Background: Patients with acquired brain injury, may present social difficulties more specifically in the emotional recognition of faces. The present research aims to test the discriminative validity of Gandra-BARTA to the changes in the emotional recognition of faces after the acquired brain injury and to perceive its connection with the general cognitive functioning, executive functioning and other variables associated to the acquired brain injury.

Methods: The sample consists in two groups, the Clinical Group (n = 20) constituted by individuals with acquired brain injury and the Control Group (n = 16) compounded by healthy subjects. All participants were submitted to a global cognitive assessment through the Montreal Cognitive Assessment (MoCA), the evaluation of executive functioning through the INECO *Frontal Screening* and the evaluation of emotional recognition of faces through Gandra-BARTA.

Results: The results demonstrate that Gandra-BARTA presents discriminative capacity for the evaluation of emotional recognition of faces in patients with acquired brain injury. Differences in the existence of acquired brain lesions in the emotional recognition of faces are evidenced by the difference in the identification of anger, disgust, happiness and surprise. The study also shows the existence of a decline in the identification of emotions along the age, in the recognition of the disgusting emotion presents deficit related to the age and executive functioning, and in the rage the decline is related to the age and schooling. The emotional recognition of faces presents improvements in time after injury. Identification of the neutral expression demonstrates improvement over time after injury.

Conclusion: The discriminative ability of Gandra-BARTA allows it to be an instrument to be used in the evaluation of the emotional recognition of faces in patients with acquired brain injury. Individuals with brain injury have difficulties in identifying anger, disgust, happiness and surprise. Emotional recognition differs in what concerns to age, executive functioning, schooling, and time after injury.

Keywords: Emotions, Stroke, Traumatic Brain Injury, Facial Expressions

Introdução

A comunicação interpessoal inclui linguagem não-verbal, tal como as expressões faciais (Busso et al. 2004). A perceção e reconhecimento emocional de expressões é essencial na interação social tendo grande influência na regulação do comportamento e na comunicação de informações importantes e sinais sociais (Chan, 2009; Damásio, 2011). A correta identificação da expressão emocional fornece pistas sobre qual a reação adequada à interação social (Grossman & Johnson, 2007) podendo ser afetada por diversos fatores dentro e fora da face (Lipp, Craig & Dat, 2015).

A face partilha informações relativas ao estado emocional interno do indivíduo (Chan, 2009) através da alteração do movimento dos músculos da cara, na comunicação de diferentes emoções (Busso et al., 2004). Para a identificação das emoções transmitidas são necessárias operações cerebrais e cognitivas complexas através da reaquisição das informações específicas armazenadas sobre a emoção e a perceção através da face e/ou da voz dos diversos elementos fornecidos (Grossman & Johnson, 2007). O reconhecimento emocional ganha cada vez maior importância, tendo sido incluído no DSM-V como parte dos exemplos de avaliações do domínio cognitivo Cognição Social, sendo da máxima importância a sua inclusão nas baterias de testes de cognição social (Chiu et al., 2015).

O reconhecimento emocional com base nas vias neurais que trabalham em paralelo, mas de forma separada pode ser considerado um processo de múltiplas fases (Spreengelmeyer, Rausch, Eysel & Przuntek. 1998) que pode ser seletivamente danificado por uma doença neurológica ou por um traumatismo (Green, Turner & Thompson, 2004).

O grupo de estruturas envolvidas no reconhecimento emocional de faces é diversificado, como o córtex occipitotemporal, córtex orbitofrontal, córtex parietal direito, gânglios basais, amígdala, entre outros (Adolphs, 2002).

Os indivíduos com lesão no hemisfério esquerdo, aparentemente não apresentam dificuldades no reconhecimento emocional, em comparação com pacientes com lesões no hemisfério direito (Adolphs, Damásio, Tranel & Damásio, 1996). As regiões mais relacionadas com esta dificuldade são o córtex parietal interior direito e o córtex calcarino medial anterior direito (Adolphs et al., 1996). O desempenho na identificação de emoções é mais eficiente com o envolvimento dos dois hemisférios, devido à importância da

transferência interhemisférica de informação (Tamietto, Adenzato, Geminiani & Gelder, 2007). Neste sentido, o corpo caloso também desempenha um papel importante, sendo que a redução da sua integridade e atividade conduzem e mantêm as dificuldades no processamento das emoções (Bridgman et al., 2014).

A amígdala está implicada no reconhecimento emocional de faces mediante duas vias, uma via subcortical através do colículo superior e do pulvinar e uma via cortical através do neocórtex visual (Adolphs, 2002). A amígdala ativa-se perante diferentes emoções, tanto negativas como positivas (Yang et al. 2002, Derntl et al. 2009). Quando esta se encontra lesionada bilateralmente verifica-se uma maior dificuldade no reconhecimento de emoções negativas (Adolphs & Tranel, 2003), assim como um maior défice na identificação de emoções secundárias do que em primárias, tanto com lesão unilateral como bilateral (Adolphs, Baron-Cohen & Tranel, 2002). A lesão na substância branca pode também prejudicar o reconhecimento emocional de faces (Philippi, Mehta, Grabowski, Adolphs & Rudrauf, 2009).

Diferentes estruturas cerebrais podem ser mais sensíveis a diferentes reações emocionais (Laughead, Gur, Elliot & Gur, 2008). A expressão da emoção de alegria desencadeia uma ativação mais elevada no tálamo (Laughead et al., 2008), no giro cingulado anterior (Phillips et al. 1998, Killgore & Yurgelun-Todd, 2004) e posterior e ainda no córtex frontal medial existindo também um aumento do sinal no giro supramarginal esquerdo (Phillips et al. 1998). Estes achados são acompanhados por uma ativação bilateral da amígdala (Killgore & Yurgelun-Todd, 2004). Relativamente à emoção tristeza existe uma maior ativação da amígdala esquerda, do giro temporal medial e do giro temporal inferior direito quando comparados com a emoção raiva (Blair, Morris, Frith, Perrett & Dolan, 1999), também se demonstrou a ativação do giro cingulado anterior esquerdo (Killgore & Yurgelun-Todd, 2004). A existência de défices no reconhecimento da emoção raiva foi demonstrada na presença de lesão ao nível do estriado ventral (Calder, Keane, Lawrence & Manes, 2004), e foi associada com maior ativação no córtex orbitofrontal direito (Blair et al., 1999). O medo apresenta maior ativação em diferentes estruturas tais como o pulvinar, ínsula anterior, cingulado anterior (Morris et al. 1998), córtex frontal medial (Fusar-Poli et al., 2009) e tálamo (Laughead, et al., 2008). Quando comparado com a emoção de alegria apresentou uma maior ativação na amígdala esquerda (Morris et al. 1998). A amígdala bilateral

apresentou maior sensibilidade na emoção medo quando comparado com a alegria e tristeza (Fusar-Poli et al., 2009). O nojo quando exibido ativa a ínsula (Schroeder et al,, 2004), mais especificamente o córtex insular anterior (Phillips et al., 1997) e a ínsula anterior ventral (Krolak-Salmon, 2003). A expressão de surpresa utiliza estruturas do lobo temporal medial, mais concretamente o giro hipocampal direito (Schroeder et al., 2004).

Com o envolvimento de um conjunto tão diversificado de estruturas cerebrais no reconhecimento emocional de faces é importante perceber como indivíduos com lesão cerebral adquirida (Traumatismo Crânio Encefálico (TCE), Acidente Vascular Cerebral (AVC)) podem ser prejudicados nesta função.

No sentido de colmatar a falta de instrumentos para a identificação de diferenças individuais no reconhecimento emocional de faces foi desenvolvido o instrumento Gandra-BARTA, constituído por 59 fotografias a cores com as expressões emocionais universais (alegria, tristeza, medo, raiva, nojo, surpresa e expressões neutras) recuperadas da base de dados do *Bolton Affect Recognition Tri-Stimulus Approach* (BARTA) (Lawrence, Nabi & Charlton, 2011). Cada emoção está representada em 9 fotografias e a expressão neutra em 5. Mesmo sendo recente já demonstrou sensibilidade na identificação de dificuldades no reconhecimento emocional no envelhecimento normal e patológico (Páris, Carvalho, Lemos & Peixoto, 2014), na esquizofrenia (Silva, Pimentel & Monteiro, 2014) e na doença de Parkinson (Rocha & Monteiro, 2013). Contudo, não se conhecem indicadores de validade discriminativa na lesão cerebral adquirida.

