OTO, A compressive armchair to perform deep pressure in children with ASD: a user-centered design and feasibility study

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Table of Contents

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Abstract

Background: Deep Pressure Therapy (DPT) is widely used to reduce anxiety in autism spectrum disorder (ASD) but evidence of its efficacy is limited.

Objective: To design a usable, non-stigmatizing compressive armchair which can be easily controlled, electronically, by the user.

Methods: We used a user-centered design to assess the usability of the device. We tested the device in a Day Hospital for children with autism spectrum disorder (ASD) in France with a convenience sample of 39 children with severe forms of autism spectrum disorder and intellectual deficiency. The compression armchair has four different cells which can be inflated to induce tailored pressure on the body. The pressure level is recorded electronically. We used Witteman design guideline. We measured System Usability Scale and time of use.

Results: The design was user centered. Usability was between good and excellent. The device was used by 39 children, for 3 to 20 minutes with one or two sessions each week, for 31 months in the center. The armchair takes up less space than the hug machine. Performing sessions with the chair is feasible.

Conclusions: This device opens perspective for controlled evaluation of deep pressure therapy to treat anxiety in ASD. First clinical impressions show a decrease of anxiety, a better emotional and attention regulation. Deep pressure therapy is widely used in occupational therapy and frequently requested by parents, but efficacy studies are too scarce to make evidence-based recommendations for its use.

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Authors

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Background: Deep Pressure Therapy (DPT) is widely used to reduce anxiety in autism spectrum disorder (ASD), but evidence of its efficacy is limited.

Objective: To design a usable, non-stigmatizing compressive armchair which can be easily controlled, electronically, by the user.

Methods: A user-centered approach was used to assess the usability of the device. Testing was carried out in a Day Hospital for children with autism spectrum disorder (ASD) in France, with a convenience sample of children with severe forms of autism spectrum disorder and intellectual deficiency (N=39).The Witteman design guideline was used. The System Usability Scale and time of use are reported.

Results: The final product is a compression armchair, designed to be user-centred, with four different cells which can be inflated to induce tailored pressure on the body. The pressure level is recorded electronically. Usability was between good and excellent. The device was used by 39 children, once or twice weekly, over a period of 31 months. Each session lasted between 3-20 minutes in duration. The armchair takes up less space than the hug machine. Performing sessions with the chair is feasible.

Conclusions and Relevance: First clinical impressions show a decrease in anxiety, improved emotional regulation and improved attention. Deep pressure therapy is widely used in occupational therapy and frequently requested by parents, but efficacy studies are too scarce to make evidence-based recommendations for its use. The results presented here support further controlled efficacy studies of deep pressure therapy in the treatment of anxiety in ASD.

Keywords: Deep pressure therapy; proprioception; compression; autism spectrum disorder

Article

Introduction

Autism Spectrum Disorder (ASD) is defined by (1) persistent deficits in social communication and social interaction across multiple contexts and (2) restricted, repetitive patterns of behavior, interests,

or activities American Psychiatric Association, 2013). According to the American Psychiatric Association (2013), the prevalence of autism is 1%.
Sensory difficulties are frequently found in individuals with ASD (Kojovic et al., 2019), in particular somatosensory system difficulties like aberrant skin sensitivity [Asmika et al, 2018; Zhong et al., 2013] (including pressure detection) and proprioception. These sensory anomalies could underly the pathophysiological processes that lead to impaired social development [].
Proprioception is the sensory registration of the ongoing spatial configuration of the body. It includes the position of the body segments in space, the force and the speed of movement, and the integration of gravity and body balance. Proprioception impacts behavioral regulation and motor control].
Blanche et al. showed that Children with ASD present proprioceptive processing difficulties that are different from those of children with other developmental disabilities and their typically developing counterparts]. However, Morris et al., 2015 and Fuentes et al., 2011 did not confirm these proprioceptive difficulties in experimental paradigms. It is possible that the deficits rely mostly on multisensory integration [].

