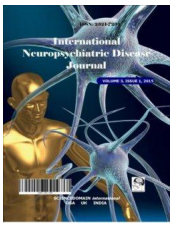

International Neuropsychiatric Disease Journal

11(1): 1-11, 2018; Article no.INDJ.36820
ISSN: 2321-7235, NLM ID: 101632319

Remediation of the Children with Autism by Jestimule in Morocco

H. Harchaoui[1*], A. Ahami[1], F-Z. Azzaoui[2], Y. Aboussaleh[1], S. Boulbaroud[3] and M. El Hioui[1]

[1]Unit of Neuroscience and Applied Nutrition, Laboratory of Nutrition, Health and Environment, Department of Biology, Faculty of Science, IBN TOFAIL University, PoBox.133, Kenitra, Morocco.
[2]Department of Biology, Faculty of Science Ben M'Sik, Hassan II University, Driss Harti Sreet, PoBox. 7955, 20700 Sidi Othmane, Casablanca, Morocco.
[3]Department of Biology, Polydisciplinary Faculty, Sultan Moulay Sliman University, Beni Mellal, Morocco.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/INDJ/2018/36820
Editor(s):
(1) Vincenzo La Bella, Department of Clinical Neurosciences, ALS Clinical Research Center, University of Palermo, Italy.
Reviewers:
(1) Suprakash Chaudhury, Dr. D. Y. Patil University, India.
(2) Ibrahim El-Zraigat, University of Jordan, Jordan.
Complete Peer review History: http://www.sciencedomain.org/review-history/23546

Original Research Article

Received 18th September 2017
Accepted 15th January 2018
Published 8th March 2018

ABSTRACT

The difficulties of processing facial emotions in Autism Spectrum Disorder (ASD) were reported. The traditional educations have provided evidence that traditional educations improve social skills. Nonetheless, the processing of facial emotions was limited.

A serious game, called JeStiMulE, used as a computer-based game, has been developed in order to teach emotions to individuals with ASD. The long-term use of this novel game would be of interest in teaching social skills. Interestingly, the input stimuli combine both the entertainment and education. The aim of the present study was to assess the ability of children to play the game and whether they could improve and develop social skills via recognition facial emotions. A heterogeneous group of forty (n=40) children and adolescents with ASD received two one-hour JeStiMulEsessions per week over four weeks and forty (n=40) of normally developing children took part in this experiments. All participants were presented before and after training with emotion

**Corresponding author: E-mail: hakim.harchaoui@gmail.com;*

recognition tasks, two including pictures of game avatars (faces).Descriptive data showed an overall enhancing at the recognition of facial emotions after the training. The comparisons results have provided wide differences between controls.
.Jestimule exhibited encouraging results in terms of recognition of emotions and thus would help children to extend this acquisition to the real-life world. Ultimately, this striking tool should be integrated into educational therapies.

Keywords: Serious game; social skills training; emotion recognition; computer-based intervention.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) are characterized by deficits in communication and social interaction as well as by repetitive stereotyped behaviours [1]. Social impairment is associated with atypical emotion processing. Individuals with ASD have difficulties to recognize facial emotions [2]. These are complex and heterogeneous disorders affecting the quality of reciprocal social interactions, which is one of the most persistent symptoms in ASD [3].

These difficulties are associated with social cognitive difficulties in ASD [4] and, thus, are a major source of handicap for these individuals. It is undeniable that emotions conveyed by facial expressions, gestures, words or situations ,are crucial signals for comprehending other's mental state and for modulation social interaction [5]. In addition, impairment in ASD has been related to a deficit of empathy [6]. Furthermore, emotion recognition and empathy skills, compose with others skills the concept of emotional competence Emotional competence is a developmental concept which corresponds to the ability to understand, express and regulate emotions appropriately [7]. Individuals with ASD show atypical emotion processing. A number of studies have found deficits in this domain, often related to level of intelligence. However, the results of these studies are sometimes controversial [7]. These deficits concern not only emotional facial expressions but also emotional gestures [8], emotional scenes [9] and the recognition of emotions on the basis of contextual cues [10]. Furthermore, individuals with ASD have reduced spontaneous social motivation [11] and shared emotions [12]. The social world is a highly complex system, constantly undergoing major, non-predictable, multi-domain, and random changes. The individual with ASD is unable to process different social stimuli in real-life settings. Of importance, it has been suggested that if rules exist in such a system, they are too complex to be fully understood by individuals with ASD. The same assumption is valid for the integration of these rules in social training [13]. For this reason, the development of social training in ASD has been limited [14]. Yet, emotion processing skills in ASD progress over time [15] suggesting that individuals with ASD have a certain learning potential, [16] possibly based on the development of compensatory strategies [17].Previous studies suggest that using stimuli with relatively reduced complexity, like cartoons, to teach emotions to children and adolescents with ASD is a beneficial therapeutic option. Indeed, there is evidence that emotion processing of real faces may be affected, while emotion processing of cartoon/avatar faces is relatively spared [18].