Assim, o primeiro grande objetivo da presente investigação, passa por testar a validade discriminativa (sensitividade e especificidade) do Gandra-BARTA relativamente à capacidade de reconhecimento emocional de faces em indivíduos com lesão cerebral adquirida, o segundo objetivo é perceber as relações entre a capacidade de reconhecimento emocional, o funcionamento cognitivo geral, o funcionamento executivo e algumas variáveis associadas à lesão cerebral adquirida.

Metodologia

Amostra

A amostra é constituída por 36 participantes divididos em dois grupos, o grupo clínico e o grupo de controlo. O grupo clínico é composto por 20 indivíduos, 18 pertencentes ao sexo masculino e 2 ao feminino, com lesão cerebral adquirida dos quais 12 sofreram TCE grave, fechado e difuso e 8 tiveram um primeiro AVC (1 isquémico esquerdo, 3 isquémicos direitos, 1 hemorrágico esquerdo, 1 hemorrágico direito, e 2 hemorrágicos medianos), tendo como tempo pós lesão médio de 42,4 meses (± 60,17), as idades estão compreendidas entre os 23 e os 57 anos e a escolaridade entre 4 e 12 anos, 12 pertencem a profissão de colarinho azul e 8 de colarinho branco. O grupo de controlo é constituído por 16 indivíduos, dos quais 15 do sexo masculino e 1 do sexo feminino, sem lesão cerebral adquirida, com idades compreendidas entre os 23 e os 53 anos e escolaridade entre os 4 e 12 anos, a profissão divide-se por 10 pertencentes ao colarinho azul e 6 ao colarinho branco.

Os dois grupos não diferem entre si no que refere à idade (p=.558), escolaridade (p=.733), sexo (x^2=.164, p=1) e profissão (x^2=.023, p=1). A caracterização da amostra é apresentada na Tabela 1.

Avaliação

Os seguintes instrumentos foram aplicados a todos os participantes: *Montreal Cognitive Assessment* (MoCA) (Freitas, Simões, Martins, Vilar & Santa, 2010), INECO *Frontal Screening* (IFS) (Caldeira, Baeta & Peixoto, 2011) e o Gandra-BARTA (Páris et al., 2014). O MoCA e IFS foram utilizados com o objetivo de determinar possíveis relações entre o reconhecimento emocional de faces, o funcionamento cognitivo geral e funcionamento frontal. O número total de identificações corretas e tempo de resposta foram tomados em conta, bem como o número de identificações corretas de cada emoção.

Procedimento

Este estudo foi aprovado pelo conselho diretivo do Centro de Reabilitação Profissional de Gaia (CRPG).

O grupo clínico é constituído por participantes do programa de reabilitação neuropsicológica do CRPG. A realização dos testes sucedeu-se individualmente.

Anteriormente à recolha de dados o consentimento informado foi obtido. De seguida foram explicados e aplicados os diferentes instrumentos. Todos os dados foram tratados anonimamente.

A recolha do grupo de controlo sucedeu-se junto da comunidade.

Análise Estatística

Para a análise estatística foi utilizado o *software* estatístico IBM SPSS *Statistics,* versão 23 para *Windows.*

Foram utilizadas medidas de tendência central e de desvio para caracterização da amostra e descrição dos resultados obtidos nas provas.

Recorreu-se ao teste U de *Mann-Whitney* para efetuar comparações do desempenho dos grupos nas provas.

A capacidade discriminativa do Gandra-BARTA foi estabelecida através da curva *Receiver Operating Characteristic* (ROC), com extração dos valores de sensitividade e de especificidade relativa a diferentes pontos de corte.

Para determinar a relação entre variáveis contínuas foi utilizada a correlação de *Spearman*.

Consideraram-se significativos resultados com $p<.05$.

Resultados

Os resultados obtidos pelos dois grupos nas provas neuropsicológicas encontra-se na Tabela 2.

A Tabela 3 apresenta a comparação entre grupos nos testes neuropsicológicos. O grupo clínico obteve resultados inferiores no MoCA, no tempo de resposta e número de acertos no Gandra-BARTA. Além disso o grupo clínico apresentou dificuldades acentuadas na identificação das emoções nojo, raiva, surpresa e alegria.

A capacidade discriminativa do Gandra-BARTA através da curva de ROC representada na Figura 1, demonstrou no ponto de corte de 41 reconhecimentos emocionais corretos, diferenciando o grupo de controlo do grupo clínico com uma capacidade de sensitividade de 81,3% e de especificidade de 75%.

Na Tabela 6, observa-se que o número de acertos total do Gandra-BARTA se correlaciona negativamente com a idade e positivamente com o tempo pós-lesão. Quanto à identificação na emoção nojo foi obtida uma correlação negativa com a idade e uma correlação positiva com o INECO *Frontal Screening*. A identificação da emoção raiva também demonstrou que se correlaciona negativamente com a idade e positivamente com a escolaridade.

Relativamente à identificação de faces neutras foi obtida uma correlação positiva com o tempo pós lesão.

Discussão

O primeiro grande objetivo deste estudo foi avaliar a capacidade discriminativa do Gandra-BARTA na avaliação do reconhecimento emocional de faces em pacientes com lesão cerebral adquirida. O Gandra-BARTA demonstrou uma boa capacidade discriminativa entre o grupo de controlo e o grupo clínico. O Gandra-BARTA demonstra vantagens em relação a outros instrumentos de avaliação como por exemplo o *FEEL Test* que apresenta um estímulo de curta apresentação (300 ms) (Braun, Traue, Frisch, Deighton & Kessler, 2005) enquanto que no Gandra-BARTA a duração do estímulo é controlada pelo sujeito. Além disso no Gandra-BARTA é possível identificar a emoção durante a visualização da imagem, enquanto que no *FEEL Test* a resposta é dada 500ms após a imagem desaparecer (Braun et al., 2005) aumentando o esforço da memória de trabalho. Outro benefício do Gandra-BARTA é que ao contrário do *FEEST* que apresenta imagens a preto e branco do *Pictures of Facial Affect Series* (Spikman et al., 2013), o Gandra-BARTA apresenta imagens a cores.

Outro objetivo deste estudo, era perceber a relação de diferentes variáveis relacionadas com a lesão cerebral adquirida.

Na ocorrência de lesão cerebral adquirida, é frequente a existência de declínio cognitivo (Srikanth et al., 2003; Schretlen & Shapiro, 2003; Rasquin et al. 2004; Wong, et al.2012). No presente estudo quando comparados os dois grupos, tal como esperado, é apresentada diferença ao nível dos resultados do MoCA. Os pacientes com lesão cerebral comummente apresentam défices no funcionamento executivo (Hart, Whyte, Kim & Vacarro, 2005; Zinn, Bosworth, Hoening & Swartzwelder, 2007) que mesmo na ocorrência de certas melhorias ao longo do tempo, continuam a demonstrar dificuldades (Kersel, Marsh, Havill & Sleigh, 2001; Schretlen & Shapiro, 2003). Inesperadamente os resultados obtidos não indicaram diferenças relativamente aos resultados do INECO, podendo dever-se ao facto do grupo clínico se encontrar em fase de reabilitação num programa holístico de reabilitação neuropsicológica que aparenta estar relacionado com melhorias ao nível do funcionamento da memória de trabalho e componentes do funcionamento executivo (Guerreiro,2014). Um estudo sugeriu que apesar de o funcionamento executivo não parecer afetar as dificuldades de reconhecer emoções, pode ter influência na toma de decisão posterior de como reagir à emoção percebida (Yim, Babbage, Zupan, Neumann & Willer, 2013). Apesar da possibilidade

de existirem défices no reconhecimento emocional de faces e no funcionamento executivo ao mesmo tempo depois de uma lesão cerebral, a sua baixa correlação demonstra que podem ser fatores autónomos, não existindo associação entre os dois (Spikman et al. 2013). Apesar disso, os resultados obtidos neste estudo apresentaram relação entre o funcionamento executivo e a capacidade da identificação da emoção nojo, contrariando assim a corrente literatura.