Sensory Integration Theory

Ayres (1972) introduced sensory integration theory to explain sensory processing issues in children with ASD (Lane et al., 2019). The focus of sensory-based intervention is to maintain an optimal level of arousal, between hypo- and hyper- stimulation, allowing the individual to respond to the environment in an adaptive manner].
Several techniques or devices can be used in sensory based interventions, in particular deep pressure therapy (DPT) for instance, Wilbargers suggested a Deep Pressure and Proprioceptive protocol [Lancaster et al, 2016]. Systematic reviews show that sensory integration therapies, that use play activities and sensory-enhanced interactions, have positive effects, but the quality of the studies is not sufficient to confirm these results [Case-Smith et al., 2015; Lane et al., 2019]. The American occupational therapy association recommends the use of sensory strategies for individuals with ASD].
In an online survey involving 552 parents of children with ASD, Green et al. 2006 showed that sensory integration was the 3rd most used treatment after speech therapy and visual schedules, and before behavioral methods [Green et al., 2006]. In a survey involving 152 parents of children with ASD, Peña et al. 2021 reported high acceptability of sensory based methods. These interventions were considered to be ‘very important’ or ‘important’]. Main barriers to use of sensory based methods were lack of recommendations, difficulty in using, or difficulty in accessing this kind of intervention [Peña et al., 2021]. Among these techniques, deep pressure therapy was of particular interest.

Deep Pressure Therapy

Different devices and strategies can be used to deliver Deep Pressure Therapy to patients with ASD (Table 1)

Table 1.
Comparison of several devices used to induce deep pressure in children with ASD

Type of device	Principle	Level of evidence	N	Time of use	Measure of efficacy	Control	Efficacy	Acceptance	Cost	Autonomy of the patient
Weighted blankets	Weight	Systematic review, population based observational study	Observational: 1785; Interventional: 160	> 8h daily	Sleep, STAI, Electrodermal activity, Pulse rate	Nothing or light plastic chain blanket	Conflicting evidence	+++	+	+++
Therapeutic body wrap	Tightening	One RCT	48	45 min; 2/week	Aberrant Behavior Checklist irritability	Dry versus wet-sheet TBW	+ but no waiting -list comparative arm	+/-	+	- - -
Shape memory vest	Tightening	None, prototypes	None	Unknown	None	None	Unknown	Unknown	++	Unknown
Compression vest	Pressure by inflation	SCRD	3	20 min, daily? for 22-50 days	Stereotypies	Fully deflated vest or no vest	No efficacy	+++ ?	++	+++
Manual squeezing	Manual squeezing	SCRD	8	5-15 min, until 3/day for 3 months	Visual analogue scales (Calmness, Engaged, Responsivity, Happy, Communicative)	Nothing	+/-	+++	+	-
Hug or squeeze machine	Compression by a plate	RCT	12	20 min; one/week for 6 weeks	Conners' Parent Rating Scale, Electrodermal activity	Not receiving deep pressure in the disengaged hug machine	++	+	+++ (reusable)	-
Compressive garments	Tightening	Observational study	14	>1h-16h daily for 6 weeks	Aberrant Behavior Checklist, Sensory integration (Dun. Profile), postural sway, motor performance	Nothing	+ but no comparative arm	+++	+++ (tailored)	+/-
Sitting hug machine	Compression by a plate	SCRD	2	Not reported	Stereotypical behaviors	Nothing	+ but no comparative arm	+++	++ (reusable)	+++
Compression chair	Compression by inflated cushions	None, prototype	None	Unknown	None	None	Unknown	+++	++ (reusable)	+++

k: number of included studies in a systematic review, STAI: State Trait Anxiety Inventory-10, RCT: randomized control trial, SCRD: single case research design

