Behavioral and Brain Sciences

@page { size: 21cm 29.7cm; margin: 2cm }
p { margin-bottom: 0.25cm; line-height: 115%; background: transparent }

Other and other waters in the river: Autism and the futility of prediction
--Manuscript Draft--

Manuscript Number:	
Full Title:	@page { size: 21cm 29.7cm; margin: 2cm } p { margin-bottom: 0.25cm; line-height: 115%; background: transparent } Other and other waters in the river: Autism and the futility of prediction
Short Title:	Autism and prediction
Article Type:	Open Peer Commentary
Corresponding Author:	Matthew Belmonte The Com DEALL Trust Bangalore, Karnataka INDIA
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	The Com DEALL Trust
Corresponding Author's Secondary Institution:	
First Author:	Matthew Belmonte
First Author Secondary Information:	
Order of Authors:	Matthew Belmonte
Order of Authors Secondary Information:	
Abstract:	@page { size: 21cm 29.7cm; margin: 2cm } p { margin-bottom: 0.25cm; line-height: 115%; background: transparent } Autism has been described as a neural deficit in prediction, people with autism manifest low perceptual construal are impaired at traversing psychological distances, and Gilead et al.'s hierarchy from iconic to multimodal to fully-abstract, socially-communicated representations is exactly the hierarchy of representational impairment in autism, making autism a natural behavioural and neurophysiological test case for the prediction-abstraction relationship.

Commentary on GILEAD, TROPE & LIBERMAN

Abstract: 60 words
Main text: 1039 words
References: 1096 words
Entire text: 2249 words

Other and other waters in the river: Autism and the futility of prediction
Matthew K. Belmonte
ORCID 0000-0002-4633-9400

The Com DEALL Trust
224, 6th 'A' Main Road, 2nd block, HRBR Layout
Bangalore 560043, India

Division of Psychology
Nottingham Trent University
Shakespeare Street
Nottingham NG1 4FQ, UK

+1 617 715 2049
belmonte@mit.edu
http://www.mit.edu/~belmonte/

ABSTRACT: Autism has been described as a neural deficit in prediction, people with autism manifest low perceptual construal are impaired at traversing psychological distances, and Gilead et al.'s hierarchy from iconic to multimodal to fully abstract, socially communicated representations is exactly the hierarchy of representational impairment in autism, making autism a natural behavioural and neurophysiological test case for the prediction-abstraction relationship.

Gilead et al. lament that theories of abstract cognition have been left unintegrated in part because of a lack of terms of discourse common across branches of the cognitive sciences, or even between social and biological aspects of psychology. There is indeed some irony in this all too lowly construed approach to the cognitive science of construal and abstraction, distinct threads of which have been appearing in the history of cognitive science for at least the past seven decades. Our story begins with Witkin's (Witkin & Asch, 1948; Witkin et al., 1962) notion of '*field dependence*' in perception and psychophysics, and its subsequent relation to gestalt-orientated cognition and to social affiliation and perspective-taking (Witkin & Goodenough, 1977). This same idea of a concrete-abstract representational axis cutting across perceptual and social aspects of cognition was recapitulated by Frith (1989; Frith & Happé, 1994) as '*central coherence*' in describing both autism's decontextualised detail-orientated perceptual stance and its likewise decontextualised egocentric social perspective. Around the same time the idea was introduced to social psychology by Trope (1989) first as an account of dispositional trait versus situational state explanations of others' behaviour, then extended to effects of temporal and other psychological distances on what Trope et al. had come to call perceptual '*construal*' (Trope & Liberman, 2003), the term adopted in the rest of this commentary.