Estudos desenvolvidos demonstraram a existência de défices no reconhecimento emocional de faces na ocorrência de lesão cerebral. No que se refere ao AVC (Braun et al., 2005; Blonder, Pettigrew & Kryscio, 2012; Cooper et al.,2014), lesões no hemisfério direito estão mais associadas a este tipo de dificuldades (Mandal, Tandon & Ashtana, 1991; Kucharska-Pietura, Phillips, Gernand & David, 2003; Yuvaraj, Murugapan, Norlina, Sundaraj & Khairiyan, 2013). Alterações na capacidade de reconhecimento emocional, são igualmente comuns no TCE (Spell & Frank, 2000; Milders, Fuchs & Crawford, 2003; Green et al, 2004; Crocker & McDonald, 2005; Waats & Douglas, 2006; Radice-Neumann;, Zupan, Babbage & Willer, 2007; Ietswaart, Milders, Crawford, Currie & Scott, 2007; Milders, Ietswaart, M., Crawford & Currie, 2008; Know & Douglas, 2009; Babbage et al., 2011; Martins et al. 2011; Spikman et al., 2013; Rosenberg, McDonald, Dethier, Kessels & Westbrook, 2014). Estima-se que cerca de 34% dos pacientes com TCE avaliados apresentam défices no reconhecimento emocional independentemente do tipo de traumatismo (Zupan, Babbage, Neumann & Willer, 2014). Os resultados demonstram que os indivíduos com lesão cerebral adquirida apresentam maiores dificuldades no reconhecimento emocional de faces quando comparados com indivíduos saudáveis.

Muitas das investigações efetuadas nesta área, demonstraram a existência de uma maior dificuldade no reconhecimento de emoções de carácter negativo quando comparadas com emoções positivas (Kucharska-Pietura et al., 2003; Crocker & McDonald, 2005; Radice-Neumann et al., 2007; Spikman et al., 2013; Rosenberg et al., 2014). Uma das emoções que é mais afetada no seu reconhecimento é o nojo (Braun et al., 2005; Crocker & McDonald, 2005; Rosenberg et al., 2014). Mais especificamente, um estudo demonstra que essa diminuição acontece quando ocorre uma interrupção do funcionamento do córtex pré-frontal ventromedial (Vandekerckhove, et al., 2014). A identificação da raiva também se

apresentou prejudicada nos resultados, corroborando investigações efetuadas precedentemente (Karow, Marquardt & Marshall, 2001; Braun et al., 2005; Martins et al. 2011; Rosenberg et al., 2014; Zupan, et al., 2014).

Como referido anteriormente, pacientes com lesão cerebral adquirida demonstram maior dificuldade na identificação de emoções negativas. Contrariamente a esta observação, estudos demonstram a existência de défices na identificação da alegria (Karow et al., 2001; Braun et al., 2005) e da surpresa (Martins et al. 2011; Rosenberg et al.,2014; Vandekerckhove, et al., 2014), tal como observável nos resultados da investigação em que o grupo clínico apresentou dificuldades não só na identificação de certas emoções negativas (raiva e nojo) como nas positivas (alegria e surpresa). Esta diferença pode dever-se ao facto da amostra não ser muito alargada e conter lesões diversificadas. Défices no reconhecimento emocional de faces são apresentados tanto em lesões do hemisfério direito como em lesões do hemisfério esquerdo (Abbott, Cumming, Fidler & Lindell, 2013), sendo que o hemisfério direito aparenta ter um maior envolvimento no reconhecimento emocional. A maioria dos estudos demonstra que na existência de lesão no hemisfério direito, a dificuldade no reconhecimento emocional é superior, do que em lesões no hemisfério esquerdo e no grupo de controlo (Yuvaraj et al., 2013). Nos danos no hemisfério direito, o reconhecimento de emoções negativas aparece mais prejudicado (Adolphs, Jansari & Trunel, 2001; Abbott et al, 2013) enquanto que, para a identificação de emoções positivas não parece existir uma assimetria hemisférica (Adolphs et al., 2001). Outros estudos já demonstraram mais especificamente a existência de um predomínio do hemisfério direito na identificação da alegria (Charbonneau, Scherzer, Aspirot & Cohen, 2003; Alves, Aznar-Casanova & Fukusima, 2009), surpresa (Charbonneau et al., 2003), raiva, tristeza (Torro-Alves, Sousa & Fukusima, 2011) e medo (Charbonneau et al., 2003; Alves et al., 2009).

O tempo de resposta nesta avaliação também surgiu diferenciada entre os grupos, apresentando maior lentidão no grupo com lesão cerebral adquirida, já demonstrada num estudo em que o grupo com lesão cerebral apresentou maior lentidão de resposta na identificação de tristeza, medo, raiva e surpresa (Martins et al., 2011). A velocidade de processamento da informação sensório-percetiva é uma das sequelas mais comuns após uma lesão cerebral (Madigan, DeLuca, Diamond, Tramontano & Averill, 2000), este facto

conduz a uma maior lentidão na tomada de decisão (Marleen, et al. 2003), o que pode justificar as diferenças do tempo de identificação emocional entre os grupos.

A presente investigação indicou uma relação inversa entre a idade e o reconhecimento emocional. A literatura demonstra que os adultos mais jovens e adultos de meia-idade apresentam capacidades semelhantes no reconhecimento emocional de faces (Khawar, Malik, Maqsood, Yasmin & Habib, 2013), apresentando os adultos mais jovens uma capacidade mais apurada nesta função do que os idosos (Horning, 2011). No que concerne à faixa etária dos idosos, esta função apresenta declínio (Khawar et al., 2013; Horning, 2011; Moosavian & Borry, 2015), podendo o envelhecimento cognitivo diferir nas consequências do reconhecimento de cada emoção (Atsunobu & Akiyama, 2013). Os resultados obtidos assim o indicaram, fundamentalmente nas emoções raiva e nojo, existindo um declínio do reconhecimento ao longo da idade. Diversos estudos executados demonstram que a taxa de sucesso na performance de reconhecimento da emoção raiva diminui com a idade (Sullivan & Ruffman, 2004; Orgeta & Phillips, 2007; Ruffman, Henry, Livingstone & Phillips, 2008; Mill, Allik, Realo & Valk, 2009; Ebner & Johnson, 2009; Hunter, Phillips & MacPherson, 2010; Atsunobu & Akiyama, 2013; West et al. 2012), atestando assim os nossos resultados. Outra particularidade dos resultados acerca do reconhecimento da raiva, é o aumento da performance comparativamente com os níveis de escolaridade, esta variável ainda se encontra pouco estudada na literatura, mas em termos gerais, o reconhecimento emocional de faces demonstra melhoria da performance em função de um maior nível de escolaridade (Dodich et al., 2014).

Relativamente à identificação do nojo, existe alguma divergência na literatura relativamente à sua ligação com a idade, diferentes investigações apontam que o reconhecimento do nojo mostra preservação ao longo da idade (Horning & Cornwell, 2012), exibindo até uma certa melhoria (Calder et al., 2003; Suzuki, Hoshino, Shigemasu & Kawamura, 2007; West et al., 2012; Atsunobu & Akiyama, 2013; Circelli, Clark & Cronin-Golomb, 2013), mas contradizendo esses resultados existem estudos, que tal como nesta investigação, é exibido um declínio na identificação desta emoção (Sze, Goodkind, Gyurak & Levenson, 2012), acontecendo esse decrescimento essencialmente a partir dos 40 anos (Moosavian & Borry, 2015), diminuindo de forma gradual durante a velhice (Khawar et al.,

2013). Apesar do reconhecimento da expressão neutra não aparecer muito estudada, os resultados deste estudo demonstram um aumento da capacidade ao longo do tempo após a lesão.

Estes resultados demonstram ainda que o desempenho no reconhecimento emocional de faces melhora ao longo do tempo após a lesão, ao contrário do que nos demonstra a literatura, em que a capacidade de reconhecimento não demonstrou melhorias, estando o défice presente após a lesão e um ano depois (Ietswaart et al., 2007).

As principais limitações deste estudo passam pela reduzida amostra tanto a nível clínico como de controlo. O aumento da amostra permitiria analisar diferencialmente os efeitos da lesão cerebral adquirida de etiologia vascular e traumática ao nível dos diferentes domínios do reconhecimento emocional. Em investigações futuras seria importante o aumento da amostra para perceber se as diferenças se mantêm e ainda perceber se existem diferenças no reconhecimento emocional entre diferentes tipos de lesões e lateralização.

Em conclusão, o instrumento Gandra-BARTA apresenta capacidade discriminativa para a avaliação do reconhecimento emocional de faces em pacientes com lesão cerebral adquirida. O grupo clínico difere do grupo de controlo ao nível do declínio cognitivo, identificação das emoções, essencialmente na raiva, nojo, alegria e surpresa e tempo de resposta. O estudo também apresenta a existência declínio da identificação de emoções ao longo da idade, no reconhecimento da emoção nojo apresenta défice ao nível da idade e funcionamento executivo, e da raiva ao nível da idade e escolaridade. O reconhecimento emocional de faces apresenta melhorias no tempo após lesão. A identificação da expressão neutra demonstra melhoria ao longo do tempo após lesão.