Hug or Squeeze Machine

Kraus used a pressuring apparatus consisting of two stacked air mattresses, to deliver deep pressure therapy to 23 typically developing college students during an examination period. They measured heart rate and self-reported anxiety using the State-Trait Anxiety Inventory (STAI). The control group did not receive deep pressure therapy. There was no objective difference between the two conditions. Subjectively, participants in the deep pressure group reported a relaxing effect. The baseline level of anxiety in this population was low. The authors do not exclude that the confinement alone may have induced subjective feelings of relaxation [].
Grandin. 1992 developed a hug device to allow self-administration of lateral body pressure, for individuals with high levels of anxiety []. Edelson and colleagues tested this device on children with ASD (n=12) []. A control group received deep pressure via a disengaged Hug Machine. Participants had 20-minute sessions every week for 6 weeks. Arousal and anxiety was measured using Conners parents rating scale and Electrodermal activity (EDA). The hug device decreased anxiety according to both behavioral and physiological measures. As pressure can be controlled by the individual, this device may be useful for children with marked anxiety. No side effects were reported.
The ergonomic of the device is an important issue [Lane et al, 2019; Edelson et al. 1999]. Lo & Hang interviewed professionals and patientsconcluding that it was important to improve ergonomic design of the device and its acceptability. For instance, it is necessary to lie down or to squat which can be difficult for some children. The system is very bulky. The controller is outside of the machine and cannot be activated autonomously. It is not possible to choose the part of the body that the individual or professional want to squeeze [].
Lo and Huang suggested a sitting hug machine which is more compact, controllable by the patient or the therapistand can apply pressure selectively to either the shoulders or bottom part of the body. Stereotypies decreased during intervention for 2 children [].
Afif. 2021 designed a portable, inflatable hug machine []. It was tested on 5 children with ASD. They measured heart rate variability. They found that the inflatable wrap model decreased heart rate but could not find this effect with a manual pull (Maula et al., 2021).
This article reports the design of a hug machine that aimed to (1) improve controllability of the pressure by the professional, allowing replicability and making the device useful for both care and research (2) improve controllability of the pressure by the children or adults with ASD, allowing different pressure on the bottom and top of the body (3) use pressure instead of restraint (4) make a more attractive and less stigmatizing device. This article describes the method of design, the device and evaluates the usability of the device.

Method

In a population with special needs such as ASD with intellectual deficiency, gathering children or adults with ASD feedback could be complicated by communication and social difficulties. It is important to have a tailored, user-centered strategy to improve acceptability and usability before assessing efficacy []. Thus, we will report the feedback of the professional that guide and observe the children to the care with the prototype since many of the children were not verbal due to associated intellectual deficiency. We asked also feedback from one adult with ASD. The first usages of the device were video recorded to tailor the design of the device to the needs of the patient and the therapist.

