AS Tracking Assessment

An ecological assessment to measure and track Steering Cognition

Introduction

The AS Tracking assessment is an online self- assessment which measures and tracks a component of affective-social self-regulation called Steering Cognition. Pupils between the ages of eight and eighteen complete the assessment twice within an academic year. From their data, schools those pupils who are developing limiting thinking and behavioural biases, enabling them to be proactive, targeted and evidence based in their pastoral care.

The AS Tracking assessment was developed to overcome the limitations of traditional self-report assessments. Traditional self-reports require pupils to report on their response to different questions often using a Likert scale. For example, one question might be '*I share my ideas with others'*, to which a pupil might select - *always, sometimes, rarely or never*. This data is limited in two ways. Firstly, it measures pupils' *perception* of their self-regulation which may not correlate with their *actual* self-regulation. Secondly, it can only measure what pupils disclose, rather than what may remain hidden and undisclosed. Such self-reports will not necessarily make visible those pupils with hidden or unconscious biases in their thinking. The AS Tracking assessment measures pupils' actual self-regulation by exploiting the role of the imagination in the function of self-regulation.

The role of the imagination in decision making, planning and self-organisation

Wide research, using fMRI techniques, has identified and confirmed the role that the imagination plays in mental tasks associated with goal setting, self-representation and self-organisation. From neuroimaging studies in rats and humans, Buckner suggested that the interaction of sub-regions within the hippocampus *'could provide the neural building blocks for simulating upcoming events during decision-making, planning, and when imagining novel scenarios'* (Buckner 2010). Schacter and Addis argue from abundant studies that the hippocampus is involved in both episodic memory retrieval but also prospective, future memory (Schacter, Daniel L., Addis, Donna Rose and Buckner, Randy L. 2007; Schacter 2012; Schacter et al. 2012; Addis, Schacter 2012). They assert that complex sub-regions within the hippocampus play various roles in the mental simulation of possible events and actions. Metastudies have also implicated a wider set of neural bases involved in functions relating to the prospective function of memory (Spreng et al. 2009), the simulation of self and other mental states (Decety, Sommerville 2003; Decety, Grèzes 2006) including Tempero Parietal Junction (TPJ), Precuneus (PC) and medial Pre Frontal Cortex (mPFC) (van Overwalle, Baetens 2009).

Gaesser provides evidence that the regions of the brain that structure memory and imagination are involved in the construction of our affective, empathic responses to our environment (Gaesser 2012). Neuroimaging studies have evidenced that remote memory retrieval is also associated with the hippocampus (Ryan et al. 2010) and involves data of different kinds- spatial, visual, somatic, auditory, emotional. However, the imagination is not limited to concrete, sensorial data manipulation but is involved in early-stage concept formation, as well as novel abstraction and concept-association (Leszczynski 2011; Halford et al. 2007; Colgin 2015).

The imagination may provide the de-coupled mental environment in which experimental actions, choices and thoughts are simulated, played out, selected or inhibited. Decoupled simulation may be a critical process of heuristic imagination by which data of unfamiliar structure is mentally manipulated. Like a three-dimension jigsaw piece might be manipulated and turned round in order to find the right orientation to fit it into the model, decoupled simulations within the imagination may play a role in the fitting of alien data into existing mental frames of reference. A model of *cognitive decoupling* has

been proposed by several authors as a central mechanism by which the mind simulates possible scenarios in order to come to judgements (Evans, J. S. B. T., Stanovich 2013; Evans, Jonathan St B T, Frankish 2009).

The role of imagination within executive function and metacognition

An increasing number of studies have identified the link between decision-making and action with imagination. Decety et al. evidence that the imagination plays a central role in organising our behaviours (Decety, Grèzes 2006; Garry, Polaschek 2000). Schacter et al. evidence that the brain projects forward a method of self-operation prior to then enacting that projected sequence (Schacter, Daniel L., Addis, Donna Rose and Buckner, Randy L. 2007), serving as a guide or route map directing action (Schacter 2012; Stein 1994). In this regard, prospective memory may play an important role in imagining future selves (Decety, Grèzes 2006; Schacter 2012).

> "*A rapidly growing number of recent studies show that imagining the future depends on much of the same neural machinery that is needed for remembering the past. These findings have led to the concept of the prospective brain; an idea that a crucial function of the brain is to use stored information to imagine, simulate and predict possible future events*" (Schacter et al. 2007)

The imagination integrates with other circuits in the executive function system, which provide a mechanism for self-regulation, effortful control, attentional bias, self-other thinking and metacognition. In his series of experiments with secondary school students, Walker (2014 g.) provides evidence that the ability to regulate *imagined* social, emotional and cognitive responses toward different, varied and flexible learning environments accounted for 15% of academic outcomes not explained by CAT score. The imagination was shown to contribute to planning, sequencing, perspective-taking and learner-responsiveness (Walker 2014 g). Such metacognitive ability is conceptualised as a central component of executive function (Halloran 2011; Miyake et al. 2000; Fernandez-Duque et al. 2000). Whilst there are many models of executive function (Elliott 2003; Banich 2009) Miyake and Friedman's (Miyake et al. 2000) influential theory proposes that updating, inhibition, and shifting are central tasks of executive function, each of which relates to the capacity to adapt one's cognition to the task in hand. Updating is defined as the continuous monitoring and quick addition or deletion of contents within one's working memory. Inhibition is one's capacity to supersede responses that are prepotent in a given situation. Shifting is one's cognitive flexibility to switch between different tasks or mental states. This suggests that mental states required for mental activities may exists in a state of neural inertia or require a costly switch to be thrown to be activated (Derakshan 2010; Mayr, Keele 2001; Monsell 2003).

Steering Cognition: unifying imagination, executive function and self-regulation

Walker proposes a model of this executive prospective and retrospective imagination function which he calls 'Steering Cognition' (Walker 2015f). Walker conjectures that Steering Cognition is a central mechanism by which a person self-regulates their cognitive, emotional and social attention and responses. Steering Cognition describes how the brain biases attention toward specific stimuli whilst ignoring others, before coordinating responsive actions which cohere with our past patterns of self-representation. As such, Steering cognition requires the capacity to self-represent, associating memories of our past and possible future selves. Steering Cognition has been shown to be a distinct process from the 'engine' of our mind, sometimes referred to as 'algorithmic processing', which is responsible for how we process complex calculations (Walker 2015f; Stanovich, West 2008; Stanovich et al. 2011; Stanovich 2011). The analogy of the car has been used to explain Steering Cognition: Steering Cognition regulates the mind's direction, brakes and gears as it navigates across the epistemological landscape.