O presente estudo vem reforçar a importância da utilização do Gandra-BARTA em pessoas com lesão cerebral adquirida, devido à sua capacidade discriminativa para a avaliação do reconhecimento emocional de faces nessa população. Realçando a importância da integração na reabilitação neuropsicológica, de programas de treino do reconhecimento emocional de faces para uma melhor integração do indivíduo a nível social. Os programas aplicados em pacientes com lesão cerebral adquirida demonstraram melhorias

significativas (Bornhofen & McDonalds 2008; Radice-Neumann, Zupan, Tomita & Willer, 2009).

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Anexos

Anexo I – Tabelas e Figuras

Tabela 1 – Caracterização da Amostra

	Grupo de Controlo (n=16)	Grupo Clínico (n=20)
Idade (M/DP)	38.81/10.78	36.70/10.51
Escolaridade(M/DP)	9.19/2.76	9.50/2.66
Sexo (M/F)	15/1	18/2

Tabela 2 – Resultados obtidos pelos dois grupos nas provas neuropsicológicas

	Grupo de Controlo (n=16)	Grupo Clínico (n=20)
MoCA (M±DP)	23.63/3.70	20.80/4.07
INECO (M±DP)	21.90/3.92	19.07/4.71
Gandra-BARTA Tempo (M±DP)	267.44/88.71	553/236.84
Gandra-BARTA Acertos (M±DP)	42.88/6.89	34.30/9.34
Nojo (M±DP)	6.94/1.91	5.45/1.90
Raiva (M±DP)	8.06/1.24	5.25/2.84
Tristeza (M±DP)	4.56/2.28	3.90/2.07
Neutra (M±DP)	4.50/1.37	3.95/1.50
Medo (M±DP)	2.06/2.38	2.40/1.72
Surpresa (M±DP)	7.81/1.83	5.90/1.94
Alegria (M±DP)	8.94/.250	7.60/2.04

Tabela 3 – Comparação do desempenho dos dois grupos nas provas neuropsicológicas

	p	U
MoCA	.023	230.5
INECO	.058	219.5
Gandra-BARTA Tempo	.000	16
Gandra-BARTA Acertos	.003	251.5
Nojo	.014	237
Raiva	.001	258
Tristeza	.404	187
Neutra	.149	206
Medo	.352	130.5
Surpresa	.002	254.5
Alegria	.020	.233

Figura 1 – Capacidade discriminativa do Gandra-BARTA através da curva *Receiver Operating Characteristic* (ROC)

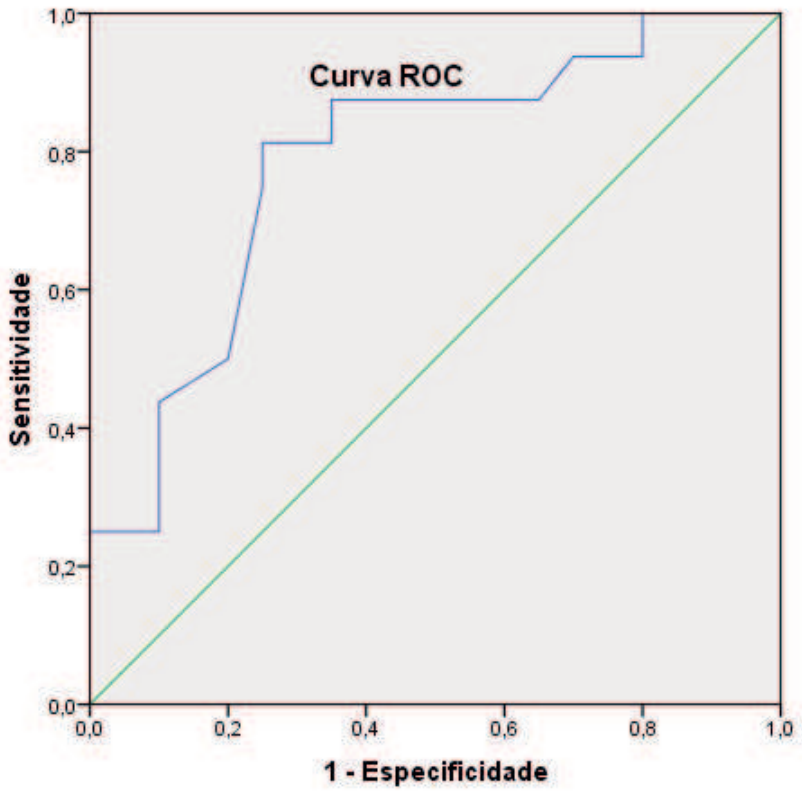

Tabela 4 – Características da curva de ROC

Área sob a curva	Erro Padrão	p	Intervalo de confiança
.786	.078	.004	[.633-.933]

Tabela 5 – Pontos de corte e valores de sensitividade e de especificidade gerados na distinção dos dois grupos através do número de acertos no Gandra-BARTA

Ponto de corte	Sensitividade (%)	Especificidade (%)
38	87,5	65
39	81,3	65
40	81,3	70
41	**81,3**	**75**
42	75	75
43	50	80
44	43,8	90

Tabela 6 – Correlações entre o Gandra-BARTA e idade, escolaridade, tempo após lesão, MoCA e INECO *Frontal Screening*

	Idade	Escolaridade	Tempo após lesão	MoCA	INECO
Gandra-BARTA Tempo	-.104	-.404	.185	-.339	-.414
Gandra-BARTA Acertos	-.574**	.396	.567**	.205	.337
Nojo	.536*	.146	.338	.400	.482*
Raiva	.482	.453*	.394	.050	.149
Tristeza	-.335	.318	.431	-.248	.007
Neutra	-.316	.407	.649**	.208	.404
Medo	-.130	.112	.173	.060	.089
Surpresa	-.166	.310	.155	.183	.220
Alegria	-.305	.043	.409	.128	.152

Valores expressos em coeficiente de correlação

*p ≤ .01

** p ≤ .05

Anexo II - Normas para a submissão da revista *Acta Neuropsychologica*

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– the brain/mind problem;

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Authors are encouraged to submit manuscripts on theoretical and clinical topics in neuropsychology, broadly understood; interdisciplinary studies that explore issues not previously regarded as strictly neuropsychological are particularly welcome.

Acta Neuroopsychologica publishes articles of several types:

– experimental and clinical research papers (group studies, case studies, metaanalyses);

– theoretical essays;

– reviews (normally by invitation of the Editors, but unsolicited submissions of particular value can be considered);

– letters to the editor (at the Editors' discretion, these can be published as commentary articles);

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The essential features of a structured abstract for a clinical or empirical research

study are given below.

Background: Describe the background to the study, including the central problems or issues and their importance, the aims and objectives of the study, research questions or hypotheses advanced, etc.

Material and methods: Outline the research subjects / participants with relevant demographics and clinical information, the basic tests and parameters, and the experimental design, including statistical methods if different from routine tests and measures.

Results: Outline the important and relevant results generated by the experiment in general terms, without undue specificity of data.

Conclusions: The most important conclusions and implications of the study, with particular emphasis on any implications for clinical practice.

The foregoing should be treated as a model and not a prescription. Essays of a more discursive nature need not have a structured abstract. If the Editors upon review of the manuscript feel that the abstract should be structured, they will ask the author(s) to do so prior to publication.

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Anexo III – Abstract submetido ao *14th European Conference on Psychological Assessment*

14th European Conference on Psychological Assessment

Lisbon, 5-8 July 2017

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Abstract of Contribution 7

ID: 7

Paper presentation

Gandra-BARTA for the assessment of facial emotions recognition in acquired brain injury

Marcela Leite[1], Sandra Guerreiro[2], Isabel Almeida[2], Bruno Peixoto[3,4]

[1]CESPU, Instituto de Investigação e Formação Avançada em Ciências da Saúde. Gandra / Portugal, Portugal; [2]Departamento de Reabilitação Neuropsicológica no Centro de Reabilitação Profissional de Gaia . Arcozelo, Gaia/ Portugal; [3]CESPU, Instituto Universitário de Ciências da Saúde. Gandra / Portugal; [4]NeuroGen - Center for Health Technology and Services Research (CINTESIS). Porto/ Portugal; marcela.filipa@hotmail.com

Background: Difficulties in social interaction due to impaired facial emotions recognition, is a common feature after acquired brain injury (ABI). The present study aims to determine the discriminative validity (sensitivity and specificity) of the Gandra-BARTA test on the context of ABI, and to establish its relation to general cognitive function, executive functioning and psychosocial and clinical variables related to ABI.