1. Design goal and process (Figure 1)

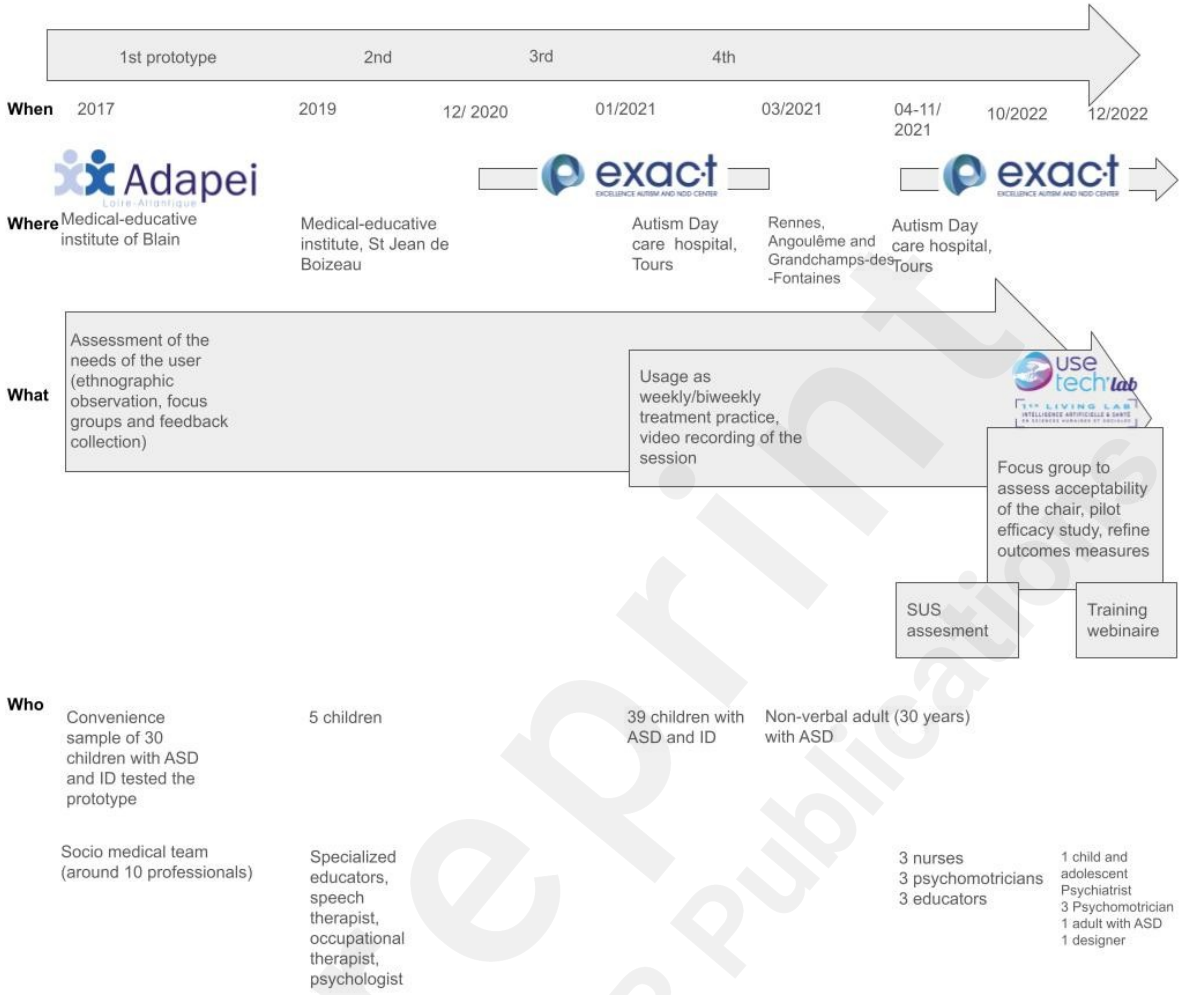

Figure 1. Timeline of the design of the oto chair
ASD: Autism Spectrum Disorder, ID : intellectual deficiency, SUS : system usability Scale

The seat was designed by Alexia Audrain ([https://www.oto-chair.com/] [https://www.oto-chair.com/], furniture maker, to address the needs of individuals with ASD for deep pressure. The project was carried out in partnership with the medical-educative institute of Blain, France, over a period of 1.5 years. After the review of existing technologies, we chose the sitting position which is natural, relaxing but allow to be active. During the sessions, it allows the professional to keep an eye on the individual with ASD to keep an eye on him and facilitate the communication to better understand his needs. To assess ergonomic of the shape of the chair. We tested several inclinations with sacco or bean bag chair (a large fabric bag, filled with polystyrene beans). It allows to test several postures and choose one.
The educators, psychomotrician and the director of the center identified the requirements of the device and gave feedback during the design process.
The prototype consisted of inflatable cushions, and was used to understand the amount of pressure required, to verify the principle of action required to apply side pressure on the body and define the main technical characteristics (Figure 2).