The syndrome of autism, along with its dimensional extension to individual differences in autistic (or what Witkin called field-independent) traits, exemplifies this association between construal and psychological distance: Spatial, temporal, social and hypothetical distances resurface as autistic differences in mapping between allocentric and egocentric space (Frith & de Vignemont, 2005; Hamilton et al., 2009; Pearson et al., 2014; Conson et al., 2015; Ring et al., 2018), impulsivity and executive disinhibition (Hill, 2004), social perspective-taking and other aspects of cognitive empathy (Baron-Cohen, 1995), and repetitive-behavioural aversion to unpredictability and change (Gomot & Wicker, 2012). Gilead et al. relate the distinction between raw perceptual observations and elaborated cognitive models (abstracta) to the contrast between detail-orientated, first-person *simulation* and abstract, allocentric *theory* in predicting the behaviour of the world; impairment in prediction when constraints are underspecified, dynamic or real-time- as is the case in social cognition- has been identified time (Courchesne & Allen, 1997) and again (Van de Cruys et al., 2014; Sinha et al., 2014) as a unifying feature of autism which may drive the co-occurrence of anxiety and rituals, perceptual dysmodulation, visuomotor deficits, slowed orienting of attention, and undifferentiated processing of stimuli regardless of task-relevance. Because autistic predictions tend to be founded more on iconic, concrete perceptual data rather than on abstracta, they evoke many violations of expectation in instances where observations would match the broad strokes of an abstract model yet fail to match these minutiae (Van de Cruys et al., 2014). This hyper-reliance on

iconic representations produces a style of cognitive inference by *bricolage,* that is, by effortful construction and maintenance of complex representations and ideas bottom-up from the underlying details and instances (Belmonte, 2008a), which are preserved in lieu of abstracta (Belmonte, 2008b). This flattening of Gilead et al.'s hierarchy of abstracta implements a cognitive style adroit at recognising relationships amongst numerous, low-construal percepts, described by Baron-Cohen et al. (2009) as 'systemising'. Whilst it can confer superiority at detail-orientated disciplines, this systemising style imposes such a great cognitive representational load that it cannot scale. Because predictions based on inappropriately detailed cognitive models frequently evoke mismatches with observations, and such errors of accidental detail are not differentiated from errors of essence (Van de Cruys et al., 2014), the world amounts to a constant chaos of Heraclitean flow in which one's expectations are always and inexplicably wrong, sabotaging social and other domains of reward and thus impairing learning and development. It's no surprise, then, that Gilead et al.'s hierarchy of representational qualities- from concrete, iconic, modality-specific impressions, through multimodal convergences (Brandwein et al., 2013, 2015; Ostrolenk et al., 2019), to socially communicated, categorical abstractions (Smith et al., 2017; Stevenson et al., 2017; Beker et al., 2018; Feldman et al., 2018)- is exactly the hierarchy of perceptual and representational abnormality in autism.

All this evidence shows Gilead et al.'s ontology of abstraction and prediction to be consistent with historical concepts and findings, and with what we know about autism, its prime test case. But retrospection is the game of Monday-morning quarterbacks- what of prospective predictions, and experiments yet to be performed? Drawing together all these strands can relate behavioural and neural aspects of prediction and abstraction, psychological distance and construal, with corollary implications for cultural and sex differences in cognition: Gilead et al. speculatively peg the default-mode network as the home of their cognitive abstracta, although the true locus may lie rather in this network's interactions with other control networks. The default-mode network is constitutively active in autism (Kennedy et al., 2006), perhaps reflecting constant and largely fruitless attempts at predictive modelling (Raichle, 2015) of accidental detail, associated with low-construal impulsive action (Shannon et al., 2011) and anxious affect (Simpson et al., 2001ab).

The female advantage in default-mode network deactivation in reward contexts (Dumais et al., 2018) seems consistent with autism's association with male-typical cognition (Baron-Cohen et al., 2005), linking construal to cognitive sex differences. And Witkin (1979) himself noted that construal variations can be a function of culture; indeed individualistic cultures are associated with a more systemising bias (Nisbett & Masuda, 2003; Markus & Kitayama, 1991) and collectivistic cultures with higher construal (Masuda & Nisbett, 2006; Boduroglu et al., 2009). One might

predict, then, associations of individual trait construal level (a.k.a. autistic traits, field dependence), situational state construal level, sex and/or gender, and individualistic/collectivistic culture with the frequency and/or duration of dynamic coupling of default-mode with attentional and executive control networks (Ryali et al., 2016). The degree of network coupling would reflect individual and situational differences in the bias and range of model-driven feedback versus environmentally bound feedforward cognitive control of perception, action, and affect, and would be measurable with fMRI, or perhaps EEG/MEG (Kitzbichler et al., 2015). Such a study would afford an opportunity to reconstrue (as it were!) as a neurophysiological variable the diversity with which individual humans walk the tightrope between Aristotelian category and Heraclitean instance, between Lacan's (1966) *le symbole* and *la chose.*

REFERENCES

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind.* Cambridge, Massachusetts: MIT Press.