Methods: The study includes two groups: ABI group (n=20), constituted by patients with traumatic brain injury and stroke; Control group (n=16), composed by participants without clinical history of ABI or any neuropsychiatric pathology.

Results: Gandra- BARTA differentiated the two groups, in several items such as: time of completion, total number of correct emotional identifications and in the identification of specific emotions (discuss, anger, surprise and happiness). The number of correct emotional identifications showed a sensitivity of 81.3% and specificity of 75% for a cutoff of 41 points. Age, schooling, time after injury and executive functioning relate to the identification of some of the emotions.

Conclusion: The obtained values of sensitivity and specificity are satisfactory. Gandra-BARTA seems to be a valid instrument for clinical use on the context of ABI. Age, schooling, time after injury and executive functioning of ABI patients must be taken in account in the interpretation of test results. Facial emotions recognition assessment and intervention must be incorporated in neuropsychological rehabilitation programs.

Anexo IV – Confirmação da submissão do Abstract submetido ao 14th European Conference on Psychological Assessment

EO ECPA 14 Organizers
14:20

ECPA 14: New Submission Received. Contribution ID: 7
Para: marcela.filipa@hotmail.com Cc: sandra.guerreiro@crpg.pt; isabel.almeida@crpg.pt; bruno.peixoto@iucs.cespu.pt

Dear Ms. Marcela Filipa Barbosa Leite,

We have received your submission. Thank you.

Submission Details
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Type : Paper presentation
Title : Gandra-BARTA for the assessment of facial emotions recognition in acquired brain injury
Author(s) : Leite, Marcela; Guerreiro, Sandra; Almeida, Isabel; Peixoto, Bruno
Presenting Author : Leite, Marcela
Presenter's E-Mail: marcela.filipa@hotmail.com

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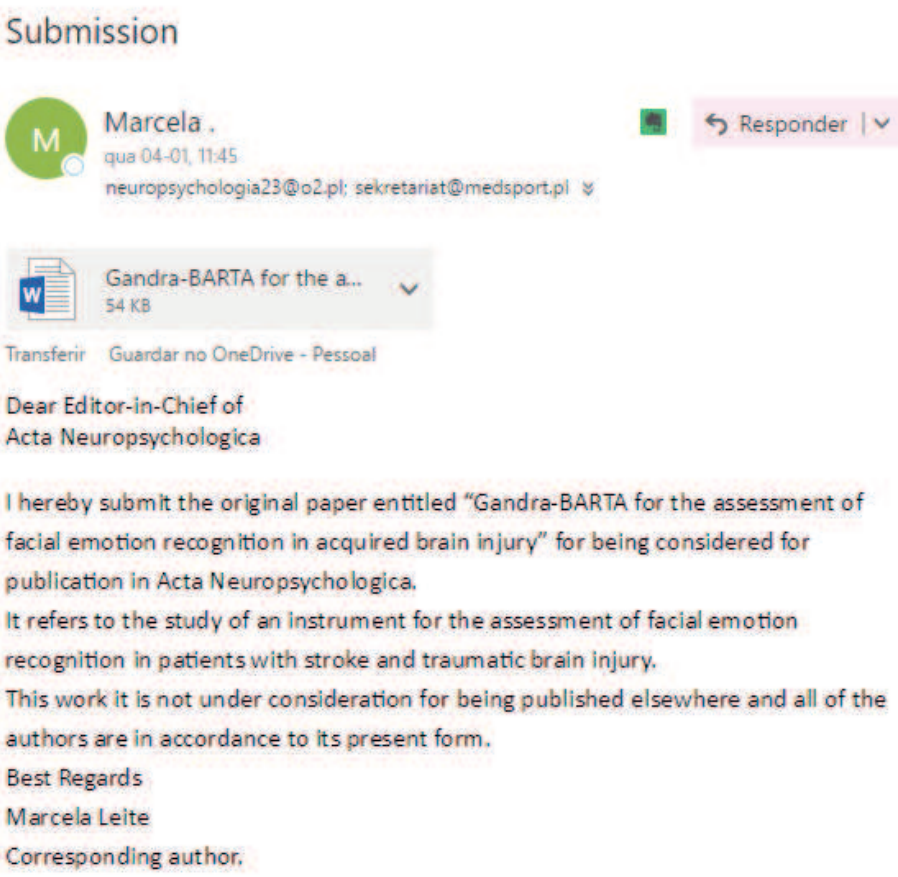
Anexo V – E-mail de submissão do artigo "*Gandra-BARTA for the assessment of facial emotions recognition in acquired brain injury*" à revista *Acta Neuropsychologica*.



Submission

Marcela .
qua 04-01, 11:45
neuropsychologia23@o2.pl; sekretariat@medsport.pl

Responder

Gandra-BARTA for the a...
54 KB

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Dear Editor-in-Chief of
Acta Neuropsychologica

I hereby submit the original paper entitled "Gandra-BARTA for the assessment of facial emotion recognition in acquired brain injury" for being considered for publication in Acta Neuropsychologica.
It refers to the study of an instrument for the assessment of facial emotion recognition in patients with stroke and traumatic brain injury.
This work it is not under consideration for being published elsewhere and all of the authors are in accordance to its present form.
Best Regards
Marcela Leite
Corresponding author.

Anexo VI – Artigo submetido à revista *Acta Neuropsychologica*.

Gandra-BARTA for the assessment of facial emotion recognition in acquired brain injury

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Abstract

Background: Patients with acquired brain injury (ABI), may present social difficulties more specifically in the emotional recognition of faces. The present research aims to test the discriminative validity of Gandra-BARTA to the changes in the emotional recognition of faces after ABI and to perceive its connection with the general cognitive functioning, executive functioning and other variables associated with ABI.

Methods: The sample consists in two groups, the Clinical Group (n = 20, ABI participants) and the Control Group (n = 16, healthy participants). All participants underwent a global cognitive assessment through the Montreal Cognitive Assessment (MoCA), executive functioning was measured by INECO *Frontal Screening* and the evaluation of emotional recognition of faces through Gandra-BARTA.

Results: The results demonstrate that Gandra-BARTA presents discriminative capacity for the evaluation of emotional recognition of faces in patients with acquired brain injury. We observed differences between the two groups at the capacity of emotional recognition especially at identification of emotions such as anger, disgust, happiness and surprise. The study also shows the existence of a decline in the identification of emotions along the age, in the recognition of the disgusting emotion presents deficit related to the age and executive functioning, and in the rage the decline is related to the age and schooling. The emotional recognition of faces presents improvements in time after injury. Identification of the neutral expression demonstrates improvement over time after injury.

Conclusion: The discriminative ability of Gandra-BARTA allows it to be an instrument to be used in the evaluation of the emotional recognition of faces in patients with acquired brain injury. Individuals with brain injury have difficulties in identifying anger, disgust, happiness and surprise. Emotional recognition differs in what concerns to age, executive functioning, schooling, and time after injury.

Keywords: Emotions, Stroke, Traumatic Brain Injury, Facial Expressions

Introduction

Interpersonal communication includes nonverbal language such as facial expressions (Busso et al., 2004). The perception and emotional recognition of expressions is essential in social interaction, having a great influence on the regulation of behavior and the communication of important information and social signals (Chan, 2009; Damásio, 2011). Correct identification of emotional expression provides clues to determine which is the appropriate response to social interaction (Grossman & Johnson, 2007) and it can be affected by several factors inside or outside the face (Lipp, Craig & Dat, 2015).

The face shares information regarding the individual's internal emotional state (Chan, 2009) through the change of movement of the face's muscles, in the communication of different emotions (Busso et al., 2004). In order to identify the transmitted emotions, complex brain and cognitive operations are necessary through the reacquisition of the specific information stored about the emotion and the perception through the face and/or voice of the diverse elements provided (Grossman & Johnson, 2007). Emotional recognition becomes increasingly important, having been included in DSM-V as part of the examples of evaluations of the cognitive domain Social Cognition, being one of the utmost importance its inclusion in the social cognition test batteries (Chiu et al., 2015).

Emotional recognition based on neural pathways that work in parallel, but separately can be considered a multiple-stage process (Spreengelmeyer, Rausch, Eysel & Przuntek, 1998) that can be selectively damaged by neurological disease or trauma (Green, Turner & Thompson, 2004).

The group of structures involved in the emotional recognition of faces is diverse, such as the occipitotemporal cortex, orbitofrontal cortex, right parietal cortex, basal ganglia, amygdala, and others (Adolphs, 2002).