In this direction, ICT-based intervention seem to be of a seminal relevance as they show several advantages for children with ASD: To begin with, These individuals disclose a desire in devices and state-of-the-art technologies [19]. Moreover, these devices operate according to predictable rules and the information provided is clear, structured and unambiguous [20]. ICT implicate straightforward social-emotional expectations [21]. Additionally, the individual with ASD experiment the several situation through ICT that based on virtual and synthetic environment. ICT may include virtual or synthetic environments, allowing individuals to experiment with various social situations, while reducing their social anxiety, as well as the fear of failing or of rejection that these individuals with ASD often experience in real face-to-face interactions [22]. In the last decade, different ICT-based programs have been developed to teach social skills to individuals with ASD [23] Subsequent studies depict that tools allow to enhance the interest of children with ASD as well as typically-developed children [24]. Furthermore, this novel technologies appear of special interest as the present the advantages giving sequentially the information; controlled, predictable and safe [25]. The Harace argue that children with ASD developed intact attentional network functioning

and also visual processing using virtual reality (VR) technology. This finding validated the use of VR technology as an assessment of ASD functions and contributed to the understanding of functions in young ASD children [26]. The patients were able complete the virtual reality (VR) without problems. Most more recently, some review have provide more interest of efficacy of ICT-based approaches of these [27] training programs have targeted emotion recognition and have used photographs, videos, combined visual and audio stimuli or animated emotional expressions of fully or partially disclosed faces [28]. Other interventions have also combined emotions with stimuli likely to capture the attention and the interest of children with ASD (for example, trains on the Transporters DVDs [29]. These ICT-based programs reported are interesting and encouraging results about the possibility to enhance emotion recognition in individuals with ASD [30]. However, they present a number of limitations. These programs include, for the most part, unimodal or non-integrated isolated stimuli (for example, visual and/or auditory stimuli), a limited number of scenarios (for example, static images or videos) and a considerable verbal demand (oral/written instructions and response options). Human-machine interaction is thus limited and participants with ASD experience difficulties understanding the task and/or responding accordingly. In addition, the reduced flexibility of scenarios does not allow participants to tailor their interaction with the programs (for example, to choose the game's avatar with which they want to interact, to choose when to interact with it, and to provide an online adjustment of stimulations as a function of the participants' responses). Finally, the major limitation is that most of these programs were designed for individuals with high-functioning autism (HFA) and thus do not cover the wide spectrum of ASD, which includes around of individuals with low functioning autism (LFA) [31]. In the same vein, a novel training program has been developed, called JeStiMulE [32] deemed as interactive and multi-sensory. It aims at teaching emotions not only to children and adolescents with HFA but also to those with LFA. It is a Serious game combining the fun of playing with learning. It includes several exercises to train emotion recognition on avatars (faces, gestures and social scenes), with similar features and goals to those of common video games for children. It also includes motivating instructional aspects (for example, short sequences with an immediate feedback, visual rewards, an innovative vibrotactile gamepad). Moreover, the player has the possibility to create his/her own avatar and to move in a virtual environment. This type of training environment offers the players the opportunity to experiment with various social situations which are similar to real life, to move freely and to choose when and how to interact with other avatars. Furthermore, the environment developed in JeStiMulE is multi-sensory. Visual, audio and tactile stimulations are provided to facilitate the player's immersion in the virtual world and to increase the attractiveness of the game. JeStiMulE contains other adaptations which are appropriate to the heterogeneous profile of individuals with ASD (LFA and HFA). Each emotion corresponded to a code. This allows non-verbal children and adolescents with ASD as well as non-readrers to interact with Range processing the elements of the physical environment than in processing the social and emotional elements by logical rules. Baron-Cohen [31] stressed that patients with ASD are extreme systemizers., Given that implication of verbal or social competencies is not necessaire. The aim of JeStiMulE is to compensate difficulties in intuitively understanding the social world through learning strategies adapted to the autistic cognitive profile. In this sense, using logical skills to teach emotions to individuals with ASD seems a relevant therapeutic option. Subsequent studies has provided evidence that JeStiMulE training improved and diversified the emotional lexicon of individuals with ASD and heterogeneous intellectual, verbal, functioning and academic levels [33]. The present study aims at verifying the usability (which is its adaptability, effectiveness and efficiency) [34] of JeStiMulE, on a heterogeneous group of individuals with ASD. We hypothesized that after four-week training with JeStiMulE, a performance improvement would be found in emotion recognition tasks, including not only facial recognition but also emotions and expression conveyed by the faces.

1.1 Particpants

Fourty children and adolescents were recruited by the Autism Resources Center association Morrocco in day-care units. All participants received a diagnosis of ASd based on the Diagnostic and Statistical Manual of Mental Diseases, Fourth Edition (DSM-IV-R) [35] criteria for ASD, as well as checklist (E2) [36]. Three participants were excluded for the following reasons: 1) non- efficient use of the gamepad (N = 2), and 2) refusal to play (N = 1). The children

doesn't use efficiently the gamepad, or refuse to play were excluded. The current subjects underwent long-time behavioral intervention (i.e., ABA).The participants that unable to use efficiently the gamepad and who refuse to play were precluded.