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: Hypersystemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society of London B* **364**(1522):1377–1383.

Beker, S., Foxe, J. J., & Molholm, S. (2018). Ripe for solution: Delayed development of multisensory processing in autism and its remediation. *Neuroscience and Biobehavioral Reviews* **84**:182-192.

Belmonte MK. (2008a). Does the Experimental Scientist Have a 'Theory of Mind'? *Review of General Psychology* 12(2):192-204

Belmonte MK (2008b). Human, but More So: What the Autistic Brain Tells Us about the Process of Narrative. In: *Autism and Representation* (Mark Osteen, ed.). New York: Routledge, pp 166-179.

Boduroglu, A., Shah, P., & Nisbett, R. E. (2009). Cultural differences in allocation of attention in visual information processing. *Journal of Cross-Cultural Psychology* **40**(3):349-360.

Brandwein, A. B., Foxe, J. J., Butler, J. S., Russo, N. N., Altschuler, T. S., Gomes, H., Molholm, S. (2013). The development of multisensory integration in high-functioning autism: high-density electrical mapping and psychophysical measures reveal impairments in the processing of audiovisual inputs. *Cerebral Cortex* **23**(6):1329-1341.

Brandwein, A. B., Foxe, J. J., Butler, J. S., Frey, H. P., Bates, J. C., Shulman, L. H., & Molholm, S. Neurophysiological indices of atypical auditory processing and multisensory integration are associated with symptom severity in autism. *Journal of Autism and Developmental Disorders* **45**(1):230-244.

Conson, M., Mazzarella, E., Esposito, D., Grossi, D., Marino, N., Massagli, A., Frolli, A. (2015). "Put Myself Into Your Place": Embodied Simulation and Perspective Taking in Autism Spectrum Disorders. *Autism Research* **8**(4):454-466.

Courchesne, E., & Allen, G. (1997). Prediction and preparation, fundamental functions of the cerebellum. *Learning and Memory* **4**:1-35.

Dumais, K. M., Chernyak, S., Nickerson, L. D., & Janes, A. C. (2018). Sex differences in default mode and dorsal attention network engagement. *PLoS ONE* **13**(6):e0199049.

Feldman, J. I., Dunham, K., Cassidy, M., Wallace, M. T., Liu, Y., & Woynaroski, T. G. (2018). Audiovisual multisensory integration in individuals with autism spectrum disorder: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews* **95**:220-234.

Frith, U. (1989). *Autism: Explaining the enigma.* Oxford: Blackwell.

Frith, U., & Happé, F. (1994). Autism: Beyond "theory of mind". *Cognition* **50**(1-3):115-132.

Frith, U., & de Vignemont, F. (2005). Egocentrism, allocentrism, and Asperger syndrome. *Consciousness and Cognition* **14**(4):719-738.

Gomot, M., & Wicker, B. (2012). A challenging, unpredictable world for people with Autism Spectrum Disorder. *International Journal of Psychophysiology* **83**(2):240-247.

Hamilton, A. F., Brindley, R., & Frith, U. (2009). Visual perspective taking impairment in children with autistic spectrum disorder. *Cognition* **113**(1):37-44.

Kennedy, D. P., Redcay, E., & Courchesne, E. (2006). Failing to deactivate: Resting functional abnormalities in autism. *Proceedings of the National Academy of Sciences of the United States of America* **103**(21):8275-8280.

Kitzbichler, M. G., Khan, S., Ganesan, S., Vangel, M. G., Herbert, M. R., Hämäläinen, M. S., & Kenet, T. (2015). Altered development and multifaceted band-specific abnormalities of resting state networks in autism. *Biological Psychiatry* **77**(9):794-804.