Individuals with lesions in the left hemisphere, apparently do not have difficulties in emotional recognition in comparison to patients with lesions in right hemisphere (Adolphs, Damásio, Tranel & Damásio, 1996). The regions most related to this difficulty are the right parietal cortex and the right anterior medial calcarine cortex (Adolphs, Damásio, Tranel & Damásio. 1996). The performance in the identification of emotion is more efficient with the involvement of both hemispheres, due to the importance of interhemispheric transference

of information (Tamietto, Adenzato, Geminiani & Gelder, 2007). In this sense, the corpus callosum also plays an important role, and the reduction of its integrity and activity leads to and maintains difficulties in the processing of emotions (Bridgman et al., 2014).

The amygdala it is implicated on the emotional recognition of faces through two pathways, a subcortical pathway through the superior colliculus and the pulvinar, and a cortical pathway through the visual neocortex (Adolphs, 2002). The amygdala is activated towards different emotions, both negative and positive (Yang et al. 2002, Derntl et al. 2009). When the amygdala is bilaterally injured, there is a greater difficulty in negative emotion recognition (Adolphs & Tranel, 2003), as well as a greater deficit in the identification of secondary emotions than in primaries, with both unilateral and bilateral lesions (Adolphs, Baron-Cohen & Tranel, 2002). The white matter lesion can also damage the emotional recognition of faces (Philippi, Mehta, Grabowski, Adolphs & Rudrauf, 2009).

Different brain structures may be more sensitive to different emotional reactions (Laughead, Gur, Elliot & Gur, 2008). The expression of happiness triggers a higher activation in the thalamus (Laughead, Gur, Elliot & Gur, 2008), in the anterior and posterior cingulate gyrus (Phillips et al., 1998, Killgore & Yurgelun-Todd, 2004) and also in the medial frontal cortex, there is also an increase of the signal in the left supramarginal gyrus (Phillips et al. 1998). These findings are accompanied by bilateral activation of the amygdala (Killgore & Yurgelun-Todd, 2004). Relatively to the emotion sadness there is a greater activation of the left amygdala, the medial temporal gyrus and the right inferior temporal gyrus when compared to the angry emotion (Blair, Morris, Frith, Perrett & Dolan, 1999). The activation of the left anterior cingulate gyrus was also demonstrated (Killgore & Yurgelun-Todd, 2004). The existence of deficits in the recognition of anger was demonstrated in the presence of a lesion at the ventral striatum (Calder, Keane, Lawrence & Manes, 2004), and it was associated to a greater activation in the right orbitofrontal cortex (Blair, Morris, Frith, Perrett and Dolan 1999). Fear presents greater activation in different structures, such as the pulvinar, anterior insula, anterior cingulate (Morris et al. 1998), medial frontal cortex (Fusar-Poli et al., 2009) and thalamus (Laughead, Gur, Elliot & Gur, 2008). When compared with the emotion happiness, fear showed a greater activation in the left amygdala (Morris et al. 1998). The bilateral amygdala showed greater sensitivity in emotion fear when compared with happiness and sadness (Fusar-Poli et al., 2009). When disgust is displayed, it activates

the insula (Schroeder et al, 2004), more specifically the anterior insular cortex (Phillips et al., 1997) and the ventral anterior insula (Krolak-Salmon, 2003). The expression of surprise uses structures of the medial temporal lobe, more specifically the right hippocampal gyrus (Schroeder et al., 2004).

With the involvement of such a diverse set of brain structures in the emotional recognition of faces, it is important to note how individuals with acquired brain injury (Traumatic Brain Injury (TBI), Stroke) may be impaired in this function.

In order to overcome the lack of instruments to identify individual differences in the emotional recognition of faces, the Gandra-BARTA instrument was developed, consisting of 59 colored photographs with universal emotional expressions (happiness, sadness, fear, anger, disgust, surprise and neutral expressions) retrieved from the Bolton Affect Recognition Tri-Stimulus Approach (BARTA) database (Lawrence, Nabi & Charlton, 2011). Each emotional expression is represented in 9 photographs and the neutral expression in 5. Although it is a recent instrument, it has already demonstrated sensitivity in identifying difficulties in emotional recognition in normal and pathological aging (Páris, Carvalho, Lemos & Peixoto, 2014), in schizophrenia (Silva, Pimentel & Monteiro, 2014) and in Parkinson's disease (Rocha & Monteiro, 2013). However, no indicators of discriminative validity in acquired brain injury are known.

Thus, the first major objective of the present investigation is to test the discriminative validity (sensitivity and specificity) of Gandra-BARTA regarding the facial recognition ability in individuals with acquired brain injury.The second objective is to understand the relationships between the capacity for emotional recognition, general cognitive functioning, executive functioning and some variables associated with acquired brain injury.

Methods

Participants

The sample is composed by 36 participants divided into two groups, the clinical group and the control group. The clinical group consists of 20 individuals, 18 males and 2 females, with acquired brain injury, 12 of whom suffered severe closed and diffuse traumatic brain injury and 8 had a first stroke (1 left ischemic, 3 right ischemic, 1 left hemorrhagic, 1 right hemorrhagic, and 2 medium hemorrhagic), with a mean post-injury time of 42.4 months (± 60,17), ages ranging from 23 to 57 years and schooling between 4 and 12 years, 12 are associated to blue collar professions, while the other 8 individuals are associated to white collar professions. The control group consists of 16 individuals, 15 males and 1 female, with no acquired brain injury, aged between 23 and 53 years and schooling between the ages of 4 and 12, 10 pertaining to the blue collar and 14 to the white collar.

The two groups do not differ in age ($p = .558$), schooling ($p = .733$), gender ($x^2 = .164$, $p = 1$) and occupation ($x^2 = .023$, $p = 1$). The characterization of the sample is presented in Table 1.

Assessment

The following instruments were applied to all participants: Montreal Cognitive Assessment (MoCA) (Freitas, Simões, Martins, Vilar & Santa, 2010); INECO Frontal Screening (IFS) (Caldeira, Baeta & Peixoto, 2011); Gandra-BARTA (Páris, Carvalho, Lemos & Peixoto, 2014). MoCA and IFS were used to determine possible relationships between emotional recognition of faces, general cognitive functioning and frontal functioning. Total number of correct identifications and time of completion on Gandra-BARTA were taken, as well as the correct number of identifications of each emotion.

Procedure

This study was approved by the directorial board of the *Centro de Reabilitação Profissional de Gaia* (CRPG).

The clinical group comprised participants from the neuropsychological rehabilitation program of CRPG. Testing was carried out individually.

Prior to data collection, informed consent was obtained. All the collected data was dealt anonymously.

The control group was collected in the community.

Statistical Analysis

Statistical analysis was carried out using the program IBM Statistics version 23 for Windows. Measurements of central tendency and deviation were used to characterize the sample and describe the results obtained in the tests.

The Mann-Whitney *U* Test was used to compare the performance of the groups in the tests. The discriminative capacity of Gandra-BARTA was further determined through the Receiver Operating Characteristic curve (ROC), with extraction of sensitivity and specificity values relative to different cut-off points.

Spearman's correlation were used to determine the relationship between continuous variables.

Results with $p \leq .05$ were considered significant.

Results

The results obtained by the two groups in the neuropsychological tests is shown in Table 2. Table 3 shows the comparisons between groups on neuropsychological testing. The clinical group obtained lower results on MoCA, higher time to complete and lower number of correct identifications on Gandra-BARTA. Besides that the clinical group showed marked difficulties in the identification of specific emotions: disgust, anger, surprise and happiness.

The discriminative ability of Gandra-BARTA through the ROC curve depicted in Figure 1, demonstrated at the cut-off point of 41 correct emotional recognitions, differentiating the control group from the clinical group with a sensitivity of 81.3% and specificity of 75%.

The total number of correct answers on Gandra-BARTA correlates negatively with age and positively with time after injury ($\rho = .567$; $p = .009$). The identification of disgust correlates negatively with age ($\rho = - 536$, $p = .015$) and positively with results on INECO ($\rho = - .482$; $p = .031$). The identification of anger correlated negatively with age ($\rho = - .482$; $p = .031$) and

positively with schooling (ρ = - .453; p = .045). Regarding the identification of neutral faces, a positive correlation was obtained with time after injury (ρ = - 649, p = .002).

