Perception of human actions on the four fundamental dimensions of formidableness, friendliness, intentionality and abduction

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Introduction

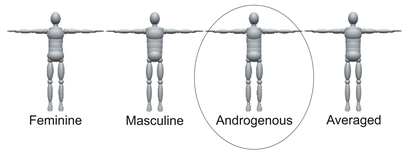
The mental representation of our external world is organised into different internal workspaces or 'conceptual spaces' (Allen, 1984; Gardenfors, 2004a). These spaces capture the similarity and differences between items of a domain, enabling classification, naming and behavioural responses. Items within a domain that are perceived to be similar, are located close within the conceptual space, while dissimilar items are located further apart. The patterns of similarity among items of a domain determine the dimensions and structure of the conceptual space (Gardenfors, 2004b), and thus the meaningful information about which we make decisions about the items within the domain.

Human actions are arguably one of the most important signals. Our ability to recognize and interpret actions allows us to respond to a wide range of human behaviours and interact successfully with other individuals. However, the organisation of our mental representation of human actions (*action space*) is poorly understood. To address this we:

1. **Determined the fundamental dimensions underlying action space**
2. **Identified the locations of 240 different actions in action space**
3. **Developed a method of action morphing to generate novel actions at precise locations in action space**
4. **Generated novel actions that varied precisely along the principle dimensions of action space**
5. **Measured perceptual discrimination performance along dimensions**

Study 1

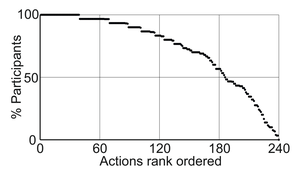
First: generate androgynous avatar that isolates action information (posture, kinematics) from other confounding information (face, body shape, clothes, context etc.). Avatar form based upon independent observer ratings.



Second: motion capture 240 different actions performed by 4 actors, data used to animate avatar. Catching action example below:

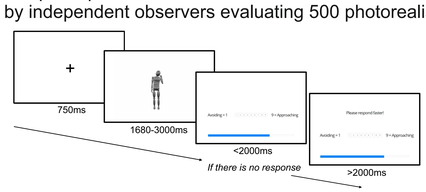
Third: 30 observers asked to identify the 240 actions.

Proportion participants recognising each action



Word clouds of example actions high/medium/low recognisability

Fourth: 230 participants rated all action on 23 different characteristics (chosen by independent observers evaluating 500 photorealistic actions).



Fifth: Exploratory Factor Analysis (EFA) used to identify factors underlying action perception. Confirmatory Factor Analysis (CFA) was used to test competeing models of action space.

Results

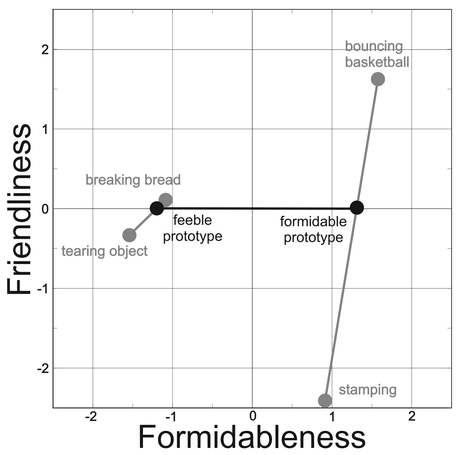
Four factor model best fit to the data:

Formidableness (22% variance)	Powerful Dominant Fluent High-speed Confident Communicating Raising
Friendliness (22% variance)	Happy Approving Desiring Trustworthy Approaching
Intentionality (7.2% variance)	Intentional Controlled
Abduction (8.6% variance)	Pushing Expelling Releasing

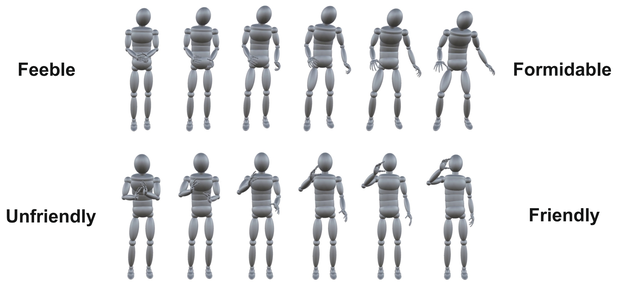
Factor loadings determines each action's location in 4D space
Fastest characteristic ratings load onto Friendliness factor
Slowest characteristic ratings load onto Intentionality factor