Lacan, J. (1966). Fonction et champ de la parole et du langage en psychanalyse. *Écrits*, pp 237-322. Paris: Éditions du Seuil.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion and motivation. *Psychological Review* **98**(2):224-253.

Masuda, T., & Nisbett, R. E. (2006). Culture and change blindness. *Cognitive Science* **30**(2):381-399.

Nisbett, R. E., & Masuda, T. (2003). Culture and point of view. *Proceedings of the National Academy of Sciences of the United States of America* **100**(19):11163-11170.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences* **8**(1):26-32.

Ostrolenk, A., Bao, V. A., Mottron, L., Collignon, O., & Bertone, A. (2019). Reduced multisensory facilitation in adolescents and adults on the autism spectrum. *Scientific Reports* **9**(1):11965.

Pearson, A., Marsh, L., Hamilton, A. F., Ropar, D. Spatial transformations of bodies and objects in adults with autism spectrum disorder (2014). *Journal of Autism and Developmental Disorders* **44**(9):2277-2289.

Raichle, M E. (2015). The brain's default mode network. *Annual Review of Neuroscience* **38**:433-447.

Ring, M., Gaigg, S. B., Altgassen, M., Barr, P., & Bowler, D. M. (2018). Allocentric versus egocentric spatial memory in adults with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders* **48**(6):2101-2111.

Ryali, S., Supekar, K., Chen, T., Kochalka, J., Cai, W., Nicholas, J., Padmanabhan, A., & Menon, V. (2016). *PLoS Computational Biology* **12**(12):e1005138.

Shannon, B. J., Raichle, M. E., Snyder, A. Z., Fair, D. A., Mills, K. L., Zhang, D., Bache, K., Calhoun, V. D., Nigg, J. T., Nagel, B. J., Stevens, A. A., & Kiehl, K. A. (2011). Premotor functional connectivity predicts impulsivity in juvenile offenders. *Proceedings of the National Academy of Sciences of the United States of America* **108**(27):11241–11245.

Simpson, J. R. Jr., Drevets, W. C., Snyder, A. Z., Gusnard, D. A., Raichle, M. E. (2001a). Emotion-induced changes in human medial prefrontal cortex: II. During anticipatory anxiety. *Proceedings of the National Academy of Sciences of the United States of America* **98**:688-693.

Simpson, J. R. Jr., Snyder, A. Z., Gusnard, D. A., Raichle, M. E. (2001b). Emotion-induced changes in human medial prefrontal cortex: I. During cognitive task performance. *Proceedings of the National Academy of Sciences of the United States of America* **98**:683-687.

Sinha, P., Kjelgaard, M. M., Gandhi, T. K., Tsourides, K., Cardinaux, A. L., Pantazis, D., Diamond, S. P., & Held, R. M. (2014). Autism as a disorder of prediction. *Proceedings of the National Academy of Sciences of the United States of America* **111**(42):15220-15225.

Smith, E., Zhang, S., & Bennetto, L. (2017). Temporal synchrony and audiovisual integration of speech and object stimuli in autism. *Research in Autism Spectrum Disorders* **39**:11-19.

Stevenson, R.A., Baum, S.H., Segers, M., Ferber, S., Barense, M.D., & Wallace, M.T. (2017). Multisensory speech perception in autism spectrum disorder: From phoneme to whole-word perception. *Autism Research* **10**(7):1280-1290.

Trope, Y. (1989). Levels of inference in dispositional judgement. *Social Cognition* **7**(3):296-314.

Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological Review* **110**(3):403-421.

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. *Psychological Review* **121**(4):649-675.

Witkin, H. A. (1979). Socialization, culture and ecology in the development of group and sex differences in cognitive style. *Human Development* **22**:358-372.

Witkin, H. A., & Asch, S. E. (1948). Studies in space orientation; perception of the upright in the absence of a visual field. *Journal of Experimental Psychology* **38**(5):603-614.

Witkin, H. A., Dyk, R. B., Fattuson, H. F., Goodenough, D. R., & Karp, S. A. (1962). *Psychological differentiation: Studies of development.* Oxford: Wiley.

Witkin, H.A., & Goodenough, D. R. (1977). Field dependence and interpersonal behavior. *Psychological Bulletin* **84**(4):661-689.