The group included 40 participants. The participants' characteristics are presented in Table 1. IQ the severity of troubles was assessed using Chiklest Autism Ratin Scale (CARS) [37] Information regarding schooling and special care (educative and/or therapeutic) was also collected for each participant. The information pertaining to the historical development of the patients was recorded by E2 (eg, schooling, special care).

Only participants who were able to discriminate primary and secondary colors and had already used a computer were included in the training. The participants that have shown the ability to use computer and could encode the colors were included. Informed consent was obtained from all participants and their parents prior to participation. All procedures were approved for all day-care unit partners by the Local Ethical Committee. Des différences significatives de réponse entre ce qui est observés entre contrôles et groupe (T=12.027, P=0.00). Des capacités de perception globale faciales est hautement distinctes entre groupe contrôles et groupe avec autisme : autisme post-hoc (M=29.97, P= 0.062) vs (M=3.93, P=2,44).

2. MATERIALS

2.1 Game Description

JeStiMulE is the prototype of an individual interactive and multi-sensory computer game played with a gamepad is advice with numerous features It was specifically designed for children and adolescents with ASD (HFA and LFA).it was mainly performed for autistic children including (HFA and LFA).

This tool allowed to learn how recognizes facial expression, emotional gesture and social situations. In this context, six expression are showcased in the device: six basic emotions (e.g,. happiness, anger, disgust, fear, sadness, surprise), one complex emotion (that is pain) and two complementary expressions (which are neutral and 'funny face'). These emotions are displayed on both static and animated avatars. However, we are limited our studies only on static avatars. The expressions of pain were included in order to promote the development of empathy [38]. Furthermore, complementary expressions were included to facilitate the distinction between emotional and non-emotional expressions. This is particularly important for children and adolescents with ASD without functional language, to whom a verbal explanation of this distinction is often inefficient. In this way, a face without emotional expression corresponded to a neutral/non-emotional facial expression and a 'funny face' reflected an intentional inappropriate facial expression. Each expression was associated to one facial expression and three gestures. Each facial expression was different from another by mouth, eyes and eyebrows shape, opening or tilt. Only one emotional valence was presented for each emotion JeStiMulE is a virtual reality game with a multi-sensory environment. Visual, tactile, and auditory stimulations are provided to facilitate game immersion. In JeStiMulE, each expression was linked to a visual non-verbal code a corresponding verbal written code (which comprises emotional words and idiomatic expressions), and a tactile pattern (see further details below). Visual non-verbal codes corresponded to colors and a symbol. Each basic emotion was associated to a specific color from Plutchick's emotional wheel (happiness = yellow, anger = red, disgust = purple, fear = green, sadness = light blue, surprise = dark blue) [39] Pain was associated with black. Neutral was associated with the color white . Emotional words corresponded to the literal description of each emotion.

Short sentences that have a figurative meaning conventionally understood by native speakers. This meaning is different from the literal meaning of the idiomatic expression's individual elements. Idiomatic expressions are very common in everyday language and constitute one essential part of the human's emotional communication [40]. Each emotion was associated to a specific tactile pattern to promote the association between emotions and a physical imprint. Each tactile pattern could be considered as a word in an emotional language corresponding to an icon in visual communication [41]. Tactile patterns reinforce emotional meaning. The patterns were developed in a number of iterative user tests. The tactile stimulations were produced by eight actuators distributed over the gamepad body (The actuators position was defined by measuring the contact zones between the hand and the gamepad.