Figure 21.Prototype of the OTO Armchair

The socio medical team (around 10 professionals) and a convenience sample of 30 children with ASD tested the prototype. The designer observed the behaviors of professionals and children during the test and asked questions about the experience of using the device.
Based on test results, different models of compression chair were designed and sketched in 3 dimensions to validate the form, the materials and the colors of the prototype, before construction. The first model was made in June 2019 and presented to medical educative center professionals, children and the graduation committee.
Following this, the model was presented to a general audience, another Medical-educative institute (Specialized educators, speech therapist, occupational therapist, psychologist), St Jean de Boizeau near Nantes, France; and was tested with 5 children. The device was also used with a non-verbal adult (30 years) with ASD.

1.1 Testing within the hospital and modification

In December 2020, OTO the squeezing armchair was presented to and tested by Tours hospital teams before introducing it for use in the hospital. During this first meeting the medical team gave suggestions to enhance the experience of people with ASD.
New functionalities were added before the seat was installed in the day care hospital:

- Access to pressure measurement in real time for the professional
- Logging of pressure measurement, action used, timestamp
- Seat operation monitoring and safety protocol in case of failure
- Remote control connected to the outside of the seat

1.2 Integration in the ward

The device was transferred to the Autism Day hospital of the Excellence Center of Neurodevelopmental Disorders in the university hospital of Tours, France in January 2021. After gaining consent from parents, 39 children with ASD and ID used the device in everyday care (weekly or bi-weekly). First sessions were filmed,pressure logs recorded by the device, in order to better understand usage in the field. Suggested improvements following these sessions include: cushions tailored to the morphology of participants, upper and lower cells deflation dissociated, control panel to set the pressure limit, the feedback light was deactivated because it was too stimulating for children. The noise accompanying inflation and deflation was reduced.
A second group of modifications were made after two months and delivered in March 2021:

- A range of different sizes of back cushion
- New cells with a different design for upper and lower cells to adjust the squeezing effect
- New valves, pipes and pump to reduce noise
- New remote design with 4 buttons to reduce air pressure independently in upper or lower cells, and a light that can be deisactivated
- Addition of a tablet connected to the seat that lets the professional define the maximum pressure

Between April and November, the seat was used in the hospital and tested for two months in services in Rennes, Angoulème and Grandchamps-des-Fontaines. Based on the feature request from professionals in Tours, and feedback from three other services, some adjustments were made:

- Enhanced experience: easier on/off process, enhanced pressure measurement
- Noise reduction with valves modification and firmware adjustment
- Control panel enhancement, addition of a second remote
- Safety: continuous monitoring of program execution, error handling and codification

1.3 Description of the end-product (Figure 3)

Figure 3.: OTO, the Compressive Armchair to Perform Deep Pressure in Children with ASD (Final Product)

OTO is a squeezing armchair that uses inflatable cells to induce deep pressure on the legs and the trunk. The pressure is progressive, measurable, homogenous and can be tailored for each child. Four different inflatable cells allow for modulation through use of differentiate pressions on either shoulders and arm or hip and thighs.
The pressure can be controlled by the children via a remote with simple pictograms, to improve autonomy and predictability for the child. The control panel allows the children to set the maximum pressure level for upper and lower cells. The maximum default pressure is 60 mmHg for upper cells and 80mmHg for lower cells. This corresponds to the pressure a swimmer perceives one meter under the water. The seat records the use of the device with accompanying time logs.
The sitting position makes the device less bulky and allows more freedom of movement for the children, who does not need to lay down as they would in a hug machine. It allows the

child to easily leave the armchair if uncomfortable. The footrest can be used to (1) rest the legs (2) as a step for smaller children to enhance stability (3) by the healthcare provider to have the same height as the children and to maintain eye contact.
Pastel colors were used to limit sensory stimulation. Edges were avoided to make the armchair safer and more attractive. The device was developed to look like a cocoon to induce a feeling of privacy, to limit the stigmatization of its use and to limit outside noise or light stimulation. The structure is made from beech wood with a metallic structure for the base. All cloth is removable and washable.