Study 2

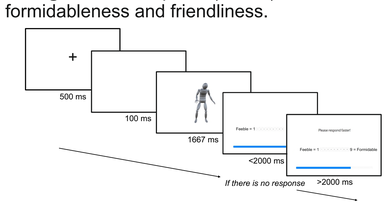
First: generated method of morphing between up to 16 different actions located within the 4-Dimensional action space by calculating the weighted average of local joint angles (Ferstl et al. 2017; de la Rosa et al. 2016). The initial aim was to generate prototype actions that were high or low on one dimension, but zero on the other dimensions. However, the distribution of our 240 actions across 4D action space is uneven. Therefore, we isolated and controlled only the two most important dimensions (friendliness & formidableness). Finally, generate novel actions varying in 100 steps between both prototypes. Method to generate formidable actions illustrated below:



Feeble-formidable continuum (upper actions) and unfriendly-friendly continuum (lower actions) illustrated in 20% steps from 0% to 100% below:



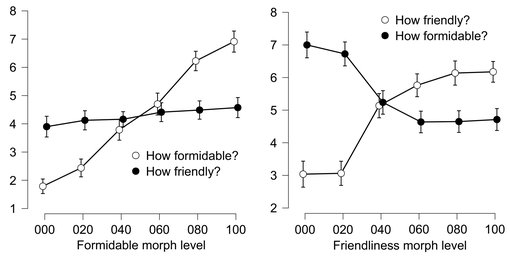
Experiment 1: rating task. Participants (n = 80) rated both sets of actions on 1-9 Likert scale on formidableness and friendliness.



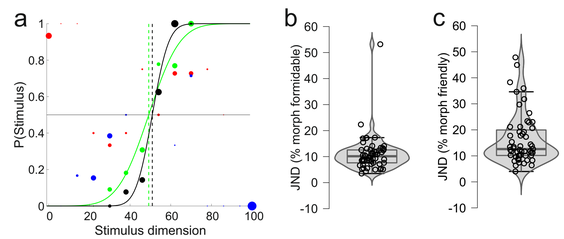
Experiment 2: discrimination task. Participants (n = 55) took part ins a 2-AFC adaptive procedure discriminating formidable continua on formidableness and friendliness, and discriminating friendly continua on formidableness and friendliness, in 4 separate blocks of testing. On each trial, one action was the *standard* (e.g. 50% formidable) and other action the *comparison*. Comparison action morph was determined by 4 interleaved staircases, each with different reversal rules. To eliminate order and learning effects task each task was repeated until performance plateaued. JNDs were calculated by fitting cumulative Gaussian functions to the data. Autism Quotent (AQ) determined to explore effect of autistic traits on perceptual discrimination performance.

Results

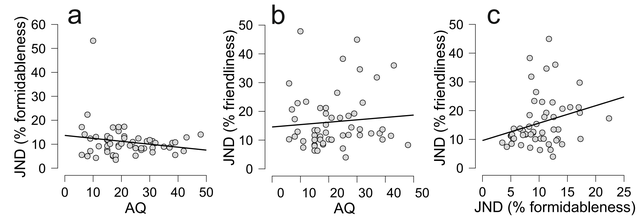
Experiment 1: rating task. Morphed action stimuli vary along the intended dimension (see Figure below), and little on the unintended dimension.



Experiment 2: Discrimination task. Participants can only discriminate actions along the intended dimensions. a) functions fitted to data from one example individual. Data colours are: **Friendly actions discriminated on friendliness, Formidable actions discriminated on formidableness,** (for **Formidable actions discriminated on friendliness, Friendly actions discriminated on formidableness** - functions could not be fitted as the task was too hard). b) Distribution of JNDs **Formidable actions discriminated on formidableness**. 540% interindividual variance. c) Distribution of JNDs **Friendly actions discriminated on friendliness**. 1100% interindividual variance.



Influence of AQ. a) Anecdotal evidence that AQ doesn't predict formidableness discrimination (BF10 = .58, R^2 = .033). b) Moderate evidence that AQ doesn't predict friendliness discrimination (BF10 = .32, R^2 = .008). c) Extreme evidence that formidableness discrimination performance predicts friendliness discrimination performance (BF10 = 220, R^2 = .25).



Discussion

- Actions are represented within a 4D action space, with the principle dimensions of: formidableness, friendliness, intentionality, abduction
- Each of our 240 actions is located within 4D space with coordinates based upon their loadings onto each dimension, they are available at: **https://osf.io/4vew8/**
- Morphing between joint angles allows the generation of novel actions with precise coordinates, or vary along dimensions of 4D action space
- Improved distribution of actions would allow control of all 4 action dimensions
- There is considerable interindividual variation in the ability to discriminate fundamental action qualities, but this is not explained by variance in individual autistic traits.

References:

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