The mind's mental taxi driver

Regulating our Steering Cognition involves conscious effort. Much like driving off-road, we particularly need to regulate our Steering Cognition when we are facing unpredictable and varied situations and stimuli. Walker conjectures that steering cognition is susceptible to cognitive miserliness and may, therefore, behave like a mental taxi driver. Cognitive miserliness, first evidenced in 1981 by Fisk and Schneider, describes how the brain chooses the lowest cost route to a solution rather than choosing a more effortful, higher cost route which may be more accurate (Fisk, Schneider 1984). Cognitive miserliness in the self-regulation of our Steering Cognition can result in the emergence of cognitive, affective (emotional) and social biases. By establishing habituated, or automatic biases of attention, Steering Cognition can preserve limited cognitive resources in the same way that a taxi driver will take the shortest, most familiar route from A to B. This can reduce cognitive load, but result in the iteration and habituation of cognitive, affective, social Steering Cognition biases. Steering Cognition is conjectured to describe organised patterns of cognitive biases rather than moods and fleeting affective states which may be governed by sub-cortical and limbic circuits (LeDoux 2000).

The model of Steering Cognition, therefore, predicts two kinds of Steering Cognition judgement risks: First, instances where individuals habituate biased, fixed, effortless and fast patterns of Steering Cognition. These may contribute to the fast and errorful thinking observed by Kahneman inter al in their 'biases and heuristics programme' (Kahneman, Tversky 1973; Kahneman et al. 1982; Kahneman 2011).

Second, instances where individuals expend excessive effort over-regulating their Steering Cognition rather than ever habituating, unconscious Steering patterns. This can result in hyper-vigilance, social and self-monitoring. Like a car which is unable to ever go into 'autopilot mode' such a load is predicted to place strain upon the individual's self-regulatory resources, resulting in an increased risk of depletion and loss of control (Baumeister et al. 1998).

The AS Tracking assessment data model and assessment of Steering Cognition

Between 2002-2015, Walker conducted a Steering Cognition test with more than 11,000 candidates between the ages of 8 and 60. Using Principle Component Analysis, Walker was able to identify 7 latent largely independent Steering Cognition factors (Walker 2007, 2009, 2014c, 2014c) from the results. In the most recent and largest ever study, involving 8,000 secondary pupils in the UK, exploratory factor analysis confirmed a largely orthogonal factor structure. In 2015, Walker J. described four of the factors in great detail elucidating the relationships of the factors to affective-social self-regulation literature. For a thorough explanation of these factors see (Walker 2015b, 2015a, 2015d, 2015c). AS Tracking utilises Walker and Walker's four factor model to measure *four discreet tasks* a pupil's self-regulation must perform.

The fours tasks are:

1. *Self- disclosure: the degree to which a pupil chooses to share or hold back their thoughts, feelings, ideas and opinions*
2. *Trust of self: the degree to which a pupil trusts or questions their own qualities, skills, ideas and opinions*
3. *Trust of others: the degree to which a pupil trusts or questions others' qualities, skills, ideas and opinions*
4. *Seeking change: the degree to which a pupil seeks to bring about or reduce change, novelty and risk.*

How pupils complete the AS Tracking assessment

Including the time required to introduce, prepare and initiate the test, the AS Tracking assessment takes pupils between fifteen and thirty minutes depending on the age of pupils. It is deployed through a secure on line interactive assessment platform. Pupils hear an age appropriate introduction to the assessment before they begin the assessment. The first part

of the assessment is a led visualisation in which pupils imagine and then occupy a physical place in their mind. The assessment introduces this imagined place as their own 'space' which is seen as distinct from what is around it. The characteristics of the this place are primed through the use of clean language cues (Grove, Panzer ©1989). Its scale, dimensions, features, occupants and activities are determined by the pupil. Pupils do not write down, represent or share their imagined space at any point in the assessment process. In assessment development, the same set of verbal priming cues were used with 15,000 candidates between 2002-2015 with only minor, modifications to language and number of cues.

AS Tracking measures the ability of the pupil to adjust their self-regulation of the fours factors of Steering Cognition between two discreet environments: instinctive and at school. Pupils are led through the first of two parallel imagination exercises which measure two comparative sets of Steering Cognition data.

Instinctive assessment

The first exercise measures how pupils instinctively regulate their Steering Cognition in response to imagined priming stimuli taking place within their imagined space. Pupils respond to four clusters of priming stimuli, each cluster measures their self-regulation of one of the factors above. The priming clusters are:

1. How a pupil defines their space (measures trust of self)
   Example item cue: *Would a visitor looking at your Space know this Space belongs to you*
   Response options: *Definitely; yes; maybe; not really; no; definitely not*
2. How a pupil responds to others in their space (measures trust of others)
3. How a pupils manages change in their space (measures seeking change)
4. How much a pupil discloses of their space (measures self-disclosure).

Pupils select their response form a Likert scale. Selecting a response triggers the next stimuli to appear, enabling the pupil to direct the speed of the assessment. The speed, direction and variance of each response is measured. No part of the tasks requires computational, abstract or procedural calculation. Using this method, the assessment ensures that responses are a measure of the candidate's associative processing, without the interference or contribution of algorithmic processing.

Pupils' item responses are computed to give a score from 0-15 for each of the four factor clusters, indicating the degree of bias a pupil has in each factor. This instinctive score is a measure of a pupil's habitual bias in each of the fours factors at this stage of their development. Walker and Walker conjecture that a pupil's instinctive bias represents an unconscious 'baseline' or resting state of Steering Cognition bias to which the individual would revert unless primed to respond to a distinct, specific, contextual cue (Figure 1).