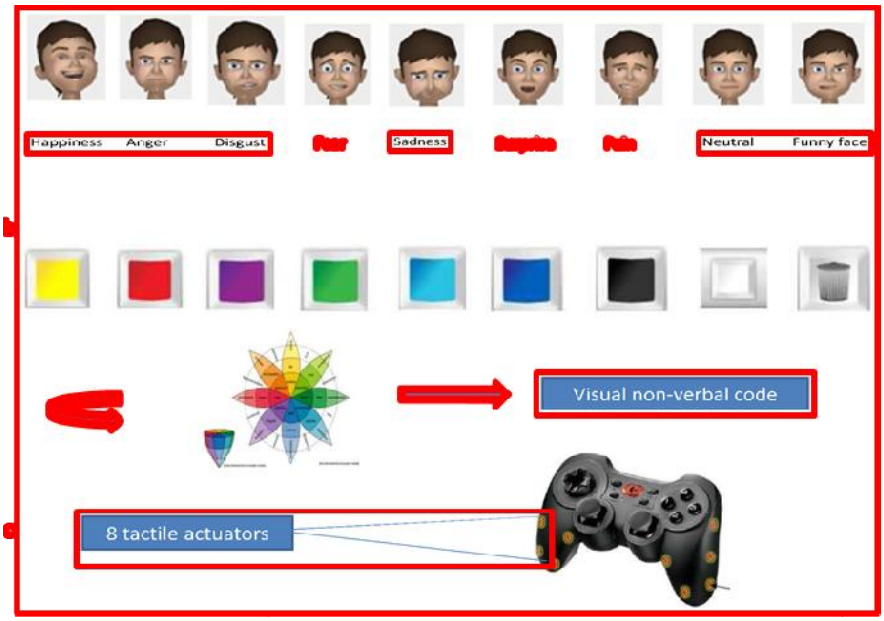

Fig. A. Basic emotion associated to each colour

Auditory stimulations were repetitive musical sequences, emotional onomatopoeias and environmental noises presented along and according to the social scenes. JeStiMulE was designed based on specific user requirements. In order to offer adapted response options to all participants, Complexity increased with the gradual introduction of static then animated avatars, of additional emotional cues (which were faces + gestures), as well as by diversifying the avatars' identities, ages and clothes. In game 2, the participants' emotional expression recognition was tested. On the first level, a static avatar with a facial expression appeared on the screen. The participants had to click on a moving target featuring the avatar's eyes and mouth. This was done in order to guide the participants' gaze towards the avatar's face. Then, the visual non-verbal code appeared on the bottom of the screen. The participants could then choose the correct color corresponding to a given emotion. They switched to the next game after having succeeded three out of ten emotional recognitions for each emotion presented. On the level 2, an animated avatar appeared on the screen with a facial expression combined with an inappropriate gesture (game 2a) and a masked face with an appropriate gesture (game 2b). Following this, the visual non-verbal code appeared and the participants had to choose the correct responses. As described above, the participants switched to the next game after having succeeded in three out of ten emotional recognitions for each emotion presented. The participants learned to establish priority rules in order to successfully extract the relevant emotional information (for example, focus on eyes and mouth; focus on face if gestures were inappropriate; and focus on gestures if the face was masked).In game 3, the participants' learning and acquisition were tested. They switched to the next game after having succeeded in three out of ten emotional recognitions for each emotion presented. It is important to note that, in contrast with the other levels, level 3 of game 3 was exclusively dedicated to children and adolescents with HFA and AS. The recognition of emotion was performed on all avatars (facial and gestural expressions) of the game. It involved three consecutive responses modalities (visual non-verbal code, verbal written code with emotional words and idiomatic expressions).

Finally, game (called 'odd one out' game) introduced multiple avatars with different emotions in order to promote emotion categorization. Participants scrolled down avatars (on an invisible carousel) with the gamepad joystick. They clicked on one, two or three avatars which did not express the same emotion as the others. In this game, there were three levels: one odd one out of three avatars (game 4a), two odd ones out of six avatars (game 4b) and three odd ones out of nine avatars (game 4c). During each game of the

learning phase, the participant could monitor his/her performance on a vertical colored gauge showing their progression. Feedback is provided. To summarize, this learning phase offered a structured, progressive and adapted learning procedure, involving implicit learning, visual discrimination, attention to detail, categorization and memory skills.

2.2 Procedure

The first, the autistic subject were tested on emotion recognition and they were coped with using JeStiMulE.

The sessions were realized in the structured and organized environment. The test was accompanied by a caregiver in order to help efficiently the participants. The training lasted somewhat one hour according to the performance of participants and during approximately four weeks. The second evaluation was performed after training. Likely, the controls subjects were assessed. The results obtained from controls were compared to post-intervention's result of autistic patients. The game levels were performed to the playing-ability of each child.

2.3 Statistical Analyses

To evaluate the enhancement of emotion recognition, the descriptive analysis was conducted. Descriptive analyses of recognition of emotion were conducted to Data on JeStiMulE's avatars were analyzed using a re-peated measures analysis of variance (ANOVA), including session (Before *versus* after). Analyses were completed by a post-hoc Benforni test.

Data obtained from controls were analyzed by a repeated measures ANOVA including Session (Before versus after). The data obtained from controls were compared to post results of patients by using T independent test (Post data *vs.* controls data). The mean comparison were assessed by post hoc analysis mainly Benforni test.

The normality and sphericity of assumption have been confirmed respectively by Kolmogorov Smirnov test and Mauchly test with multivariate statistics.

3. RESULTS AND DISCUSSION

We hypothesized Jestimule would improve the recognition of facial emotion, Indeed, The children assessed showed an improvement in recognition of facial expression of emotion. Of important, the children assessed have previously benefited from behavioral therapy mainly (ABA).

