Cognition and Therapy in Autism Spectrum Disorder (ASD)

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Abstract

Recent results on cognitive processing styles in autism spectrum disorder (ASD) open new avenues for successful psychological support and interventions. Previously, psychological treatment for ASD focussed on shaping behaviour by use of classical or instrumental conditioning or on addressing co-morbid mental health conditions. Few psychological interventions directly address deficits such as social communication issues or repetitive behaviours. The objective here is to review recent research results on cognitive processing in ASD and to introduce a framework for psychological interventions that directly addresses core deficits within the spectrum. From a research perspective, the framework allows the identification of gaps without appropriate psychological techniques are and facilitates strategies for empirical research. For the clinical practitioner, a structure for psychological interventions is introduced to facilitate the search for treatment options.

Autism Spectrum Disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM)

According to the Center for Disease Control and Prevention (CDC, 2014), there is a continuing rise in the prevalence of autism, currently around 1 in 68 children (Donaldson & Stahmer, 2014). Autism is a neurodevelopmental disorder that changed with every new edition of the DSM (The Diagnostic and Statistical Manual of Mental Disorders): in DSM-I (1952), it was placed under schizophrenic reaction –childhood type, in DSM-II (1968) it was placed under schizophrenia – childhood type, in DSM-III (1980) it was moved to a separate category titled infantile autism, in DSM-III-R (1987) the name changed to autistic disorder and in DSM-IV (1990) and DSM-IV-R (2000), it was characterized as one of the five pervasive developmental disorders (PDDs). Finally, in the newest version DSM-5, it was renamed to become a broad category: Autism Spectrum Disorder (Gensler, 2012). DSM-5 also featured the removal of Asperger's disorder as an independent diagnostic category and its inclusion in ASD which generated significant debate (Parsloe and Babrow, 2016). ASD in DSM-5 has two dimensions, social relations/communication and restricted interests/repetitive behavior with seven criteria (Zuddas, 2013).

DSM-5 also incorporated a severity scale for the assessment of autism that could facilitate determination of therapy options and prognosis (Mehling & Tasse, 2016). Severity was assessed in previous DSM versions according to the level of intellectual functioning and ASD symptoms but it was shown to fall short of capturing properly the diversity among people diagnosed with ASD (Di Rezze et al., 2012; in Mehling and Tasse (2016) p.2001). The new scale consists of three severity level ranging from assistance to very substantial support (Kite, Gullifer

& Tyson, 2013). According to Mandy et al. (2012), the scale was necessary because a single measure in line with previous criteria (IQ and symptomology) could not correlate well with the new two-dimensional diagnosis of ASD (Mandy et al., 2012; in Mehling & Tasse (2016) p.2010). For instance, a measure of 10 on the old scale could be attributed entirely to social communication deficits in one individual and to repetitive behaviour in another, so two individuals with the same severity level can have a different prognosis (Hus et al., 2014; in Mehling and Tasse (2016) p.2010). Notwithstanding the assessment of severity level in the DSM 5 using clinical interviews, standardized measures of severity (ADOS-II, SRS-2, Vineland-2 for social communication and RBS and ADOS II for repetitive and restricted behaviors) can also be potent in informing the decision making process (Mehling & Tasse, 2016).

DSM-5 was introduced in 2013 and states (p.51) that "Individuals with a well-established DSM-IV diagnosis of ... Asperger's disorder ... should be given the diagnosis of autism spectrum disorder. Individuals who have maked deficits in social communication, but whose symptoms do not otherwise meet the criteria for autism spectrum disorder, should be evaluated for social (pragmatic) communication disorder."

Disputes have risen over the removal of Asperger's from DSM-5 (Zuddas, 2013). A pre-dominant concerns is that some individuals will no longer meet the criteria for diagnosis, thus losing access to public health support services (Zuddas, 2013). However, rates of diagnosis are increasing even though it is unknown whether the increase is due to an elevated awareness, the broader diagnostic criteria or a true increase in the incidence of ASD (Kulage, Smaldone & Cohn, 2014). Another concern expressed during the transition to DSM-5 is that autism has more negative connotations than Asperger's which may lead to increased stigma (Kite, Gullifer &

Tyson, 2013). However, at least one study has shown that there is no support for this claim and that both labels are advantageous for help-seeking and optimism about treatment success (Ohan, Ellefson & Corrigan, 2015).

Cognitive Processing and Autism Spectrum Disorder

The Bayesian inference approach is a statistical computational model that is thought to be the optimal (most reliable) manner of updating beliefs (Hohwy, 2017; Palmer, Lawson, & Hohwy, 2017; Yu, & Dayan, 2005). Moreover, there is neuronal and biological evidence that the human brain makes inferences using a Bayesian approach (Clark, 2013; Friston, 2005; Mumford, 1992; Palmer et al., 2017; Payzan-LeNestour, & Bossaerts, 2011; Hohwy, Paton, & Palmer, 2016). In this context, beliefs are represented as probability distributions and the outcome expected is based on the mean of the prior belief (prior distribution) (Palmer, et al., 2017). The difference between this expected outcome and the actual outcome is the prediction error (Palmer, et al., 2017; Hohwy et al., 2016; Hohwy,, 2017). It is the prediction error that then leads to changes in beliefs (Hohwy, 2017; Palmer, et al., 2017). In short, based on the Bayesian model, beliefs are updated through bottom-up processing from sensory input to prior beliefs. However, it is strongly argued that this Bayesian model leads to optimal inference only in a stable environment, but the real world is unstable and full of contextual noise that might influence our perception (Hohwy, 2017; Palmer at al., 2017). In fact, in a changing environment, the Bayesian model would imply that beliefs are influenced even by irrelevant sensory noise (Hohwy, et al., 2016). For example, based on the traditional Bayesian model, we would have a problem in detecting the same face in different lighting conditions, but humans are able to preserve such a detection.