Measures of clinical impressions

Clinical impressions were collected via a logbook with analogic visual scales and free report in day care hospital.

2. **Technology readiness level**

The technology readiness level allows to assess the level of maturity of a technology. It was published by the Defense Acquisition Guidebook (2006),

3. **Human-Centered Design for Personal Health Tools**

The Human-Centered Design for Personal Health Tools (UCD-11 a validated scale based on systematic review of the design and development processes of 348 personal health tools) was used to assess the design process.].

4. **Time of use**

Beyond this design, it is important to assess the time of use of the device (Building Evidence for Technology and Autism, 2021) to assess children and professionals acceptability. Here, it was measured by the chair.

5. **Measure of usability**

Usability is very important when a system is used with children with special needs and should be assessed in real life [Aguiar et al., 2020The system usability scale (SUS) measured how psychometricians, nurses and educators perceived the usability of the system (Brooke, 1996). The SUS has been used previously in autism and measures perceived usability from the perspective of professionals, rather than patients themselves (Weiss, 2011). It was measured in the day care hospital.

6. **Feasibility of an efficacy study**

We used the National Institute of Health and Research (NIHR) definition reported in Figure 1 in Eldridge et al., (2016)

Results

1. **Usage**

Recruitment was done between January and July 2023 in the ASD day Hospital in Tours. Thirty-nine children between 3 and 12 years with ASD and intellectual deficiency were included. Four children had to stop using the chair due to difficulties tolerating noise, being in an enclosed space or continuing anxiety despite habituation. These children had difficulties in sensory modulation and motor and emotional regulation. The system was adapted to decrease the inflation and deflation sound of the device.
The children used the remote heterogeneously. Some children controlled the remotes by themselves, others relied on the professional. Different levels of pressure were used with different rhythms of pressure and deflation.

2. **First Clinical Impression**

First clinical impressions suggest an increase in pleasure and body relaxation, decrease of

anxiety, better postural stability, better social contact (gaze and touch). When children came back to the group, it appeared that their attention and emotional regulation had improved. However, in this population, there is marked intra and inter-person variability. Aformal evaluation in a clinical trial with a larger sample and controlled procedures, is required to formally assess the efficacy of the device.

3. Technology readiness

The technology readiness level is between 8 and 9 according to the Defense Acquisition Guidebook (2006), meaning that the system can be used for several patients. Minor bugs and user-interface issues with the control panel need to be rectified.

4. Human-Centered Design for Personal Health Tools

We used several methods following the recommendations of UCD-11 (Table 2)

Table 2. Application of the UCD-11 during the design of the oto chair

1. Were potential end users (eg, patients, caregivers, family and friends, surrogates) involved in any steps to help understand users (eg, who they are, in what context might they use the tool) and their needs?	We performed a) ethnographic observation of existing practices, b) informal needs assessment, c) contextual inquiry, d) literature review summarized here, e) A training webinar to discuss with individuals with ASD, their sensory issues, needs and how the Oto chair could be used in everyday life) a protocol to assess the efficacy was developed through a focus group led by sociologists. Several scales to measure outcomes were suggested during this focus group.
2. Were potential end users involved in any steps of designing, developing, and/or refining a prototype?	After ethnographic observation of existing practices, psychometricians gave feedback after sessions with patients to help to develop, and refine the prototype
3. Were potential end users involved in any steps intended to evaluate prototypes or a final version of the tool?	We assessed usability among professionals (psychometricians, nurses and educators) involved in guiding children during use of the Oto chair. Professionals gave feedback following use of prototypes and again following use of the final product.
4. Were potential end users asked their opinions of the tool in any way?	We are finalizing focus groupswith children, parents, and professionals (reported elsewhere) to assess the sensory issues of children with ASD and the use of different tools and techniques to tackle sensory issues in ASD.
5. Were potential end users observed using the tool in any way?	The sessions were filmed to allow the designer to tailor the design of the chair to the needs of the children.
6. Did the development process have 3 or more iterative cycles?	4 iterations were done
7. Were changes between iterative cycles explicitly reported in any way?	Major changes are reported in this article
8. Were health professionals asked their opinion of the tool at any point?	Child and adolescent psychiatrists, psychomotricians nurses and educators