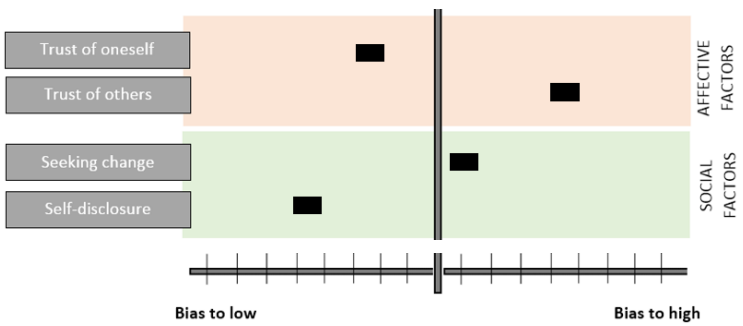


Figure 1. Pupils' instinctive, bias score set against each factor represented a conjectured neutral, resting bias to which the candidate would revert unless responding to a specific, contextual priming cue.

Walker and Walker conjecture that by inserting a contextual priming cue into the imagination exercise, followed by a repeat of the same priming stimuli, any measured deflection from the baseline scores could be attributed solely to the effect of the contextual priming cue. This pattern of deflection can be reliably compared to any wider population similarly primed (Walker 2015e; Walker 2014 g.; Walker 2015e).

Contextual Assessment

The contextual assessment measures how pupils regulate their Steering Cognition within a particular context e.g. school or a boarding house. Research evidences that whilst a pupil's steering cognition exhibits stability, it can be environmentally influenced by the surrounding environment, context or specific task (Walker 2015f, 2014 h.). Pupils respond to the same four clusters of priming cues which have a contextual edit inserted. E.g. *would your boarding house/school know this Space belongs to you? With responses: definitely; yes; maybe; not really; no; definitely not.* A comparison of a pupil's instinctive and contextual data evidences the impact of the priming cue on the pupil's steering cognition. See Figure 2.

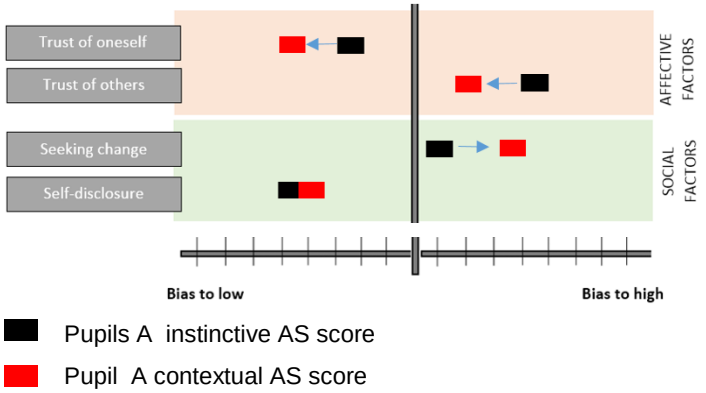


Figure 2. An example of deflection from instinctive to contextual data

Analysis of route

As well as measuring a pupil's responses to contextual priming stimuli, the assessment also measures pupils' speed and variance of response. This produces a route map showing the pattern and speed of a pupil's steering cognition.

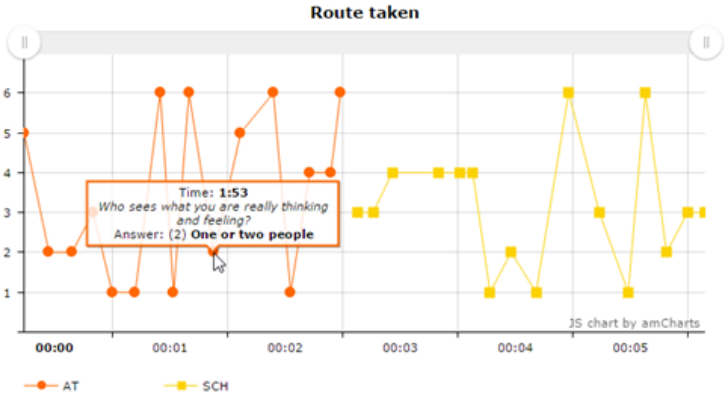


Figure 3. A chart showing a pupil's two Steering Cognition routes: the orange route shows a pupil's pattern of *instinctive* Steering Cognition; the yellow shows their Steering Cognition route *in school*.

Statistical evidence supporting AS Tracking as a tracking measure of pupil self-regulation

Norms

Norms refer to population distribution means and descriptions for a specific age, gender or other category (e.g. ethnicity) of pupil. AS Tracking norms have been obtained for gender and age in UK school pupils across ethnicity. International and ethnic norms have not been yet formally established. Norms can be obtained within the AS Tracking instrument by referring to the age-specific mean male and female icons which appear on the AS Tracking trend charts.

Norms are shown in the Appendix.

Validity of the AS Tracking assessment

Full methods and results of studies are shown in the Appendix.

Predictive Validity

Predictive validity refers to the degree to which the assessment constructs measure what they actually claim to measure. A valid test measures a psychological property which is real. Validity is demonstrated in variety of ways, the most powerful of which is to demonstrate an ability for the measured property to correlate with or even predict an independent variable which is already known; this is known as predictive validity. In a study of 2518 pupils in 16 secondary schools in the UK in 2015 poor pupil AS Tracking patterns were correlated with independently identified pupil mental health and welfare risks, in order to demonstrate such predictive validity.

Pupils were asked to respond anonymously to three written questions asking if they suffered from self-harm, had experienced being bullied over the past year or were not coping with pressure at school. Pupil's responded to a five-point Likert scale (not at all- not- not really- a bit-yes). Because these responses were provided with the assurance of anonymity to the school, we regarded responses as a reasonable indicator of actual pupil risks of these three mental health and welfare concerns. Using a sophisticated machine learning data analysis technique, described fully in the appendix, pupil risks of mental health and welfare concerns were then matched to the timings and patterns of their AS Tracking scores previously measured within the assessment procedure. The aim was to identify whether certain patterns of AS Tracking correlated with increased mental health risks.

Bullied

The AS Tracking pattern model achieved an 80% accuracy (83/78% both classes) in predicting children who were experiencing bullying. Experiencing bullying was associated with a significantly higher level of overall AS dysregulation and specifically with low self-disclosure.

Pressure

The AS Tracking pattern model achieved a 83% (88/77% both classes) accuracy in predicting children who were not coping with pressure at school. Coping with pressure was statistically associated with overall AS dysregulation as well as, specifically, with self-disclosure and embracing change.

Self-harm

The AS Tracking pattern model achieved a 80% (82/78% both classes) accuracy in predicting children who were considering self-harming. Self-harm was associated significantly with overall AS dysregulation as well as with self-disclosure and embracing change.