To correct for this limitation in the Bayesian approach, authors have suggested that the Bayesian model for updating beliefs in humans should integrate both top down and bottom up processing and should have a hierarchical structure, with higher level processing influencing the lower processing (Bolis, Balsters, Wenderoth, Becchio, & Schilbach, in press; Hohwy, 2017; Mumford, 1992; Palmer et al., 2017; Van Boxtel, &Lu, 2013; Van de Cruys, de-Wit, Evers, Boets, & Wagemans, 2013). Consequently, when the sensory input is received by the brain, it is processed simultaneously by bottom-up processing that detects prediction errors, and top-down processing, which, based on expectations of volatility in the environment, explains away these prediction errors (Bolis, et al., in press ; Hohwy, 2017; Hohwy, et al., 2016; Mumford, 1992; Palmer et al., 2017; Van de Cruys, et al., 2013). It does the latter by communicating the expectations of volatility to the lower levels thus decreasing the perceived precision of the input (the likelihood of the input), which lowers the weight given to the prediction error (Bolis,et al., in press,; Hohwy, et al., 2016; Hohwy, 2017; Mumford, 1992; Palmer et al., 2017; Van de Cruys, et al., 2013). Each higher level explains away the prediction error in the level below it (Bolis,et al., in press ; Hohwy, et al., 2016; Hohwy, 2017; Mumford, 1992; Palmer et al., 2017; Van de Cruys, et al., 2013). Back to the face detection example, the sensory differences in a familiar face under different lighting are processed as prediction errors which are sent to the higher levels. These higher processing levels have high expectations of changes in light, which they communicate to the lower levels, leading to a decrease in the likelihood of the input (the perceived facial changes), and in turn a decrease in the weight given to the prediction error. This way the person is able to ignore the imprecise facial changes and see the same familiar face. In other words, top-down processing lowers the attention given to irrelevant sensory input. It should

be noted that the whole process only takes few seconds to be completed. In summary, it seems that the expectation of uncertainty in the environment (volatility) influences the weight given to the uncertainty in our beliefs (Palmer et al., 2017; Payzan-LeNestour, & Bossaerts, 2011; Yu, & Dayan, 2005).

The use of a hierarchical Bayesian model to explain how humans understand their world is critical in the present paper due to the rising argument that autism can be fully explained by a weakness in the top-down processing mechanism (Chamberlain et al., 2013; Cook, Barbalat, & Blakemore, 2012; Lawson, Rees, & Friston, 2014; Pellicano, & Burr, 2012; Sinha et al., 2014; Van de Cyrus et al., 2014).

Top-Down Processing Sensory Overload

If top-down processing is defective in ASD, it would imply that individuals with autism have a lower ability to inhibit sensory noise, thus a lower ability to decrease the importance/ attention given to irrelevant sensory fluctuations, which could account for the sensory overload they experience (Bolis et al., in press; Friston, 2005; Lawson, Mathys, & Rees, 2017; Palmer et al., 2017; Lawson et al., 2014; Van de Cyrus et al., 2014).

Insistence on Sameness and Restrictive Repetitive Behaviors

Continuously having high precision prediction errors, even for irrelevant details, can be affectively taxing, since it makes the person hypervigilant to small fluctuations in the environment (Pellicano, & Burr, 2012; Van de Cyrus et al., 2014). This might explain the findings that individuals with autism have heightened anxiety causing intolerance for uncertainty

(IU) (Boulter, Freeston, South, & Rodgers, 2013; Chamberlain et al., 2013; Hodgson, Freeston, Honey, &Rodgers, 2017; Neil, Olsson, & Pellicano, 2016). Such an anxiety-triggering experience might create an aversion to unstable environments and a preference for predictable and restrictive environments, in individuals with ASD (Pellicano, & Burr, 2012; Van de Cyrus et al., 2014). Thus, the insistence on sameness, the repetitive restrictive behaviors and the fascination with certain sensory stimuli could be methods used by individuals with ASD to create a predictable comforting environment (Pellicano, & Burr, 2012; Van de Cyrus et al., 2014). In support of this argument, a study conducted by Wigham, Rodgers, South, McConachie and Freeston (2015) showed a significant positive association between hypersensitivity/ hyposensitivity to sensory stimuli and repetitive motor activity. Additionally, this relationship was significantly mediated by IU and anxiety (Wigham, et al., 2015). An articulate summary for this section would be Froese and Ikegami's definition of the autistic tendency for stereotypic self-stimulation as an atypical yet functional practical method of decreasing the extent of prediction errors (Froese & Ikegami, 2013, p. 213).