	provided feedbackThese professionals are the most likely to use the Oto chair with children. We gathered feedback on the usability of the chair and observed them using the tool.
9. Were health professionals consulted before the first prototype was developed?	Ethnographic evaluations were carried out with professionals.
10. Were health professionals consulted between initial and final prototypes?	After the prototype was developed , health professionals gave feedback which was used to finalize the design of the product.
11. Was an expert panel involved?	**The armchair received several prizes from several committees:** - The canopé (5k€), National innovation competition organized by Forinvest and Superior school of wood specialized in wood - The St Pierre Foundation health innovation prize (25 k€). The St Pierre Foundation specializes inchildren's health, and the award is decided by a panel of medical professionals. - James Dyson award for design. Awarded by the James Dyson Foundation and decided bya panel of engineers. - Startup and innovation day prize, 2022. This prize recognizes innovative startups. - Crédit Mutuel 4S Semeur d'innovation 2023 - Caisse d'épargne mon projet innovant 2021 - French Tech Tremplin for innovative company. Launched by people underrepresented in the tech industry - Handitech-trophy, awarded by the French Ministry of Health and French Ministry of digital technology

5. Time of use

In day care hospital, the first sessions were habituation sessions of around 5 minutes. This system was used for 3 to 20 minutes weekly or bi-weekly, with a total of 272 hours of total use in the ward. The system was always used with a therapist and never alone and planned around the schedule of the children.

6. Usability of the Product

The SUS was carried out with 9 professionals (3 psychomotricians, 3 nurses and 3 educators) in July 2022 in the day care hospital. A mean score of 81/100 was obtained (indicating between good and excellent usability); corresponding to a B score in a scale between A (best) to F (worst) (Bangor et al., 2009).

7. Feasibility of an efficacy study

1) Standard Deviation of the outcome measure, which is needed in some cases to estimate sample size

We couldn't measure clinical data due to regulations, thus it is not possible to estimate sample size. The literature review found that results from a similar device tested on 12 patients supported our clinical impression.

2) Willingness of participants to be randomised

During a focus group on October 2022, parents of children using the chair and one autistic adult confirmed their interest in the device and their willingness to participate in an efficacy trial.

3) Willingness of clinicians to recruit participants

Clinicians in the ay care hospital and 5 other centers expressed willingness to participate in an efficacy study.

4) Number of eligible patients
With a prevalence of 1%, ASD is quite frequently diagnosed. A lot of children with ASD also have sensory issues. Eligible patients seem numerous enough to run an efficacy study.

5) Characteristics of the proposed outcome measure
In the same focus group, in October 2022, one suggested outcome measure CBCL (Child Behavioural Checklist) was not considered suitable as it was not considered specific enough. Other suggested outcomes were considered relevant.

6) Adherence and Compliance rates
There was good compliance with the device, with just a few dropouts during the early phase of design when the system was too loud for some participants. Most of the questionnaires are already use in clinical practice, others seemed acceptable by the focus group.

7) Availability of data needed
Most of the children in the center have a proper diagnosis. If recruitment is done in other centers, absence of use of ADIS and ADOS and poor experience of clinical research could be a limitation.

8) Time needed to collect and analyse data
Getting all the administrative authorization for a medical device, in an at risk population (children, intellectual deficiency) and the prospective organization of an efficacy study, planned to run over 12 weeks, may make time management complicated.