One way to understand this result is that, in a population of 100 pupils, AS Tracking would correctly predict the incidences of self-harm, pressure and bullying in around 80 out of the 100 of the pupils. Statistically, there is a 1:2[3] , or

1:8 chance of correctly predicting incidences of bullying, self-harm and pressure and by chance; a correct prediction in around 12 out of the 100 pupils. The result provides evidence of predictive construct validity: AS Tracking exhibited power 6 times greater than statistical chance in correctly predicting the incidence of pupils not coping with pressure, at risk of self-harming or being bullied.

Construct validity

Construct validity refers to the degree to which the internal constructs of a test relate to each other as one would expect if they were discreet and real properties of the mind. For example, in the machine learning study, one would expect there to be a high correlation between AS Tracking patterns associated with self-harm, and those associated with being bullied and not coping with pressure.

To test this pupil AS Tracking patterns for pressure, self-harm and being bullied were internally compared to obtain measures of construct correlation. Linear regression and Spearman rank correlation analysis was performed to compare pupil AS Tracking pattern risks as identified by the machine learning technique. Schools 7, 9 and 13 were removed from the analysis because of sample size for the generation of AS Tracking patterns (less than 40 pupils/ school was regarded as statistically unreliable). Correlation results are shown in Figure 4.

	Pressure	Self Harm	Bullied
Pressure	1		
Self- harm	0.698979	1	
Bullied	0.714621	0.949087	1

Figure 4

A strong inter-correlation was found between each of the three AS Tracking 'risk' patterns which linked to pressure, self-harm and being bullied. This supports the internal construct validity of the measure: external variables that one would expect to be co-related within the internal measures of the scale are related.

Consistency with other studies

A measure's validity can also be evidenced by demonstrating results which are consistent with other, external research. A growing body of research has identified a link between academic aspiration, high performance ad mental health risks amongst teenagers. According to West and Sweeting, levels of mental health issues directly related to pressures and anxieties around academic school performance had risen dramatically in just 2 years amongst girls from 19% to 33% (Sweeting et al. 2012). US research on teenage depression indicated that 38% of 15yr old girls from the most affluent social classes were suffering with depression or anxiety compared with 27% from the lowest socio-economic class (West, Sweeting 2003). Several UK studies have shown the same correlations (Luthar, Becker 2002); the more affluent a pupil, the more driven they are to achieve both academically and through extra-curricular activities causing performance related mental health issues (Luthar, Latendresse 2005). This US figure was mirrored by the experience of *ChildLine,* a UK charity supporting children, in which 58% of calls made were by teenagers citing exam pressure, an increase of 200% from 2013-2014 (NSPCC).

One would expect that AS Tracking patterns associated with risks of self-harm and not coping with pressure, would, therefore, correlate with the academic aspirations and performance of the students.

To test this, school academic rank was obtained from publicly available 2012 A Level results. This was used as a measure of the academic aspirations attributable to the population of students in those schools. Pupil AS Tracking patterns of pupils across this population were then compared with school rank was performed by gender and overall.

Linear regression and Spearman rank correlation analysis was performed to compare school rank and pupil AS Tracking pattern risks as identified by the machine learning technique. Schools 7 and 9 were removed from the analysis because of sample size for the generation of AS Tracking patterns (less than 40 pupils/ school was regarded as statistically unreliable). Correlation results are shown in Figure 5.

	RANK
RANK	1
Pressure	0.7652
Self- harm	0.5889
Bullied	0.4691

Figure 5.

A strong correlation between school rank and AS Tracking risk patterns associated with *not coping with pressure* (0.76) and *self-harm* (-0.59) was observed. A moderate association between rank and AS Tracking patterns associated with bullying (0.47) was also found. Pupils at higher performing schools exhibit patterns of AS Tracking which are associated with poor-self regulation, increasing the risks that the pupils will struggle to cope with the pressure, and may have risks of self-harming.

Regression analysis indicated that the result for Pressure was statistically significant, [F (1,12) = 16.951, P= 0.001), indicating that there is probably a relationship between AS Tracking patterns associated with not coping with pressure and school rank. The result for Self-Harm was also statistically significant [F (1,12) = 16.951, P= 0.026), indicating that there is probably a relationship between AS Tracking patterns associated with self-harm and school rank. The result for Bullying was not significant (P>0.05), and the moderate correlation would need to be further tested with a larger sample size to confirm if it is statistically probable to represent a relationship with school rank. The relationship between school rank and pressure is shown in Figure 6.

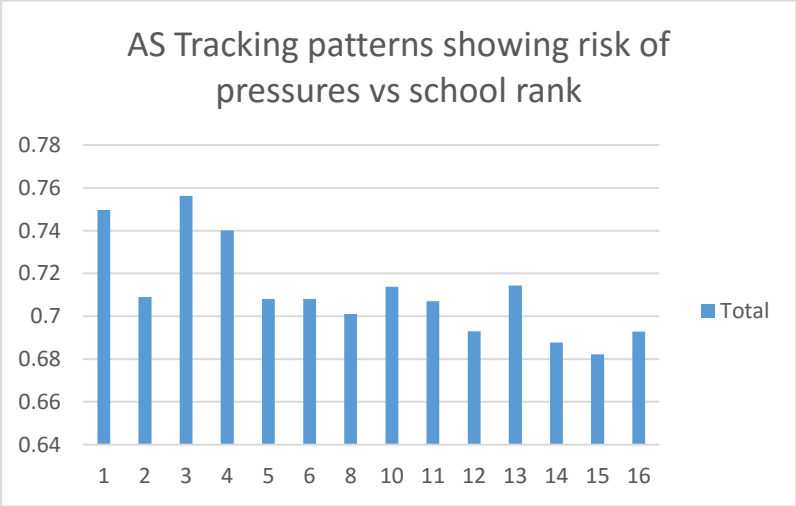


Figure 6. Showing school rank on the X axis and the AS Tracking pattern mean risk of not coping with pressure

The result of this study provides evidence that the two specific AS Tracking patterns associated with *not coping with pressure,* and with *self-harming*, are linked to high performing schools. This result correlates with wider research evidencing the link between school performance, aspiration and mental health risks. AS Tracking exhibits explanatory and convergent construct validity. Poor self-regulation of AS Tracking is a factor explaining the lower pupil welfare and mental health found by other researchers to be associated with high performers.