Local vs. Global Processing

As great attention is given to most sensory input including sensory noise, the lower levels of the perceptual hierarchy consume the processing energy in individuals with autism (Van de Cyrus et al., 2014). Thus, little processing capacity and attention would be left for the integration of information (Van de Cyrus et al., 2014). Moreover, if the precision of prediction error is high, any small spatiotemporal mismatch between two cues will make them seem separate and thus will hinder their integration, which can explain the deficits in global processing in ASD (Palmer, Paton, Hohwy, & Enticott, 2013). In short, the processing "energy" in individuals with autism is

used at the lower levels of the perceptual hierarchy leading to highly localized perception (Feldman and Friston, 2010 as cited in Lawson et al., 2014).

Social Skills

First, the most complex stimulus is another human, which explains the lowered tendency in ASD to orient towards social stimuli and cues (Pellicano, & Burr, 2012; Robic et al., 2015; Van de Cyrus et al., 2014). For example, to be able to detect relevant information from speech, the person has to disregard irrelevant acoustic features of the sounds which is difficult for someone who overly focuses on fluctuations in sensory information (Crespi, 2013; Pellicano, & Burr, 2012; Van de Cyrus et al., 2014). Actually, it has been found that people with ASD do not disregard the acoustic features of speech (Heaton, 2003; Jarvinen-Pasley, Peppe, King-Smith, & Heaton, 2008). Similarly, facial recognition should be generalized across details such as lighting conditions, face orientation, changing facial features (e.g., facial hair, freckles), and extrafacial features (e.g., hair style, hats) (Van de Cyrus et al., 2014). Thus, the deficits in facial recognition in individuals with autism might be explained by their focus on the above irrelevant details which prevent or slow down the recognition of faces (Van de Cyrus et al., 2014). Second, Social understanding requires the integration of different sources of information (Pellicano, & Burr, 2012). For instance, facial expression has varied meanings depending on the gesture and posture of the body or depending on the context (Aviezer, Trope, & Todorov, 2012). Due to its top down nature, such integrative skills, might be lacking in ASD (refer to the previous section). Finally, it has been disputed that social processing happens at a higher level than non-social processing which might explain the deficits in such processing in ASD (Van de Cyrus et al., 2014).

Savant Skills

It is estimated that one out of every ten people with ASD is an autist savant, meaning he/she shows excellence in an isolated skill (Van de Cyrus et al., 2014). In fact, all known examples of savant skills seem to combine two abilities, an exquisite discriminative sensory ability and an exceptional memory capacity (Hill, 1978; Treffert, 2009). While the latter is a general ability in savants, the former is a characteristic ability of ASD that can be considered a consequence of high precision prediction errors (Van de Cyrus et al., 2014).

Applied Behavioral Analysis (ABA)

Skinner's opperant model was an essential contribution to this field and includes a three-part contingency (the ABC): An antecedent (an event that triggers behaviour), a reaction (response or no response) and the consequence that follows the behaviour (Donaldson and Stahmer, 2014). This model is based on the premise that learning is the result of the consequence following the behavior which can either strengthen, modify or weaken it and thus affecting the probability of its reoccurrence. This operant model is the foundation of Applied Behavior Analysis which is a scientific approach to examining behavior (Donaldson and Stahmer, 2014). ABA has significant empirical support for treating children with autism (Donaldson and Stahmer, 2014).

Ivar Lovaas sought to improve the lives of children with autism; he was the pioneer of early ABA interventions and influenced their availability in the 1970s (Smith and Eikeseth, 2011). ABA relies on the operant model to teach new skills, maintain the desired behavior, generalize it and reduce unwanted responses. ABA includes two parts: assessment and intervention (Steege,

Mace, Perry & Longenecker, 2007). In the assessment phase, behavior is measured according to the indivdual's interaction with his/her environment. Assessment is done before, during and after the intervention to choose the appropriate treatment plan, monitor change and introduce modifications to the intervention if necessary (Steege et al., 2007). During the intervention stage, different techniques are employed including discrete trial training, pivotal response training, prompting and prompt fading among others (Dillenburger & Keenan, 2009).

Discrete trial training (DTT) breaks down tasks into simpler components that are taught gradually (Steege et al., 2007). It involves four stages: (1) presentation of the discriminative stimulus, (2) performance of the targeted response or an approximation of it, (3) reinforcement that is not directly related to the behavior such as a sticker and (4) intertrial interval and recording of data. Pivotal response training (PRT) is another ABA approach using a reinforcer the child likes and is related to the behavior. It also employs the antecedent, behavior and consequence model. DTT has been shown to be effective in teaching skills within a single unit of behavior as opposed to sequential behavior (Steege et al., 2007).

DTT in comparison to PRT in the field of language and generalization across children was studied by Mohammadzaheri, Koegel, Rezaee and Rafiee (2014). The yielded results of this study demonstrate that PRT is more effective in improving social communication skills. This could be explained by the increased interest of children in the sessions due to choosing items and activities they are interested in, as opposed to the use of forced reinforces in the case of DTT . In addition to that, a greater generalization in the PRT group might cause more widespread effects due to the focus on pivotal behaviors not on individual target ones (Mohammadzaheri et al.,

2014).