Table 1. Characteristics of participants

	Autism	Controls
Number	40	40
Age (years)	6 to 18	idem
Sex	22 M and 18 F	22 M and 18 F
Diagnostic	Autistic	-
Cars	45	40
Schooling	5	
Spécial care	6	

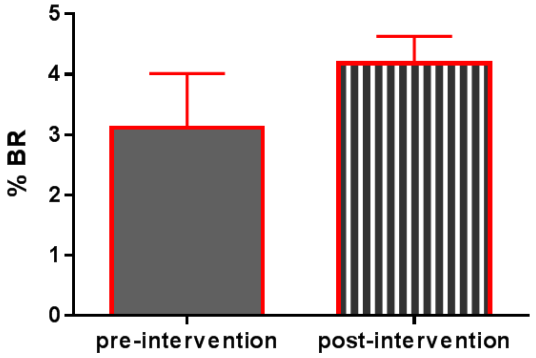

Fig. 1. The percentage of holistic correct response (CR) before and after training. The results have provided evidence of significant improvement to the recognition of basic facial emotion (*p<0.001).*

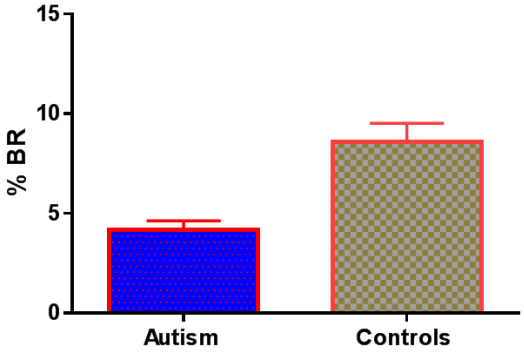

Fig. 2. The correct response (CR) post data of training collected and compared as did controls. The comparison revealed the fact that the autistic results are somewhat significantly close to controls (p<0.005)

The choice of participants was difficult owing to the inability of the most of them to use and understand the game. As such, some of them were excluded. The training phase and learned was difficult not only to the patients but also to

the caregiver and to us. The current participants were able to play en recognize displayed figure of Avatar on computer. The overall recognition after training was approximately 45% higher before training (Fig. 1). A significant improvement was observed.

The current findings are consistent with former research reporting enhancing in the recognition of facial emotions after training using Jestimule [32]. However, the controls keep wide rate approximately 98% and those results do not impede that children have made a progress. Some skills have been observed such as: the ability of using gamepad, the desire of discovering this virtual world; coping with using association. They have provided evidence that likely children could able to complete the game but not in expected time.

Results of statistical analysis revealed a significant effect of game of learning between pre-intervention and post intervention ($F(1) = 39.29$, $p<0.001$). The results suggested that the participants were more accurate in comprehensive recognizing of emotions after Jestimule ($M=29.97$, $SD=3.93$ versus $M=25.41$, $SD=5.54$). The significant differences between control and autistic children is wide ($M=4.4$, $SD=1.4$).and ($T=12.027$, $P=0.00$).

The present study had two major objectives. Firstly, it aimed at verifying the usability of JeStiMulE (which is its adaptability, effectiveness and efficiency) on a heterogeneous group of individuals with ASD. Secondly, it aimed at investigating whether four-week JeStiMulE training would improve emotion recognition on game avatars (facial emotions). The data highlighted that the autistic children could play efficiently and completed the game in time. Results indicate that JeStiMulE presents a suitable usability. Most participants were able to play and to complete the training within the expected time , the children befitted from training as they could extends their performance on emotion recognition tasks as well as they can improve their ability to utter some words suitable to the context of expression emotions. which supports the idea that JeStiMulE specificities, including sensory, cognitive and motivational dimensions, were adapted to the ASD profile. Moreover, participants were not only able to play but they also benefited from the training, as indicated by their improved performance on emotional recognition tasks. The results of this study thus provide evidence of the potential of JeStiMulE for individuals with ASD with heterogeneous intellectual, verbal and academic levels.

As every participant was tested before and after training, he/she would serve as his/her own control. This experimental decision helped us evaluate the effectiveness of the training on each individual. In this study, emotion recognition skills

Table 2. The results obtained *pre* and *post* training of autistic patients.

	Pre-intervention		**Post-intervention**		***p***
	Mean	**SD**	**Mean**	**SD**	***p<0.001***
Happiness	3,6	1,5	4,5	1,6	*p<0.001*
Sadness	3,2	1,8	3,7	1,5	*p<0.001*
Anger	3,7	1,7	4,4	1,4	*p<0.001*
Disgust	2,6	1,7	3,9	1,4	*p<0.001*
Surprise	3,1	1,4	4,3	1,1	*p<0.001*
Pain	1,3	1,2	3,5	2,1	*p<0.001*
Fear	3,9	1,7	4,7	1,1	*p<0.001*

Table 3.