This study can be read in full (Walker, J and Walker, S. 2015).

Reliability of the AS Tracking Assessment

See Appendix for further notes

Reliability is a measure of the consistency of an assessment within its self, and over repeated use. AS Tracking is designed to measure a psychological construct expected to be both ecologically and chronological sensitive. One of the most relevant research questions in the development of the AS Tracking was the stability vs plasticity of Steering Cognition scores over time. The assessment is used not as a single profile, but as a repeated tracking measure twice/year, over repeated years, to construct an emergent narrative of a pupils' development.

It was hypothesised that over a short time period of two weeks, Steering Cognition patterns would exhibit stability. Little change would be expected across a population because Steering Cognition describes organised patterns of cognitive biases rather than moods or more fleeting mental states. The reliability of AS Tracking was measured by establishing the stability of scores obtained between two tests two weeks apart in a population of 170 secondary school boys and girls between the ages of 12 and 18.

Pearson product-moment correlation coefficient, r, was used to calculate the relationship between first and second sets of test scores.

The **overall** scale instinctive score (both boy and girl combined) for test1: test 2 produced **r = 0.71**
The **boys** scale instinctive score (both boy and girl combined) for test1: test 2 produced **r = 0.68**
The **girls** scale instinctive score (both boy and girl combined) for test1: test 2 produced **r = 0.74**

The overall instinctive scale test: re-test for both genders is r = 0.71. This means that there is a strong degree of correlation between the first set of test scores and the second set of test scores. A score of 0.7 or above is considered by The British Psychological Society to be an acceptable measure of a psychological construct's stability over short term test-retest measurement. This evidence supports the hypothesis that Steering Cognition is a stable, organised pattern of thinking which exhibits ecologically triggered changes and slower emergent evolution over longer periods of time.

The stability of r across age bands between 12-18 provides additional support for this conclusion. Analysis of test: re-test for the different age groups was carried out at an overall scale level:

Age 12-13	**0.70**
Age 14-15	**0.71**
Age 16-17	**0.72**

Conclusion

AS Tracking is a tool designed to provide additional data to inform a school's judgement about the social and emotional pastoral needs of their pupils. It sits alongside other tools that school's may use to obtain related pupil data: specifically firstly, pupil surveys, conversations and other tools; secondly, teachers' own professional judgement; thirdly, parental feedback. AS Tracking provides a fourth piece of the jigsaw to add and not replace these three vital pieces (Figure 7). This paper has described how the cognitive function measured by AS Tracking, Steering Cognition, sits within a wider academic literature of self-regulation, metacognition, executive function and cognitive biases. As such, it provides an explicit basis to interpret data derived from AS Tracking assessments within existing models already in use within schools.

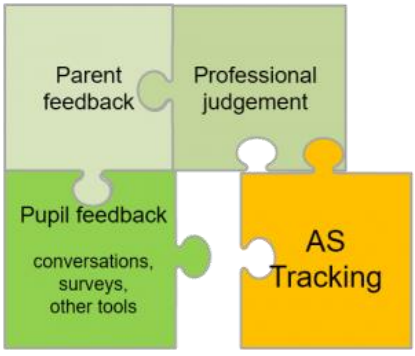


Figure 7

This paper has demonstrated that AS Tracking data exhibits validity in its formal constructs, internal structure and coherence, prediction of independent mental health variables and support of existing research findings in the field. AS Tracking data has also exhibited, through test-retest study, short term stability, sufficient for to meet the criteria of professional bodies, for psychometric reliability.

These evidences support the proposal that AS Tracking, as a measure of Steering Cognition, is measuring organised patterns of thinking which are both emergent and ecological but distinct from affective moods and states. AS Tracking is NOT a profiling tool to define who a pupil is, but a tracking tool to describe where a pupil is on their developmental trajectory within their current contexts. As such it which provides 'pupil voice' data to refine teacher's own judgements, history and understanding of the situation and the pupil.

Further work is required to evidence ethnic and international norms; to evidence long-term patterns over a period of more than three years; and to identify possibly relationships between AS Tracking scores and further cognitive, welfare and mental health variables.

Appendix

Norms

Educational type

Walker (2015i) has evidenced that there is no statistically significant difference between instinctive AS Tracking scores in pupils from state or private, day or boarding schools, when comparing a sample of 20 schools (9 boarding, 11 day of which 15 were private and 5 state, n= 4,500).

Age and gender descriptive statistics and norms/ factor

Age and gender norms are shown in Figures 6 a,b,c and d. 1st and second standard deviations for the two main age groups (year 3-8 and 9-13) are provided. Distributions behave within normal parameters, with approximately 95% of scores falling within 2 standard deviations of the mean. Mean and median scores also approximately equal. It is appropriate to use mean and first and second standard deviations as representations of spread to provide norms for age and gender.

Year	Gender	ASfactor	N	mean	median	mode	sd
y12_13	F	N	46	9.1	9	6	2.93
y12_13	M	N	171	8.95	9	8.25	2.91
y9_13	F	N	167	9.47	9	9	2.62
y9_13	M	N	491	8.83	8.25	8.25	2.71
y3_8	F	N	991	10.39	10.5	9	2.14
y3_8	M	N	1180	9.84	9.75	9	2.37

1st SD (67.5%) / 2nd SD (95%) lower	1st SD (67.5%) / 2nd SD (95%) higher
6.85 / 4.23	12.09 / 14.71
6.06 / 3.35	12.18 / 14.89
8.20 / 6.00	12.53 / 14.67
6.47 /5.10	12.21 / 14.58

Figure 6 a. Factor N= Trust of others

Year	Gender	ASfactor	N	mean	median	mode	sd
y12_13	F	P	46	6.6	6.75	6.75	2.3
y12_13	M	P	171	7.52	7.5	8.25	2.47
y9_13	F	P	167	6.51	6.75	6.75	2.31
y9_13	M	P	491	7.31	7.5	8.25	2.52
y3_8	F	P	991	5.96	6	7.5	2.55
y3_8	M	P	1180	6.5	6.75	6.75	2.73

1st SD (67.5%) / 2nd SD (95%) lower	1st SD (67.5%) / 2nd SD (95%) higher
4.20 / 1.89	8.82 / 11.13
4.79 / 2.27	9.83 / 12.35
3.42 / 0.85	8.51 / 11.07
3.77 / 1.03	9.23 / 11.96