Individuals with autism have difficulties communicating and performing certain tasks, which causes problems in social contexts. Thus, the need for developing proper communication and adaptive skills increases in adulthood to ensure quality of life (Fitzpatrick, Minshew & Eack, 2013). Psychosocial interventions are useful in helping individuals with ASD and the effect size of such interventions is positive ranging between 0.14 and 3.59 (Fitzpatrick, Minshew & Eack, 2013). Behavioral interventions specifically are shown to be effective in teaching adults with autism a large range of skills (Roth, Gillis & Reed, 2014). A systematic review of behavioral intervention research on adaptive skills in young adults with ASD has shown that interventions with low or high tech assisted procedures such as video modeling, visual cues, reinforcement contingencies and corrective feedback using prompts are effective in assisting adults to develop adaptive life skills (Palmen, Didden & Lang, 2012). Another review of researches on the topic conclude that ABA is highly effective in teaching adaptive skills to individuals of wide range of disabilities including adults with ASD (Matson, Hattier & Belva, 2012).

Beyond APA: Steps toward Cognitive Therapy

To reinforce the tendency to attend to social cues and reduce the aversion from them in individuals with ASD, complex social interactions should be reduced to single moments of interaction which reduces uncertainty and thus anxiety (Haker, Schneebeli, & Stephan, 2016). It would also be beneficial to frequently repeat these interactions to make them more interpretable (Haker, et al., 2016). Another suggestion is to make the environment, where the social situation is taking place, predictable, so that it is not anxiety provoking and it does not divert the person's

attention from the social interaction (Ferrara, &Hill, 1980). Another strategy to increase exploration and tendency to social cues is by means of tolerance of uncertainty training such as relaxation training that can be used later to expose the person to uncertain situations (Rodgers et al., 2017). Also, since integrative processing which is crucial for the understanding of social cues is dysfunctional in individuals with ASD, social training should address multisensory integration skills (Ferrara & Hill, 1980). In addition, the prediction errors that arise while executing action are due to prediction errors that arise while observing action. Therefore, one suggestion for social training is allowing individuals with autism to execute social interactions by taking the role of both parties of an interaction, with the presence of guidance from an expert. Finally, the prediction model gives implication on how to provide social training. In fact, to establish high level learning, the training situation should be predictable, meaning that feedback should be clear and consistently provided (Solomon et al., 2015).

An Intervention Model for Prediction Problems

If we adopt the computational model as an explanation of ASD, then, our intervention should focus on training individuals with autism in learning and detecting regularities in both non-social and social domains (Robic et al., 2015). This could be done by using a sheet with columns: date, time of the day, situation, three similarities with a past similar situation, and perceived uncertainties. In the next session, the therapist should give credit to the client's successful detection of three similarities and challenge the uncertainties that were detected. Challenging the uncertainties relates to the idea that people with ASD detect even the irrelevant uncertainties and observe this environmental noise as an evidence that prior expectations about the given outcome shouldn't be trusted. Thus, challenging should focus on whether uncertainty

reflects a change in the outcome or simply a consequence of change in the environment. For example, an individual with autism, would detect changes in facial details that are actually a consequence of difference in lighting. Thus, the therapist should ask the client to think of evidence that the observed changes are actually caused by changes in facial details or simply a consequence of change in light. After several sessions of challenging, the client would be asked to add a column to the sheet, where he/she would write up possible alternative environmental explanations to the perceived outcome uncertainty. Using these methods both increases the individual's attention to predictability, and decreases the weight given to uncertainties.

Top down processing can be sharpened by explicitly teaching individuals with autism the abstract and stable principles behind complex processes (Haker et al., 2016). The goal of this training is to sharpen the top-down processing pathways, and based on the shown plasticity of the brain, such a sharpening is possible.

Finally, if working on the above core features of the prediction problem in ASD seem to be challenging, work can be done superficially, by reducing sensory overload, meaning reducing the detection of irrelevant sensory fluctuations (Haker et al., 2016). Such a task can be executed by behavioral techniques, through which the person is asked to focus on one stimuli, while being flooded with different sensory stimuli.

A framework for psychological intervention in Autism Spectrum Disorder

The sections above summarize traditional approaches to therapy as well as the most recent results on cognitive processing in autism spectrum disorder. Over the last decades, clinical

practice as well as educational efforts mostly utilised behavior therapy; it is now possible to develop a framework for therapy that includes behavioural as well as cognitive aspects.

The techniques below aims at developing empathy and tolerating change in life. Table 1 and the sections below include *sample interventions to illustrate the usefulness of the framework.* No claim is made about the efficacy or effectiveness of individual interventions.

Cognitive Functioning / Therapy	**Low**	**Medium**	**High (Aspergers)**
Individual			
Pivotal response training (ABA)	Client oriented		
Discrete trial training (ABA)	Shape Behaviour		
Psychoeducation		What is ASD?	What is Aspergers?
Problem Solving Therapy	Means of dealing with problems	Making effective decisions	Goal setting and identification of obstacles
Cognitive Empathy Training		Facial Videos	Facial Videos
Social			
Behavioural Feedback		Geek Cards	Geek Cards and behaviour analysis
Stability and Change	Manage transitions	Manage transitions	Workbooks
Positive Communication	Skill training	Using all channels	Using all channels
Relaxation	Progressive Muscle Relaxation	Progressive Muscle Relaxation	Autogenic Training
Psychodrama		Modelling	Modelling

Behavioral ----------> Cognitive

Table 1: A framework for psychological interventions for Autism Spectrum Disorder.