	Control		**Post-intervention**		***p***
	Mean	**SD**	**Mean**	**SD**	
Hapiness	7,8	1,1	4,5	1,6	*p<0.05*
Sadness	8,7	0,8	3,7	1,5	*p<0.05*
Anger	7,2	2,3	4,4	1,4	*p<0.00*
Disgust	10,2	14,6	3,9	1,4	*p<0.05*
surprise	8,7	0,7	4,3	1,1	*p<0.05*
Pain	8,8	0,9	3,5	2,1	*p<0.05*
Fear	8,3	1,0	4,7	1,1	*p<0.05*

were assessed before and after four- week JeStiMulE training. A significant improvement was found in most of the tasks despite The heterogeneity of the group of participants. Though the heterogeneity of patients included, they have shown an improvement. To date, most of the studies conducted in this field have focused on homogeneous groups with ASD the previous studies have contracted on homogenous group.Hopkins et al. [28] assessed the efficacy of 'FaceSay', a computer-based social skills training program for children with LFA and HFA Their findings delineated that children improved on the condition to work with controlled, structured and interactive environment.in line with Green 1993 that computer systems tend to offer a controlled environment with minimal distractions, and the use of computers are more attractive for children with ASD. Jestimule" elicits positive feeling current subject. This observation supported by Hettinger research reporting that interaction with human is difficult. Unlike jestimule, a large portion of the traditional educational tools employs real world environment, making the task of educating children with ASD more difficult [42]. Indeed, this improvement was most significant for children with HFA. The enhancing concern mainly children with high faulting and those who had benefited lastly from behavioral therapy (eg , ABA).The paucity of studies regarding the state-of-the art interventions in this fields compelled researches to develop this serious game and to depicts their effectiveness and efficacy (serrets, 2011). Indeed, the outcome of this work involving 40 children with heterogeneous profiles stresses that the children benefited from the training by enhancing their ability to recognize facial expression displayed in input devices. According to the authors, 'it is possible that the children with LFA did not completely understand the concepts or directions in the games, and therefore, did not fully benefit from the intervention' [40]. The present study provides an advance in this research field, by showing that children and adolescents with heterogeneous ASD were able to understand, play and complete JeStiMulE as well as benefit from the intervention. A performance increase was found not only for the pictures of avatars conditions. While individuals with LFA and HFA do differ in many features (for example, IQ profile), they all share a fundamental one, that is their interest and preference for rule-based systems and their ease when interacting with them. JeStiMulE was developed specifically to provide a rule- based computer game relying on 'autistic intelligence' to develop other, more social, skills. The underlying working hypothesis was thus that rule-based learning could be a relevant pathway to reach gradually more complex, social learning in ASD. The idea that rule-based environments could compensate for difficulties in the domain of emotion recognition in ASD [43] is not novel. When designing JeStiMulE, we assumed that individuals with ASD could use their logical skills to learn emotions and could evolve in a systemizing environment [32]. JeStiMulE uses a virtual environment to simulate different social situations, offering thus more ecological learning opportunities than those of devices using static stimuli [44]

Participants included in this study only played once each game level and none of them repeated a successfully completed level or module. These training criteria clearly differ from that of more traditional approaches using repetitive learning to develop skills. For instance, behavioral methods encourage a ratio of known [45]. Although these methods have received support from therapists and family associations, their efficiency has not yet been clearly demonstrated empirically and remains a matter of debate [46]. In JeStiMulE, participants had the opportunity to learn progressively a great number of associations, in line with the idea of Kourkoulou et al. [47] that 'restricting learning to a smaller number of stimuli may impede the flexibility with which individuals with ASD can learn new associations'. The results found in the present study suggest that children and adolescents with ASD can learn new associations rapidly and without needing repetition when they are given the opportunity to use their cognitive strengths to compensate their difficulties in specific areas such as emotion processing. Interestingly, the skills trained with JeStiMulE appear to extend to other stimuli than those included in the training (pictures of real-life characters), suggesting flexible learning and a certain potential of generalization of acquisitions. The results have provided evidence those children with autism they become able to learn and use rapidly the game than before.

4. STUDY LIMITATIONS AND PERSPECTIVES

The first limitation concerns the characteristics and the number of participants. JeStiMulE has been designed to teach emotions to individuals with heterogeneous profiles of ASD. Jestimule aims for teaching emotions through the variability

of ASD. Although all participants were able to understand the set of tasks, the heterogeneity of the group requests cautiousness in interpreting the results. Therefore, a study on a larger sample would be interesting to conduct. Hence, it is relevant to be careful in interpreting the results.

The second limitation concerns the methods and strategies should be adopted in teaching each patient. And the longer we made the hypothesis that new emotional words given during the assessment after training were from the caregiver's speech. In a future study, caregiver's speech should be standardized using a precise list of emotional words, thus allow defining more precisely the origin of new emotional words. Only our study targeting to recognize the facial emotions displayed in the computer. Further research regarding emotion expression would be of interest.

The third limitation concerns the quite short duration of training (four weeks). Future research might be warranted studying the effects of a longer training period. Generalization the emotion to the real-life is not included in this study along with the short duration of training. The studies in the future should work in this field in order to enhance social skills in the patients with ASD.