Discussion

The process of development of an ergonomic compressive chair to induce deep pressure in children with ASD is described. This design was user-centered according to the methodology of Witteman. The system is considered usable by professionals, according to the SUS.

User-Centeredness

This device was accepted by the clinicians, patients and their family. The system was primarily used by psychomotor/occupational therapists, but use by nurses and educators was also possible. It did not require the support of a technician. The goal was to increase acceptability, autonomy of the subject and decrease the stigmatization associated with ASD and this kind of care.

Armchair Use, Child Profile and Time of Use

According to the experience of the psychomotricians and analysis of video footage by an independent clinician, usability was better for older children (> 8 years).
There were no side effects reported. Children could leave the armchair easily. If they experienced discomfort the therapist was able to deflate the cushion.
The system was used in a small room with limited visual and auditory stimulation.
Sometimes, professionals suggested children use a neck cushion to improve relaxation.
Time of use shows that the device was included in everyday care and suggests it would be routinely adopted in practice.

Future plans

a) Acceptability

On-going focus groups and simulations with children, parents and professionals will examine perspectives on sensory issues in ASD and the acceptability of different devices proposed for DPT and sensory therapy. This will provide more formal data on the perspectives of different users on the sensory peculiarities and needs of people with ASD, solutions and the place of this compressive armchair a therapeutic approach.

i. **Randomized Controlled TrialsThis device will enable further evaluation of deep pressure therapy. In future, we plan to properly characterize and report the data of the individuals including precise diagnostic information (ADI, ADOS), their sensory profile and proprioception deficits [Dunn -Kientz & Dunn, 1997]; score on the EPSA scale [Le Menn-Tripi et al, 2019] and underlying pathophysiological processes (Heart-Rate Variability, Electro Dermal Activity) using a wearable monitoring device to measure physiological data. To improve acceptability, in children with most anxiety, it seems that the presentation of the device should be progressive.**

Recruitment for a controlled efficacy study of Deep Pressure Therapy in ASD seems promising. We have received requests from teams out-with the original study to be involved in testing the device and expressing willingness to be involved in an efficacy study. Despite complexity of administrative authorizations and time management of a prospective study, such a study seems feasible.

Limitations

Usability testing

There is a consensus to improve usability of devices in ASD but not on the methods used to measure usability [Aguiar et al., 2020]. The SUS is widely used to measure usability but can be difficult to use in individuals with ASD. Thus, it can be amended for use with the person with autism or be filled in by the professional accompanying them [Gentille et al, 2019 ; Aguiar et al., 2020 ; Parish-Morris et al, 2018]. Usually, the SUS questionnaire is filled in by the person using the system. Here, and in previous studies like [Weiss et al, 2011], usability was reported by the therapist. Amended versions of current usability tests, or the development of alternative means of assessment would improve assessment of usability.
We think that time of usage (section 5), feedback from experts (section 4, UCD-11, item 11), reported here and simulations and focus groups with patients and their parents that we plan to report later, are complementary methods that are in favor of a good usability.

Measures of efficacy

This study does not allow any firm conclusions to be drawn about the efficacy of the device in reducing anxiety in ASD. However, this study showed that an efficacy study is feasible (Eldridge et al., 2016). In future efficacy studies, it would be important to report the precise clinical profiles of children and their pressure needs. Due to the design and preliminary nature of the study, French regulations do not allow the reporting of clinical data.

Implication for Occupational Therapy Practice

This device has the potential to facilitate the design of well conducted studies to better understand the rationale behind and efficacy of deep pressure therapy in ASD.

Conclusion

We describe the design process, end product and user feedback following the use of a compression chair to apply deep pressure therapy in ASD. This device would allow the children or adults with ASD to better control over the pressure and facilitate high quality studies to understand the rationale for (role of proprioception) and efficacy of deep pressure therapy in reducing anxiety in ASD.

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Conflict of interests

The device described in this article is the intellectual property of Alexia Audrain

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