This framework includes three core dimensions: From individual to group interventions and from the behavioural to the cognitive, that is from ABA-style interventions to cognitive

therapy informed by recent research results. The third dimension is the level of cognitive functioning, from non-verbal autistic individuals with reduced intellectual functioning to adult Aspergers with average or above average intelligence. Since a significant number of individuals with autism spectrum disorder also suffer from mood disorders, particularly depression and anxiety, interventions that address mood issues are considered as well. The framework is primarily aimed at supporting adolescent and adult clients. Social interventions include partners and family members as well.

Some of the sample interventions in Table 1 are briefly summarised below.

Psychoeducation

Education is a crucial aspect of any psychological therapy. Psychoeducation for ASD should include common challenges as well as some information on the prevalence of ASD. This may include the information below which focusses on challenges, not diagnostic definitions.

Problem-Solving Therapy

Daily clinical practice includes the observation of the behaviour of a client, partners, care-givers and families. Much of this knowledge is embodied in the sense that clients use their full presence to communicate and the psychologist is using speech, voice, gesture etc. to ask questions and to conduct psychological interventions.

For instance, an experienced psychologists may use mean-end analysis (goal decomposition) as a strategy within the general context of problem-solving therapy. Based on clinical experience and an understanding of the problem, the psychologist may suggest sub-goals

in order to achieve the overall outcome (the goal). If the psychologist has worked with clients who are on the autistic spectrum, the practitioner may may well have a set of heuristics that can help to achieve sub-goals as well as the final outcome.

"Geek cards": Feedback on behaviours.

In terms of learning theory, the "Geek cards" are markers for behaviours designed to overcome the credit assignment problem, that is how to identify a particular action within a flow of behaviours that deserves positive reinforcement or is marked as unwanted. Obviously, in the context of behavioural therapy, none of the cards should be punishing but should encourage behaviour modification.

The cards can be used as a form of behaviour feedback in autism spectrum disorder, for instance within a family or a relationship. Participants distribute cards in different colours (red, yellow and green) to mark behaviours of a partner or relative. The red card points to an unacceptable behaviour, the yellow card to actions that are not positive and should be avoided and the green card is a marker for positive reinforcement, that is it indicates behaviours that are welcomed and should be repeated. There should be no discussions of behaviours when cards are exchanged (otherwise there could be arguments). The review of behaviours should happen later in the day and outside of the context of the occurrence of a particular behaviour.

Positive Social Communications: Using all the channels.

Individuals with autism spectrum disorder may have deficits in expressing positive emotions and sentiments through body language, gestures and aspects of speech such as

intonation. As a result, these individuals may be perceived as cold and disinterested. It is important to encourage persons with ASD to communicate positive emotions *through all possible channels,* in part to compensate for deficits that may exist in the non-verbal domain. *All possible channels* includes the use of social media and mobile apps to communicate positive sentiments to partners or family members. This can be done by the use of SMS, Twitter, Facebook or any other form of textual or visual communication. The idea is to stay in touch with relevant others throughout the day and to establish a constant flow of positive comments in order to maintain relationships. All of these messages can be brief, however, the idea is to communicate frequently. Initially, these messages may be scheduled at certain times throughout the day in order to establish a pattern.

Stability and change

Insistence on routines (sameness) and intolerance of change are among the diagnostic criteria for autism spectrum disorder (Lawson, Mathys & Rees, 2017). Individuals with ASD are less surprised than neurotypical adults when their expectations are violated.

How many things in daily life do change and how many remain the same? It is helpful to record the frequency of daily change, this includes events at home, at work, in the outside environment and in relationships. This is very much the style of cognitive behaviour therapy workbooks. Did your partner move things again in your bedroom or study? Was the traffic really as bad as predicted? Did the rearrangement of desks in the office take place?

Maybe there are not as many changes as expected and hence the knowledge of stability can and should be *reassuring*. Table 2 demonstrates the recording of events that break routines,

the strength of the belief that these things will happen and the confirmation or absence of change for any given day.

Date	Expected to change	Strength of belief (0-10)	Confirmed change

Table 2: The recording of change.

Some of the changes in life are simply unavoidable, others can be controlled at least to some extent. The amount of traffic on the way to work cannot be controlled, however, it is possible to talk to colleagues and managers about timetables and the planning of events at work. If change that breaks routines goes ahead, it is useful to know well in advance and to plan for it. Table 2 can be expanded to include a classification of events: those that cannot be controlled by an individual and do not allow for any planning, those that cannot be controlled but are predictable and those events that are both foreseeable and open to individual influence.

Conclusion

This review of recent research results on cognitive processing in ASD allowed the introduction of a framework for psychological interventions that directly addresses core deficits within the spectrum. The framework for ASD outlined above includes three dimensions: (1) From psychological interventions for individuals to psycho-social forms of therapy, (2) from behavioural interventions to cognitive behaviour therapy, and (3) from low to high-cognitive functioning. A number of interventions have been identified within this framework and the objective is to use the classification as a guide for future research. Eventually, the framework should allow the utilisation of particularly effective psychological interventions and a ranking of

different forms of psychotherapy with regard to time and effort.