Figure 6 b. Factor P = Self-disclosure

Year	Gender	ASfactor	N	mean	median	mode	sd
y12_13	F	S	46	8.02	7.5	7.5	2.47
y12_13	M	S	171	8.25	8.25	8.25	2.49
y9_13	F	S	167	7.61	7.5	7.5	2.54
y9_13	M	S	491	8.38	8.25	8.25	2.45
y3_8	F	S	991	9.11	9	9.75	2.28
y3_8	M	S	1180	9.24	9	9.75	2.62

1st SD (67.5%) / 2nd SD (95%) lower	1st SD (67.5%) / 2nd SD (95%) higher
5.07 / 2.53	10.15 / 12.69
5.93 / 3.48	10.83 / 13.28
6.83 / 4.55	11.39/ 13.67
6.62/ 4.00	11.86 / 14.48

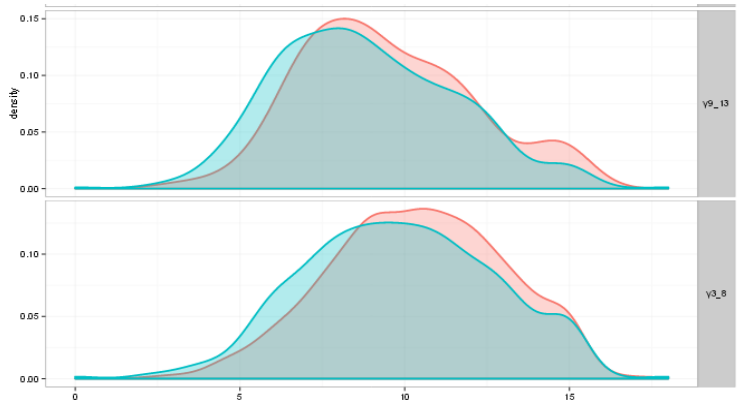
Figure 6 c. Factor S = Trust of self

Year	Gender	ASfactor	N	mean	median	mode	sd
y12_13	F	X	45	6.52	6	4.5	2.5
y12_13	M	X	171	7.53	7.5	7.5	2.54
y9_13	F	X	167	7	6.75	7.5	2.34
y9_13	M	X	491	7.64	7.5	7.5	2.66
y3_8	F	X	991	7.46	7.5	5.25	2.45
y3_8	M	X	1180	7.38	6.75	5.25	2.95

1st SD (67.5%) / 2nd SD (95%) lower	**1st SD (67.5%) / 2nd SD (95%) higher**
5.07 / 2.53	10.15 / 12.69
5.93 / 3.48	10.83 / 13.28
6.83 / 4.55	11.39/ 13.67
6.62/ 4.00	11.86 / 14.48