Discussion

The first major objective of this study was to evaluate the discriminative validity of Gandra-BARTA in the evaluation of the emotional recognition of faces in patients with ABI. The Gandra-BARTA demonstrated a good discriminative capacity between controls and patients with acquired brain injury. Gandra-BARTA has some advantages over other instruments such as the FEEL Test, which presents a short presentation stimulus (300 ms) (Braun, Traue, Frisch, Deighton & Kessler, 2005) while in Gandra-BARTA the duration of the stimulus is controlled by the subject. Also in Gandra-BARTA it is possible to identify the emotion during the image visualization, while in the FEEL Test the response is given 500ms after the image disappears (Braun, Traue, Frisch, Deighton & Kessler, 2005) increasing the load of working memory. Another benefit of Gandra-BARTA is that unlike the FEEST that features black and white pictures of the Pictures of Facial Affect Series (Spikman et al., 2013), Gandra-BARTA presents colored images.

Another objective of this study was to understand the relationship of different variables related to acquired brain injury.

In the presence of acquired brain injury, cognitive decline is common (Srikanth et al., 2003; Schretlen & Shapiro, 2003; Rasquin et al. 2004; Wong, et al.2012). In the present study when comparing the two groups, as expected, there is a difference in the level of MoCA results. Brain damage patients commonly present deficits in executive functioning (Hart, Whyte, Kim & Vacarro, 2005; Zinn, Bosworth, Hoening & Swartzwelder, 2007) that even in the occurrence of certain improvements over time, continue to demonstrate difficulties (Kersel, Marsh, Havill & Sleigh, 2001; Schretlen & Shapiro, 2003). Unexpectedly the results obtained do not indicate differences regarding the results of the INECO, and may be due to the fact that the clinical group is in rehabilitation phase in a holistic program of neuropsychological rehabilitation that appears to be related to improvements in the functioning of working memory and components of executive functioning (Guerreiro, 2014). One study suggested that although executive functioning does not seem to affect the difficulties of recognizing emotions, it may influence subsequent decision-making on how to react to perceived

emotion (Yim, Babbage, Zupan, Neumann & Willer, 2013). Despite the possibility of deficits in emotional facial recognition and executive functioning at the same time after brain injury, their low correlation shows that they may be autonomous factors, and there is no association between the two (Spikman et al., 2013). Despite this, the results obtained in this study shows a relation between the executive functioning and the capacity to identify of the disgust emotion, thus contradicting the current literature.

Studies have demonstrated the existence of deficits in the emotional recognition of faces in the occurrence of brain injury. With regard to stroke (Braun, Traue, Frisch, Deighton & Kessler, 2005; Blonder, Pettigrew & Kryscio, 2012; Cooper et al.,2014), lesions in the right hemisphere are more associated with this type of difficulties (Mandal, Tandon & Ashtana, 1991; Kucharska-Pietura, Phillips, Gernand & David, 2003; Yuvaraj, Murugapan, Norlina, Sundaraj & Khairiyan, 2013). Changes in the emotional recognition capacity are equally common in TBI (Spell & Frank, 2000; Milders, Fuchs & Crawford, 2003; Green, Turner & Thompson, 2004; Crocker & McDonald, 2005; Waats & Douglas, 2006; Radice-Neumann;, Zupan, Babbage & Willer, 2007; Ietswaart, Milders, Crawford, Currie & Scott, 2007; Milders, Ietswaart, M., Crawford & Currie, 2008; Know & Douglas, 2009; Babbage et al., 2011; Martins et al. 2011; Spikman et al., 2013; Rosenberg, McDonald, Dethier, Kessels & Westbrook, 2014). It is estimated that about 34% of patients with TBI evaluated present deficits in emotional recognition regardless of the type of trauma (Zupan, Babbage, Neumann & Willer, 2014). The results demonstrate that individuals with acquired brain injury present greater difficulties in the emotional recognition of faces when compared with healthy individuals.

Many of the investigations carried out in this area have demonstrated the existence of a greater difficulty in the recognition of negative emotions when compared with positive emotions (Kucharska-Pietura, Phillips, Gernand, & David, 2003; Crocker & McDonald, 2005; Radice-Neumann, Zupan, Babbage & Willer, 2007; Spikman et al., 2013; Rosenberg, McDonald, Dethier, Kessels & Westbrook, 2014). One of the emotions that is most affected in their recognition is the disgust (Braun, Traue, Frisch, Deighton & Kessler, 2005; Crocker & McDonald, 2005; Rosenberg, McDonald, Dethier, Kessels & Westbrook, 2014). More specifically a study demonstrates that this decrease occurs when there is an interruption in the functioning of the ventromedial prefrontal cortex (Vandekerckhove, et al., 2014). The identification of anger was also impaired in the results, corroborating investigations carried

out previously (Karow, Marquardt & Marshall, 2001; Braun, Traue, Frisch, Deighton & Kessler, 2005; Martins et al. 2011; Rosenberg, McDonald, Dethier, Kessels & Westbrook, 2014; Zupan, Babbage, Neumann & Willer, 2014).

As previously reported, patients with acquired brain injury demonstrate greater difficulty to identify negative emotions. Contrary to this observation, studies demonstrate the existence of deficits in the identification of happiness (Karow, Marquardt & Marshall, 2001; Braun, Traue, Frisch, Deighton & Kessler, 2005) and the surprise (Martins et al. 2011; Rosenberg, McDonald, Dethier, Kessels & Westbrook, 2014; Vandekerckhove, et al., 2014), as observed in the research results in which the clinical group presented difficulties, not only in the identification of certain negative emotions (anger and disgust) but also in the positive ones (happiness and surprise). This difference may be due to the fact that the sample is not very wide and contains a variety of lesions. Emotional facial recognition deficits are presented when there is a lesion in left or right hemisphere (Abbott, Cumming, Fidler & Lindell, 2013), however, the right hemisphere appears to be more involved in emotional recognition. The majority of the studies show that in the presence of right hemisphere lesion, the difficulty in emotional recognition is higher than in lesions in the left hemisphere and in the control group (Yuvaraj, Murugappan, Norlinah, Sundaraj & Khairyah, 2013). When the right hemisphere is damaged, the recognition of negative emotions appears to be more impaired (Adolphs, Jansari & Trunel, 2001; Abbott, Cumming, Fidler & Lindell, 2013) while for the identification of positive emotions there does not appear to be a hemispheric asymmetry (Adolphs, Jansari & Trunel, 2001). Other studies have demonstrated more specifically the existence of a predominance of the right hemisphere in the identification of happiness (Charbonneau, Scherzer, Aspirot & Cohen, 2003; Alves, Aznar-Casanova & Fukusima, 2009), surprise (Charbonneau, Scherzer, Aspirot & Cohen, 2003), anger, sadness (Torro-Alves, Sousa & Fukusima, 2011) and fear (Charbonneau, Scherzer, Aspirot & Cohen, 2003; Alves, Aznar-Casanova & Fukusima, 2009).

The response time in this evaluation also appeared to be differentiated between the groups, presenting a greater slowness in the group with acquired brain injury, already demonstrated in a study in which the group with brain injury presented a slower response in the identification of sadness, fear, anger and surprise (Martins et al., 2011). The processing speed of sensory-perceptual information is one of the most common sequelae after brain

injury (Madigan, DeLuca, Diamond, Tramontano & Averill, 2000), this leads to a slower decision-making process (Marleen, et al. 2003), which may justify the differences in the time of emotional identification between the groups.

The present investigation indicates an inverse relationship between age and emotional recognition. The literature demonstrates that younger adults and middle-aged adults have similar abilities in emotional face recognition (Khawar, Malik, Maqsood, Yasmin & Habib, 2013), with younger adults having a more accurate ability in this role than the elderly (Horning, 2011). Relatively to the age of the elderly, this function declines (Khawar, Malik, Maqsood, Yasmin & Habib, 2013; Horning, 2011; Moosavian & Borry, 2015), and cognitive aging may differ in the consequences of the recognition of each emotion (Atsunobu & Akiyama, 2013). The results obtained are in accordance with the literature's results, mainly in the emotions of anger and disgust, and in the decline of recognition capability throughout the age. Several studies have shown that the success rate in anger recognition performance decreases with age (Sullivan & Ruffman, 2004; Orgeta & Phillips, 2007; Ruffman, Henry, Livingstone & Phillips, 2008; Mill, Allik, Realo & Valk, 2009; Ebner & Johnson, 2009; Hunter, Phillips & MacPherson, 2010; Atsunobu & Akiyama, 2013; West et al. 2012), attesting the obtained results. Another feature of the results concerning the recognition of anger is the increase in performance compared to the levels of schooling, this variable is still poorly studied in the literature, but generally the emotional recognition of faces demonstrates performance improvement due to a higher level of schooling (Dodich et al., 2014).