References

Agius, M. M., & Vance, M. (2016). A comparison of PECS and iPad to teach requesting to pre-schoolers with autistic spectrum disorders. *AAC: Augmentative And Alternative Communication*, *32*(1), 58-68. doi:10.3109/07434618.2015.1108363

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders (5th ed., text revision): DSM-5. Author, Washington, DC.

Aviezer, H., Trope, Y., & Todorov, A. (2012). Body cues, not facial expressions, discriminate between intense positive and negative emotions. *Science, 338*(6111), 1225-1229. doi: 10.1126/science.1224313.

Bolis, D., Balsters, J., Wenderoth, N., Becchio, C. &, Schilbach, L. (2017). Beyond autism: Introducing the dialectical misattunement hypothesis and a Bayesian account of intersubjectivity. *Psychopathology*. 2017;50(6):355-372. doi: 10.1159/000484353.

Boulter, C., Freeston, M., South, M., &Rodgers, J. (2013). Intolerance of uncertainty as a framework for understanding anxiety in children and adolescents with autism spectrum disorders. *J Autism Dev Disord., 44*, 1391–1402. DOI 10.1007/s10803-013-2001-x

Bishop-Fitzpatrick, L., Minshew, N. J., & Eack, S. M. (2013). A systematic review of psychosocial interventions for adults with autism spectrum disorders. *Journal Of Autism And Developmental Disorders*, *43*(3), 687-694. doi:10.1007/s10803-012-1615-8

Campbell, J. E., Morgan, M., Barnett, V., & Spreat, S. (2015). Handheld devices and video modeling to enhance the learning of self-help skills in adolescents with autism spectrum disorder. *OTJR: Occupation, Participation And Health*, *35*(2), 95-100. doi:10.1177/1539449215570040

Chamberlain, P., Rodgers, J., Crowley, M.J., White, S.E., Freeston, M.H., & South, M. (2013).A potentiated startle study of uncertainty and contextual anxiety in adolescents diagnosed with autism spectrum disorder. *Molecular Autism, 4*(31). https://doi.org/10.1186/2040-2392-4-31

Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behav Brain Sci, 36*(3),181-204. doi: 10.1017/S0140525X12000477.

Cook, J., Barbalat, G., & Blakemore, S.-J. (2012). Top-down modulation of the perception of other people in schizophrenia and autism. *Frontiers in Human Neuroscience, 6*, 175. http://doi.org/10.3389/fnhum.2012.00175

Crespi, B. (2013). Developmental heterochrony and the evolution of autistic perception, cognition and behavior. *BMC Medicine, 11*, Article 119. doi:10.1186/1741-7015-11-119.

Diederich, J., The Mental State Tracker - Language Anlysis for Mental Health. The Australian & New Zealand Mental Health Association, January 2017.

Dillenburger, K., & Keenan, M. (2009). None of the As in ABA stand for autism: Dispelling the myths. *Journal Of Intellectual And Developmental Disability*, *34*(2), 193-195. doi:10.1080/13668250902845244

Donaldson, A. L., & Stahmer, A. C. (2014). Team collaboration: The use of behavior principles for serving students with ASD. *Language, Speech, And Hearing Services In Schools*, *45*(4), 261-276. doi:10.1044/2014_LSHSS-14-0038

Feldman, H., & Friston, K.(2010). Attention, uncertainty, and free-energy. *Frontiers in Human Neuroscience,4,*1-23. Doi: 10.3389/fnhum.2010.00215

Ferrara, C. & Hill, S.D. (1980). The responsiveness of autistic children to the predictability of social and nonsocial toys. *J Autism Dev Disord., 10*(51). Retrieved from: https://doi.org/10.1007/BF02408432

Friston, K. (2005).A theory of cortical responses. *Philos Trans R Soc Lond B Biol Sci., 360*(1456),815-836.

Froese, T., & Ikegami, T. (2013). The brain is not an isolated "black box," nor is its goal to become one. *Behavioral and Brain Sciences, 36*, 213–214. doi:10.1017/S0140525X12002348.

Gensler, D. (2012). Autism spectrum disorder in DSM-V: Differential diagnosis and boundary conditions. *Journal Of Infant, Child & Adolescent Psychotherapy*, *11*(2), 86-95. doi:10.1080/15289168.2012.676339

Golan, O., & Baron-Cohen, S. (2006). Systemizing empathy: Teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia. *Development And Psychopathology*, *18*(2), 591-617. doi:10.1017/S0954579406060305

Haker, H., Schneebeli, M., & Stephan, K.E. (2016). Can Bayesian theories of autism spec6trum disorder help improve clinical practice? *Frontiers in psychiatry, 7,* 107, 2016

Heaton, P. (2003). Pitch memory, labelling and disembedding in autism. *Journal of Child Psychology and Psychiatry, 44* (4), 543-551.

Herring, P., Kear, K., Sheehy, K., & Jones, R. (2017). A virtual tutor for children with autism. *Journal of Enabling Technologies, 11*(1), 19-27. doi:10.1108/JET-01-2016-0006

Hill, A. L. (1978). Savants: Mentally retarded individuals with special skills. *International Review of Research in Mental Retardation, 9*, 277-298.