Figure 6 d. Factor X = Seeking change

Figure 7 a, b,c and d. Instinctive score age and gender norms by factor

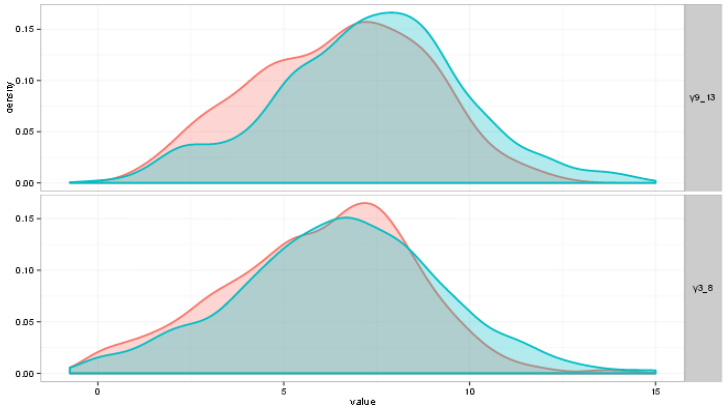


Factor N= Trust of others instinctive

Year 9-13

Year 3-8

Figure 7 a. N. Trust of others

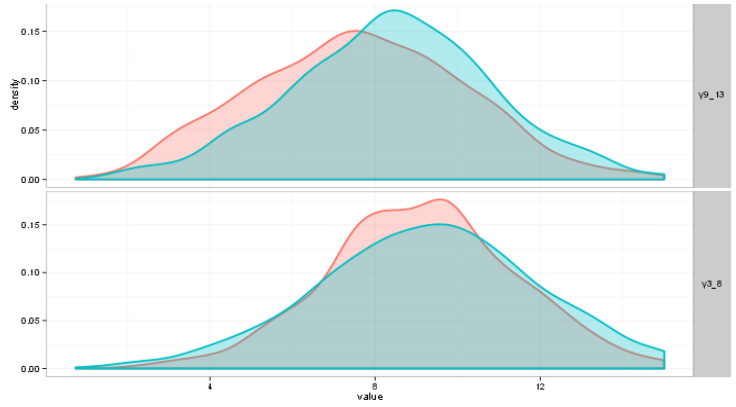


Factor P= Self- disclosure instinctive

Year 9-13

Year 3-8

Figure 7b. P. Self disclosure

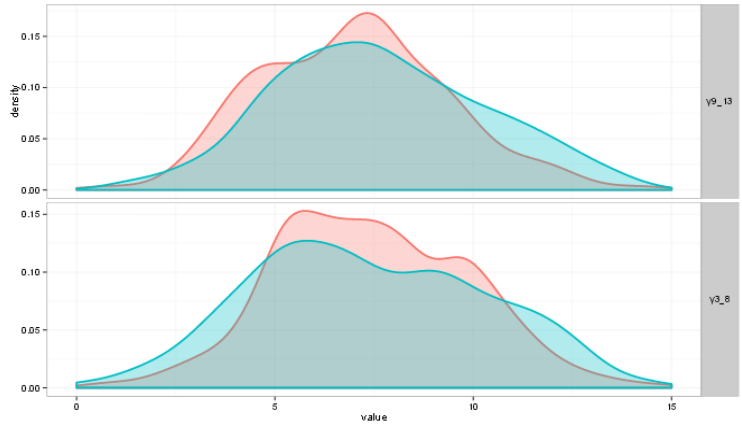


Factor S= Trust of self instinctive

Year 9-13

Year 3-8

Figure 7 c. Trust of self



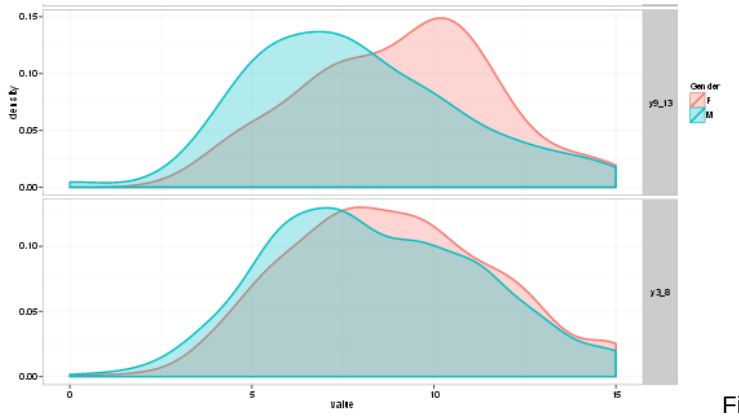
Factor X = Seeking change instinctive

Year 9-13

Year 3-8

Figure 7 d. X Seeking change

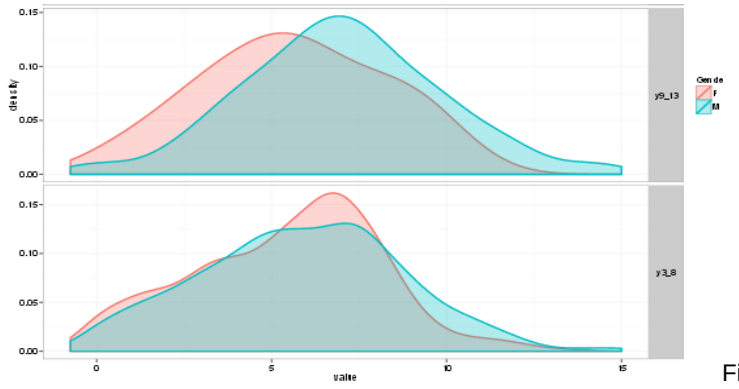
Figure 8 a, b,c and d. Contextual score age and gender norms by factor



Year 9-13

Year 3-8

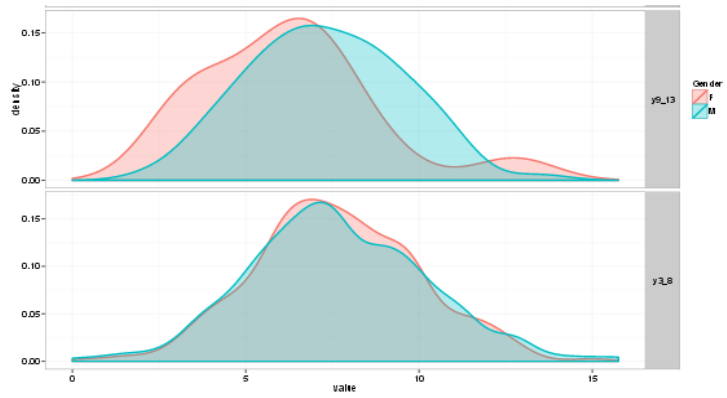
Figure 8 a. Contextual N. Trust of others



Year 9-13

Year 3-8

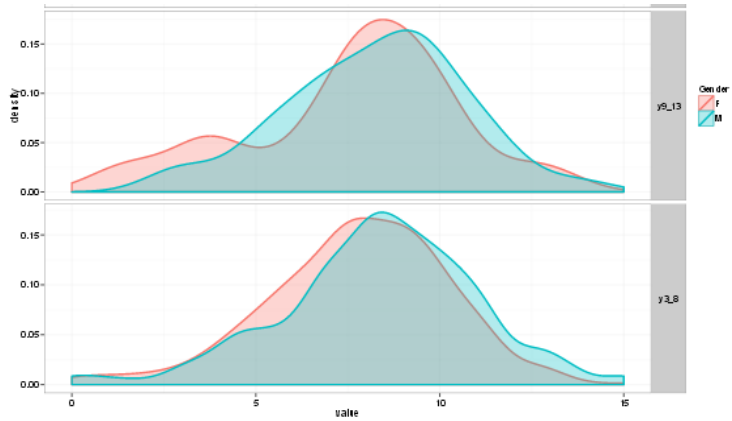
Figure 8 b. Contextual P. Self-disclosure



Year 9-13

Year 3-8

Figure 8 c. Contextual S . Trust of self



Year 9-13

Year 3-8

Figure 8 d. Contextual X. Seeking change

Predictive validity: predicting self-harm, pressure and bullying risks

Study population: Pupil age means were between 14.9 and 15.4 years, with 43% of the same being under 15, 38% between 15 and 16, and 19% between 17 and 19 years of age. 58% were boys and 42% were girls. 6 of the schools were day and 10 were boarding. Schools were selected to represent a distribution of academic ranking from those amongst the highest ranking in the UK, to schools in the mid-lower ranking for academic outcomes. Public exam A Level results from 2012 and 2013 were used to rank schools.

Method: Pupils were asked to respond anonymously to three written questions asking if they suffered from self-harm, had experienced being bullied over the past year or were not coping with pressure at school. Pupil's responded to a five-point Likert scale (not at all- not- not really- a bit-yes). Because these responses were provided with the assurance of anonymity to the school, we regarded responses as a reasonable indicator of actual pupil risks of these three mental health and welfare concerns.

Data analysis: Pupil risks of mental health and welfare concerns were then matched to timings and patterns of pupil AS Tracking scores previously measured within the assessment procedure. The aim was to identify whether certain patterns of AS Tracking correlated with increased mental health risks. To achieve this, a machine learning method was used to detect patterns which correlated with self-perceived pressure, self-harm and bullying risks. A support-vector-machines (SVM) model was first trained on the pupil perceived risk dataset. Then when used on the non-training AS Tracking data, the % accuracy of predicting only from pupil AS Tracking scores pupils who were considering self-harm, experiencing bullying or not coping with pressure was calculated. The SVM model analysed three components of each item score: the variance of individual item scores, the direction of variance and speed of response.

The model was cross-validated to test for both the % probability of both cases (bullied/not bullied etc.). The model was able to provide three % probabilities for each pupil that their AS Tracking pattern associated them with the specific risks of (i) self-harm, (ii) not coping with pressure or (iii) being bullied.