Relatively to the identification of the disgust emotion, there is some divergence in the literature regarding its connection with the age, different investigations indicate that the recognition of the disgust shows preservation along the age (Horning & Cornwell, 2012), showing up to some improvement (Calder et al., 2003; Suzuki, Hoshino, Shigemasu & Kawamura, 2007; West et al., 2012; Atsunobu & Akiyama, 2013; Circelli, Clark & Cronin-Golomb, 2013), but contradicting these results there are studies, like this research, revealing that there is a decline in the identification of this emotion (Sze, Goodkind, Gyurak & Levenson, 2012), occurring essentially from the age of 40 (Moosavian & Borry, 2015) and decreasing gradually over the age (Khawar, Malik, Maqsood, Yasmin & Habib, 2013). Although the recognition of neutral expression does not appear to be much studied, the results of this study demonstrate an increase in capacity over time after injury.

The obtained results also demonstrate that the performance in the emotional recognition of faces improves over time after injury, contrary to what the literature demonstrates, where the recognition capacity did not show improvements, being the deficit present after the injury and one year after (Ietswaart, Milders, Crawford, Currie & Scott, 2007).

The main limitations of this study are the small sample, both at the clinical and control levels. The increase in the sample would allow the differential analysis of the effects of acquired cerebral lesion of vascular and traumatic etiology on the different domains of emotional recognition. In future investigations it would be important to increase the sample size to observe if the differences remain and also to perceive if there are more differences in the facial emotional recognition between different types of injuries and lateralization.

In conclusion, the Gandra-BARTA instrument presents discriminative validity to evaluate the emotional recognition of faces in patients with acquired brain injury. The clinical group differs from the control group at different levels, like cognitive decline, identification of emotions, essentially anger, disgust, happiness, surprise, and response time. The study also shows the existence of a decline in the identification of emotions along the age, in the recognition of the disgusting emotion presents deficit in the level of the age and executive functioning, and the anger in the level of the age and schooling. The emotional recognition of faces presents improvements in time after injury. Identification of the neutral expression demonstrates improvement over time after injury.

The present study reinforces the importance of using Gandra-BARTA in people with acquired brain injury, due to its discriminative capacity for the evaluation of the emotional recognition of faces in this population. It is also important to emphasize the integration of training programs in the emotional recognition of faces in neuropsychological rehabilitation, for a better integration of the individual at a social level. The programs applied in patients with acquired brain injury demonstrated significant improvements (Bornhofen & McDonalds 2008; Radice-Neumann, Zupan, Tomita & Willer, 2009).

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Annex

Table 1 – Characteristics of the sample

	Control Group (n=16)	Clinical Group (n=20)
Age (M/SD)	38.81/10.78	36.70/10.51
Schooling (M/SD)	9.19/2.76	9.50/2.66
Gender (M/F)	15/1	18/2

Table 2 – Results obtained by the two groups in the neuropsychological tests

	Control Group (n=16)	Clinical Group (n=20)
MoCA (M±SD)	23.63/3.70	20.80/4.07
INECO (M±SD)	21.90/3.92	19.07/4.71
Gandra-BARTA Time (M±SD)	267.44/88.71	553/236.84
Gandra-BARTA Total (M±SD)	42.88/6.89	34.30/9.34
Disgust (M±SD)	6.94/1.91	5.45/1.90
Anger (M±SD)	8.06/1.24	5.25/2.84
Sadness (M±SD)	4.56/2.28	3.90/2.07
Neutral (M±SD)	4.50/1.37	3.95/1.50
Fear (M±SD)	2.06/2.38	2.40/1.72
Surprise (M±SD)	7.81/1.83	5.90/1.94
Happiness (M±SD)	8.94/.250	7.60/2.04

Table 3 – Comparison of the performance of both groups in the neuropsychological tests

	p	U
MoCA	.023	230.5
INECO	.058	219.5
Gandra-BARTA Time	.000	16
Gandra-BARTA Total	.003	251.5
Disgust	.014	237
Anger	.001	258
Sadness	.404	187
Neutral	.149	206
Fear	.352	130.5
Surprise	.002	254.5
Happiness	.020	.233

Figure 1 – ROC curve generated by the total number of correct identifications on Gandra-BARTA

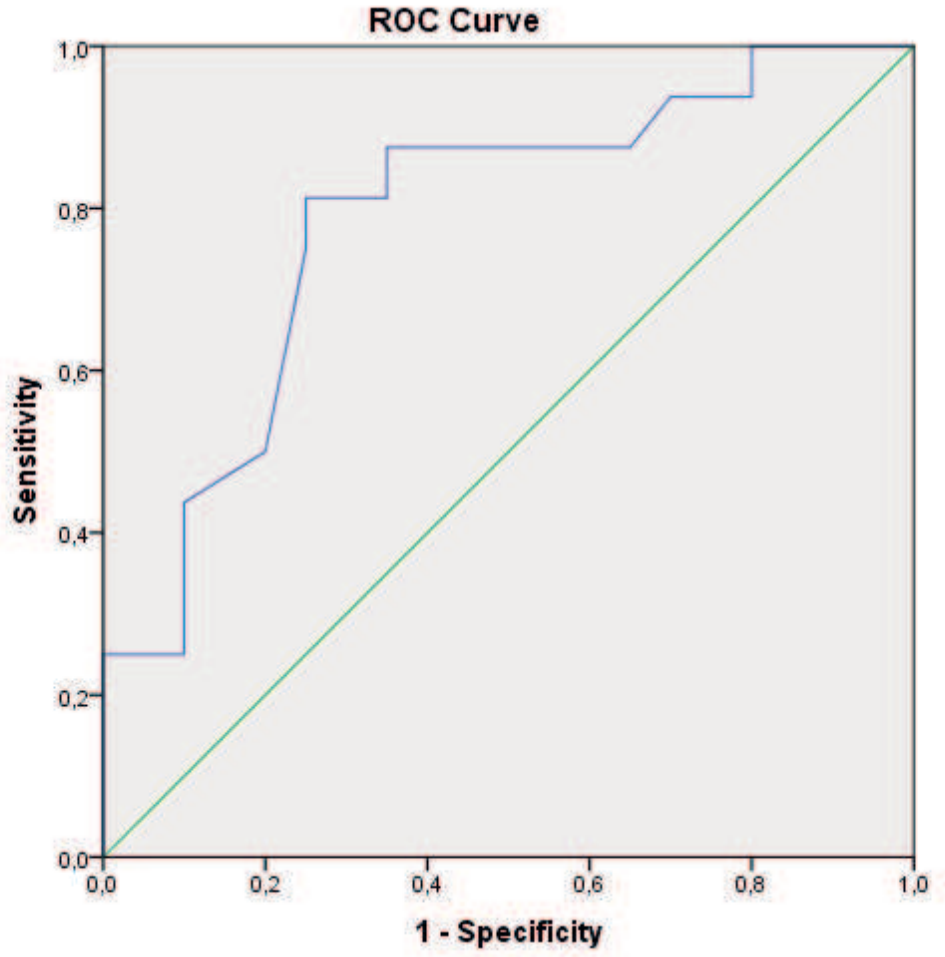

Table 4 – Characteristics of the ROC curve

Area under the curve	Default Error	p	Confidence Interval
.786	.078	.004	[.633-.933]

Table 5 – Cut-off points and sensitivity and specificity values generated in the distinction between the two groups by the number of hits in Gandra-BARTA

Cut-off Point	Sensitivity (%)	Specificity (%)
38	87,5	65
39	81,3	65
40	81,3	70
41	**81,3**	**75**
42	75	75
43	50	80
44	43,8	90

Table 6 – Correlations between Gandra-BARTA and age, schooling, time after injury, MoCA and INECO Frontal Screening

	Age	Schooling	Time after Injury	MoCA	INECO
Gandra-BARTA Time	-.104	-.404	.185	-.339	-.414
Gandra-BARTA Hits	-.574**	.396	.567**	.205	.337
Disgust	.536*	.146	.338	.400	.482*
Anger	.482	.453*	.394	.050	.149
Sadness	-.335	.318	.431	-.248	.007
Neutral	-.316	.407	.649**	.208	.404
Fear	-.130	.112	.173	.060	.089
Surprise	-.166	.310	.155	.183	.220
Happiness	-.305	.043	.409	.128	.152

Values expressed in terms of correlation

*p ≤ .01

** p ≤ .05