5. CONCLUSION

The training with Jestimule has shown promising results. This striking tool has provided evidence not only learning social skills but also enjoying playing the game. It is adapted to these of the autistic children's specificities.This improvement should be extended in daily-life of children with ASD and should be life-sustaining. The further research is needed to validate this input tool.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

1. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders. 4th edition. Washington: American Psychiatric Association; 2000.
2. Billstedt E, Gillberg C, Gillberg C: Autism after adolescence: population- based 13- to 22-year follow-up study of 120 individuals with autism diagnosed in childhood. J Autism Dev Disord. 2005; 35:351–360.
3. Harms MB, Martin A, Wallace GL. Facial emotion recognition in autism spectrum disorders. Review of Behavioral and Neuroimaging Studies. 2010;20:290-322.
4. Boraston Z, Blakemore SJ, Chilvers R, Skuse D. Impaired sadness recognition is linked to social interaction deficit in autism. Neuropsychologia. 2007;45:1501–1510.
5. Dunn J. Emotional development in early childhood: A social relationship perspective. In The handbook of Affective Science. Edited by Davidson RJ, Scherer KR, Goldsmith HH. Oxford: Oxford University Press. 2003;332–346.
6. Law Smith MJ, Montagne B, Perrett D, Gill M, Gallagher L. Detecting subtle facial emotion recognition deficits in high-functioning Autism using dynamic stimuli of varying intensities. Neuropsychologia. 2010,48:2777–2781.
7. Jones CR, Pickles A, Falcaro M, Marsden AJ, Happé F, Scott SK, Sauter D, Tregay J, Phillips RJ, Baird G, Simonoff E, Charman TA. Multimodal approach to emotion recognition ability in autism spectrum disorders. J Child Psychol Psychiatry. 2011;52:275–285.
8. Hubert B, Wicker B, Moore DG, Monfardini E, Duverger H, Da Fonseca D, Deruelle C: Brief report: Recognition of emotional and non-emotional biological motion in individuals with autistic spectrum disorders. J Autism Dev Disord. 2007; 37:1386–1392.
9. Santos A, Chaminade T, Da Fonseca D, Silva C, Rosset D, Deruelle C. Just another social scene: Evidence for decreased attention to negative social scenes in high-functioning autism. J Autism Dev Disord. 2012,42:1790–1798.

10. Da Fonseca D, Santos A, Bastard-Rosset D, Rondan C, Poinso F, Deruelle F. Can children with autistic spectrum disorders extract emotions out of contextual cues? Res Autism Spectr Disord. 2009;3:50–56.
11. Chevallier C, Kohls G, Troiani V, Brodkin ES, Schultz RT: The social motivation theory of autism. Trends Cogn Sci. 2012; 16:231–239.
12. Begeer S, Koot HM, Rieffe C, Meerum Terwogt M, Stegge H. Emotional competence in children with autism: diagnostic criteria and empirical evidence. Dev Rev. 2008;28:342–369.
13. Baron-Cohen S. The hyper-systemizing, assortative mating theory of autism. Progr Neuro Psychopharmacol Biol Psychiatry. 2006;30:865–872.
14. Andanson J, Pourre F, Maffre T, Raynaud JP. Social skills training groups for children and adolescents with Asperger syndrome: a review. Arch Pediatr. 2011;18:589–596.
15. Vicari S, Reilly JS, Pasqualetti P, Vizotto A, Caltagirone C. Recognition of facial expressions of emotions in school-age children: the intersection of perceptual and semantic categories. Acta Paediatr. 2000; 89:836–845.
16. Adolphs R, Sears L, Piven J. Abnormal processing of social information from faces in autism. J Cogni Neurosci. 2001;13:232–240.
17. Harms MB, Martin A, Wallace GL. Facial emotion recognition in autism spectrum disorders: A review of behavioural and neuroimaging studies. Neuropsychol Rev. 2010;20:290–322.
18. Rosset D, Santos A, Da Fonseca D, Rondan C, Poinso F, Deruelle C. More than just another face in the crowd: Evidence for an angry superiority effect in children with and without autism. Res Autism Spectr Disord. 2011;5:949–956.
19. Shane HC, Albert PD. Electronic screen media for persons with autism spectrum disorders: Results of a survey. J Autism Dev Disord. 2008;38:1499–1508.
20. Bölte S. The ICF and its meaning for child and adolescent psychiatry. Z Kinder Jugendpsychiatr Psychother. 2009; 37:495–497.
21. Williams C, Wright B, Callaghan G, Coughlan B. Do children with autism learn to read more readily by computer assisted instruction or traditional book methods? A pilot study. Autism. 2002; 6:71–91.
22. Kandalaft MR, Didehbani N, Krawczyk DC, Allen TT, Chapman SB. Virtual reality social cognition training for young adults with high-functioning autism. J Autism Dev Disord. 2013;43:34–44.
23. Durkin K. Videogames and young people with developmental disorders. Rev Gen Psychol. 2010;14(2):122–40. Available:http://dx.doi.org/10.1037/a0019438
24. Bernard-Opitz V, Sriram N, Nakhoda-Sapuan S. Enhancing social problemsolving in children with autism and normal children through computer-assisted instruction. J Autism Dev Disord. 2001; 31(4):377–84.
25. Knight V, McKissick BR, Saunders A. A review of technology-based interventions to teach academic skills to students with autism spectrum disorder. J Autism Dev Disord. 2013;43(11):2628–48. Available:http://dx.doi.org/10.1007/s10803-013-1814-y
26. Harace Hs IP, Cabdy hoi-Yan Lai Simpson WL Wong, Jenny KY, Richard Chen Li, Kate Shuk6 Ying Lau, Dorthy F.Y. Chan. visuospatial attention in children with autism spectrum disorder: A comparison between 2-D and 3-D environnements. Information Commnuctaion Technology in Education. 2017;9.
27. Grynszpan O, Weiss PLT, Perez-Diaz F, Gal E. Innovative technology-based interventions for autism spectrum disorders: A meta-analysis. Autism. 2014; 18(4):346–61.
28. Hopkins IM, Gower MW, Perez TA, Smith DS, Amthor FR, Wimsatt FC, Biasini FJ. Avatar assistant: improving social skills in students with an ASD through a computer-based intervention. J Autism Dev Disord. 2011;41:1543–1555.
29. Golan O, Ashwin E, Granader Y, McClintock S, Day K, Leggett V, Baron-Cohen S. Enhancing emotion recognition in children with autism spectrum conditions: An intervention using animated vehicles with real emotional faces. J Autism Dev Disord. 2010;40:269–279.
30. IP HSH, Wong SWL, Chan DFY, Byrne J, Li C, Yuan SNV, Wong JYW. Virtual reality enabled training for social adaptation in inclusive education settings for school-aged with autism spectrum disorder (ASD). In K.S.S. Cheung L. Kwork, J. shang A.