Results

Bullied

The AS Tracking pattern model achieved an 80% accuracy (83/78% both classes) in predicting children who were experiencing bullying. Experiencing bullying was associated with a significantly higher level of overall AS dysregulation and specifically with low self-disclosure. The model showed that pupils who exhibit an AS bias toward low self-disclosure, as well as a high degree of dysregulated bias (a high deviation from the mean across their AS item scores) are more likely to have been or experienced bullied. In contrast, pupils who have high self-disclosure and high self-regulation (low deviation from the mean in their item scores) are less likely to have been bullied.

Pressure

The AS Tracking pattern model achieved a 83% (88/77% both classes) accuracy in predicting children who were not coping with pressure at school. Coping with pressure was statistically associated with overall AS dysregulation as well as, specifically, with self-disclosure and embracing change. Pupils who have an AS bias toward low self-disclosure, or a bias toward low embracing change, or a high degree of dysregulated bias (a high deviation from the mean across AS item scores) manage less well with the pressure experienced at school. In contrast, pupils who have high self-disclosure, high embracing change scores and high self-regulation (low deviation from the mean in item scores) cope better with school pressures. Pupils who show a combination of these factors (low embracing change, low disclosure and high dysregulation) are the most at risk population coping with school pressures.

Self-harm

The AS Tracking pattern model achieved a 80% (82/78% both classes) accuracy in predicting children who were considering self-harming. Self-harm was associated significantly with overall AS dysregulation as well as with self-disclosure and embracing change. Pupils who have an AS bias toward low self-disclosure, or a bias toward high embracing change, or a high degree of dysregulated bias (a high deviation from the mean across their AS item scores) are significantly more likely to have self harmed or considered it. In contrast, pupils who have high self-disclosure, low embracing change scores and high self-regulation (low deviation from the mean in their item scores) are significantly less likely to have self-harmed or consider doing so. Pupils who show a combination of these factors (high embracing change, low disclosure and high dysregulation) were the most at risk population when it came to self-harm.

Discussion:

One way to understand this result is that, in a population of 100 pupils, AS Tracking would correctly predict the incidences of self-harm, pressure and bullying in around 80 out of the 100 of the pupils. Statistically, there is a $1{:}2^3$, or 1:8 chance of correctly predicting incidences of bullying, self-harm and pressure and by chance; a correct prediction in around 12 out of the 100 pupils. The result provides evidence of predictive construct validity: AS Tracking exhibited power 6 times greater than statistical chance in correctly predicting the incidence of pupils not coping with pressure, at risk of self-harming or being bullied.

Real or false positives and negatives?

False positives refer to the model predicting a condition in a pupil who had not exhibited it. False negatives refer to the reverse. A high number of false positives/negatives might occur in an experiment with a skewed distribution of negatives. In this experiment, there is a skewed distribution of negatives for self-harm, bullying and not coping with pressure, in that the large majority of pupils ***do not*** strongly exhibit these conditions. A high accuracy in predicting incidences of NOT showing pressure, self-harm or being bullied could be attributed simply to this skewed negative distribution, simply by guessing that most children would not show these conditions.

To test for this, the method of cross-validation was used to reduce the incidence of false positives and false negatives. Cross-validation measures accuracy both for exhibited and then non-exhibited conditions. Accuracy on both cases is required to eliminate the instances of false readings, and small difference between the two results is sought. In this result, the difference between both cases was small (83/78, 88/77, 82/78) with both positive and negative predictions showing high accuracy, thus largely eliminating the explanation of false positive/negative readings.

Reliability of AS Tracking

Test-retest reliability

In 2016, a study measured the AS Tracking of 170 pupils in 2 day/boarding secondary schools. Pupil age means were between 14.9 and 15.4 years, with 45% aged 12-13 years, 30% between 14-15 years, and 25% between 16-17 years of age. 104 were boys and 66 were girls. 84 boys were day pupils, 20 were boarding pupils. All girls were day pupils. Participant schools were invited to take part in the research without remuneration following attendance at a research conference hosted by the publisher. Pupils aged 8-12 were not included in the research because no primary or prep schools attended the research conference.

Pupils were administered the AS Tracking assessment using the standardised procedure twice, at an interval of 3 weeks. AS Tracking pupil scores from test 1 and test 2 were compared. Because the data was non-ranked, Pearson Product Moment correlation was used to test for the relationship between both *instinctive* and *school* assessment scores from test 1 and test 2, for the overall scale and for sub scales, for both boys and girls separately and combined.

The **overall** scale instinctive score for test1: test 2 **r = 0.71**
The **boys** scale instinctive score for test1: test 2 **r = 0.68**
The **girls** scale instinctive score for test1: test 2 **r = 0.74**

The overall instinctive scale test: re-test is r = 0.71. This means that there is a strong degree of correlation between the first set of test scores and the second set of test scores. A score of 0.7 or above is considered by The British Psychological Society to be an acceptable measure of a psychological construct's stability over short term test-retest measurement. This evidence supports the hypothesis that Steering Cognition is a stable, organised pattern of thinking which exhibits ecologically triggered changes and slower emergent evolution over longer periods of time.

The stability of r across age bands between 12-18 provides additional support for this conclusion. Analysis of test: re-test for the different age groups was carried out at an overall scale level:

Age 12-13 **r= 0.70**
Age 14-15 **r= 0.71**
Age 16-17 **r= 0.72**

Contextual (in school) assessment test: re-test results

In addition to the instinctive assessment r = 0.71, for comparison, contextual, or *school* test- retest scores were analysed. Because this contextual assessment inserts the additional variable of *school* into the assessment, reduced r is predicted; the independent variable *school* will be likely to increase the inconsistency between the two repeated measures, and reduce r. The relevance of this analysis is not to obtain a high r, but to evidence the relationship between *instinctive r* and *school r*, which the assessment design predicts will be lower.

The **overall** scale *school* score for test1: test 2 **r = 0.64**
Boys' subscale *school* score for test 1: test 2: r **=0.62** **(**difference from instinctive**= 0.05).**
Girls' subscale *school* score for test 1: test 2: r **=0.66** **(**difference from instinctive**= 0.07).**

The close relationship between the instinctive and the school test: re-test scores conform to the prediction that school will add an additional variable. Interestingly, the variance between the two is small, and for some scales positive, indicating that, over the short term school can be stabilising rather than de-stabilising variable.

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