Hodgson, A, Freeston, M., Honey, E., &Rodgers, J. (2017). Facing the unknown: Intolerance of in children with autism spectrum disorder. *Journal of Applied Research in Intellectual Disabilities, 30*, 336–344. Doi: 10.1111/jar.12245

Hohwy, J., Paton, B., &Palmer, C. (2016). Distrusting the present. *Phenomenology and the Cognitive Sciences, 15*(3), 315-335.Doi: https://doi.org/10.1007/s11097-015-9439-6

Hohwy, J. (2017). Priors in perception: Top-down modulation, Bayesian perceptual learning rate, and prediction error minimization. *Consciousness and Cognition, 47*, 75-85. https://doi.org/10.1016/j.concog.2016.09.004

Imamoto, S., & Monji, K. (2016). Effects of a 'wait card' to teach tolerance of delayed presentation of reinforcers: Child with autism spectrum disorder. Japanese Journal Of Special Education, 54(2), 111-120.

Jarvinen-Pasley, A., Peppe, S., King-Smith, G., & Heaton, P. (2008). The relationship between form and function level receptive prosodic abilities in autism. *Journal of Autism and Developmental Disorders, 38* (7), 1328-1340.

Kagohara, D. M., van der Meer, L., Achmadi, D., Green, V. A., O'Reilly, M. F., Mulloy, A., & ... Sigafoos, J. (2010). Behavioral intervention promotes successful use of an iPod-based communication device by an adolescent with autism. *Clinical Case Studies*, *9*(5), 328-338. doi:10.1177/1534650110379633

Kite, D. M., Gullifer, J., & Tyson, G. A. (2013). Views on the diagnostic labels of autism and Asperger's disorder and the proposed changes in the DSM. *Journal Of Autism And*

Developmental Disorders, *43*(7), 1692-1700. doi:10.1007/s10803-012-1718-2

Kulage, K. M., Smaldone, A. M., & Cohn, E. G. (2014). How will DSM-5 affect autism diagnosis? A systematic literature review and meta-analysis. *Journal Of Autism And Developmental Disorders*, *44*(8), 1918-1932. doi:10.1007/s10803-014-2065-2

Labrador, F. J. (2004). Skinner and the rise of behavior modification and behavior therapy. *Spanish Journal of Psychology, 7*(2), 178-187. Retrieved from www.scopus.com

Lawson, R., Mathys, C., & Rees, G. (2017).Adults with autism overestimate the volatility of the sensory environment. *Nature Neuroscience, 20*(9). doi:10.1038/nn.4615.

Lawson, R., Rees, G., & Friston, K.(2014). An aberrant precision account of autism. *Front Hum Neurosci., 8*, 302. doi: 10.3389/fnhum.2014.00302

Matson, J. L., Hattier, M. A., & Belva, B. (2012). Treating adaptive living skills of persons with autism using applied behavior analysis: A review. *Research In Autism Spectrum Disorders*, *6*(1), 271-276. doi:10.1016/j.rasd.2011.05.008

Mehling, M. H., & Tassé, M. J. (2016). Severity of autism spectrum disorders: Current conceptualization, and transition to DSM-5. *Journal Of Autism And Developmental Disorders*, *46*(6), 2000-2016. doi:10.1007/s10803-016-2731-7

Mohammadzaheri, F., Koegel, L. K., Rezaee, M., & Rafiee, S. M. (2014). A randomized clinical trial comparison between pivotal response treatment (PRT) and structured applied behavior analysis (ABA) intervention for children with autism. *Journal Of Autism And Developmental Disorders*, *44*(11), 2769-2777. doi:10.1007/s10803-014-2137-3

Mumford, D. (1992). On the computational architecture of the neocortex: II The role of cortico-cortical loops. *Biological Cybernetics, 66*(3),241-251.Doi: https://doi-org.ezproxy.aub.edu.lb/10.1007/BF00198477

Neil, L., Olsson, N.C., & Pellicano, E. (2016). The relationship between intolerance of uncertainty, sensory sensitivities, and anxiety in autistic and typically developing children. *Journal of Autism and Developmental Disorders, 46*(6), 1962-1973.Retrieved from:https://link.springer.com/article/10.1007/s10803-016-2721-9

Ohan, J. L., Ellefson, S. E., & Corrigan, P. W. (2015). Brief report: The impact of changing from DSM-IV 'Asperger's' to DSM-5 'autistic spectrum disorder' diagnostic labels on stigma and treatment attitudes. *Journal Of Autism And Developmental Disorders*, *45*(10), 3384-3389. doi:10.1007/s10803-015-2485-7

Palmer, C., Lawson, R., & Hohwy, J. (2017). Bayesian approaches to autism: Towards volatility, action, and behavior. *Psychological Bulletin, 143*(5), 521-542. Doi: http://dx.doi.org/10.1037/bul0000097

Palmer, C., Paton, B., Hohwy,J., & Enticott, P.(2013). Movement under uncertainty: the effects of the rubber-hand illusion vary along the nonclinical autism spectrum. *Neuropsychologia,51*(10),1942-1951.doi: 10.1016/j.neuropsychologia.2013.06.020

Palmen, A., Didden, R., & Arts, M. (2008). Improving question asking in high-functioning adolescents with autism spectrum disorders: Effectiveness of small-group training. *Autism, 12*(1), 83-98. doi:10.1177/1362361307085265

Palmen, A., Didden, R., & Lang, R. (2012). A systematic review of behavioral intervention research on adaptive skill building in high-functioning young adults with autism spectrum disorder. *Research In Autism Spectrum Disorders*, *6*(2), 602-617. doi:10.1016/j.rasd.2011.10.001

Pellicano, E., & Burr, D. (2012). When the world becomes 'too real': A Bayesian explanation of autistic perception. *Trends in Cognitive Sciences,16*(10), 504-510. Retrieved from:

https://doi.org/10.1016/j.tics.2012.08.009.