Wang, R. Kwan (eds), blended learnings: Aligning Theory with practices. 2016;94-102. Switzerland springer. Fombonne E: Epidemiological surveys of autism and other pervasive developmental disorders: An update. J Autism Dev Disord. 2003; 33:365–382.

31. Baron-Cohen S, Golan O, Ashwin E: Can emotion recognition be taught to children with autism spectrum conditions? Philos Trans R Soc Lond B Biol Sci. 2009; 364:3567–3574.
32. Serret et al. Facing the challenge of teaching emotions to individuals with low- and high-functioning autism using a new Serious game: A pilot study. Molecular Autism. 2014;5:37.
33. Hun S, Thümmler S, Askenazy F and Serret S. Emotional Lexicon in Autism Spectrum Disorders: Impact of Emotion Recognition Training with a Serious Game. Austin J Autism & Relat Disabil. 2016;2(1): 1015
34. Nielsen J. Usability Inspection Methods. New York: Wiley; 1994.
35. American Psychiatric Association. Diagnostic and statistical manual for mental disorders. 4th edition; 2000.
36. Rimland B. Infantile autism: The syndrome and its implications for a neural theory of behavior. New York: Appleton-Century-Crofts; 1964.
37. Schopler E, Reichler RJ, Lansing M. Individualized assessment and treatment for autistic and developmentally disabled children. Teaching strategies for parents and professionals: volume II. Austin, TX: PRO-ED; 1980.
38. Minio-Paluello I, Baron-Cohen S, Avenanti A, Walsh V, Aglioti SM: Absence of embodied empathy during pain observation in Asperger syndrome. Biol Psychiatry. 2009;65:55–62.
39. Plutchik R. Emotion: Theory, research, and experience. Theories of Emotion. New York: Academic Press. 1980;1.
40. Gibbs R, Leggitt J, Turner E. Why figurative language is special in emotional communication. In The Verbal Communication of Emotions. Edited by Fussell S. New Jersey: Erlbaum. 2002:125–150.
41. Brewster SA. Providing a structured method for integrating non-speech audio into human-computer interfaces. UK: PhD Thesis, University of York, York; 1994.
42. Frith U, Morton J, Leslie AM. The cognitive basis of a biological disorder: Autism. Trends in Neurosciences. 1991;14(10): 434438.
43. Golan O, Ashwin E, Granader Y, McClintock S, Day K, Leggett V, Baron-Cohen S. Enhancing emotion recognition in children with autism spectrum conditions: An intervention using animated vehicles with real emotional faces. J Autism Dev Disord. 2010;40:269–279.
44. Parsons S, Mitchell P. The potential of virtual reality in social skills training for people with autistic spectrum disorders. J Intellect Disabil Res. 2002,46:430–443.
45. Dunlap G: The influence of task variation and maintenance tasks on the learning of autistic children. J Exp Child Psychol. 1984;37:41–64.
46. Spreckley M, Boyd R. Efficacy of applied behavioral intervention in preschool children with autism for improving cognitive, language, and adaptive behavior: A systematic review and meta-analysis. J Pediatr. 2009,154:338–344.
47. Kourkoulou A, Leekam SR, Findlay JM: Implicit learning of local context in autism spectrum disorder. J Autism Dev Disord 2012;42:244–256.

© 2018 Harchaoui et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23546