Parsloe, S. M., & Babrow, A. S. (2016). Removal of Asperger's syndrome from the DSM V: Community response to uncertainty. *Health Communication*, *31*(4), 485-494. doi:10.1080/10410236.2014.968828

Payzan-LeNestour, E., & Bossaerts, P. (2011). Risk, unexpected uncertainty, and estimation uncertainty: Bayesian learning in unstable settings. *Plos Comput Biol, 7*(1), e1001048.doi:10.1371/journal.pcbi.1001048.

Robic, S., Sonié, S., Fonlupt, P., Henaff, M.A., Touil, N., Coricelli,G., …& Schmitz, C. (2015). Decision-making in a changing world: A study in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 45*(6), 1603–1613. Doi: https://doi.org/10.1007/s10803-014-2311-7

Rodgers, J., Hodgson, A., Shields, K., Wright, C., Honey, E., & Freeston, M.(2017). Towards a treatment for intolerance of uncertainty in young people with autism spectrum disorder: development of the coping with uncertainty in everyday situations (CUES) programme. *Journal of autism and developmental disorders, 47* (12), 3959-3966.

Raja, P., Saringat, M. Z., Mustapha, A., & Zainal, A. (2017). Prospect: A picture exchange communication system (PECS)-based instant messaging application for autism spectrum condition. Paper presented at the *IOP Conference Series: Materials Science and Engineering, , 226*(1) doi:10.1088/1757-899X/226/1/012088

Roth, M. E., Gillis, J. M., & DiGennaro Reed, F. D. (2014). A meta-analysis of behavioral interventions for adolescents and adults with autism spectrum disorders. *Journal Of Behavioral Education*, *23*(2), 258-286. doi:10.1007/s10864-013-9189-x

Sinha, P., Kjelgaard, M.M., Gandhi, T.K., Tsourides, K., Cardinaux, A.L., Pantazis, D., …&

Held, R.M.(2014). Autism as a disorder of prediction. *Proc Natl Acad Sci USA, 111*(42), 15220–15225. doi: 10.1073/pnas.1416797111.

Smith, T., & Eikeseth, S. (2011). O. Ivar Lovaas: Pioneer of applied behavior analysis and intervention for children with autism. *Journal Of Autism And Developmental Disorders*, *41*(3), 375-378. doi:10.1007/s10803-010-1162-0

Solomon, M., Frank, M., Ragland, D., Smith, A., Niendam, T., Lesh, T., …&Carter, C. (2015). Feedback-driven trial-by-trial learning in autism spectrum disorders. *Am J Psychiatry, 172*(2), 173-181. Retrieved from: http://c3po.media.mit.edu/wp-content/uploads/sites/45/2016/03/Solomon_FeedbackLearninginASD.pdf

Steege, M. W., Mace, F. C., Perry, L., & Longenecker, H. (2007). Applied behavior analysis: Beyond discrete trial teaching. *Psychology In The Schools*, *44*(1), 91-99. doi:10.1002/pits.20208

Treffert, D.(2009). The savant syndrome: An extraordinary condition. A synopsis: past, present, future. *Philos Trans R Soc Lond B Biol Sci., 364*(1522), 1351-1357.doi: 10.1098/rstb.2008.0326

Van Boxtel, J. J. A., & Lu, H. (2013). A predictive coding perspective on autism spectrum disorders. *Frontiers in Psychology, 4*, 19. http://doi.org/10.3389/fpsyg.2013.00019

Van de Cruys, S., de-Wit, L., Evers, K., Boets, B., &Wagemans, J. (2013). Weak priors versus overfitting of predictions in autism: Reply to Pellicano and Burr. *I-Perception, 4*(2). Doi:10.1068/i0580ic

Van de Cruys, S., Evers, K., Van der Hallen, R., Van Eylen, L., Boets, B., De-Wit, L., & Wagemans, J. (2014). Precise minds in uncertain worlds: predictive coding in autism. *Psychol Rev., 121*(4),649-675. doi: 10.1037/a0037665.

Wigham, S., Rodgers, J., South, M., McConachie, H., & Freeston, M. (2015). The interplay between sensory processing abnormalities, intolerance of uncertainty, anxiety and restricted and repetitive behaviours in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(4), 943-952. Doi: https://doi.org/10.1007/s10803-014-2248-x

Yu, A., & Dayan, P.(2005). Uncertainty, neuromodulation, and attention. *Neuron,46,*681-692. Doi: 10.1016/j.neuron.2005.04.026

Zuddas, A. (2013). Autism assessment tools in the transition from DSM-IV to DSM-5. *European Child & Adolescent Psychiatry*, *22*(6), 325-327. doi:10.1007/s00787-013-0424-8