

Cambridge Mindware Lab

Analysis of Multiple Intelligences Survey

Mark Ashton Smith, Sept-Oct: 2019

Descriptive Statistics

The Sample: IQ Mindware subscribers, and additional social media (e.g. LinkedIn, Twitter) connections. The sample is biased towards more educated professionals.

Descriptive Statistics					
	N	Minimum	Maximum	Average	Std. Deviation
Verbal Comprehension-Knowledge	136	2	10	7.52	1.885
Episodic processing	135	1	10	7.36	2.118
Social-Cultural Intelligence	136	1	10	7.29	
Encoding/Learning efficiency	118	1	10	7.27	2.151
Unconscious Incubation	118	0	10	7.19	2.145
Meta-monitoring & control	118	2	10	7.12	1.864
Emotional-motivational engagement in thinking	119	1	10	7.04	2.176
Quantitative Ability / Math	134	1	10	6.93	2.154
Visuospatial processing	136	1	10	6.81	2.206
Emotional Intelligence	137	1	10	6.79	2.038
Processing speed	136	1	10	6.74	2.280
Resolving conflict or uncertainty	119	3	10	6.66	1.915
Retrieval fluency	119	0	10	6.66	2.121
Psychomotor Ability / Skills	136	0	10	6.63	2.234
Working Memory	122	0	10	6.55	2.041
Internal task management	120	2	10	6.48	2.066
Self-Actualizing intelligence	137	1	10	6.46	2.216
Cognitive resilience	119	1	10	6.44	2.360
Disengagement Ability	120	1	10	6.41	2.144
Social-Political-Intelligence	136	0	10	6.37	2.422
Auditory processing	134	0	10	6.09	2.136
Practical-Mechanical Intelligence	135	1	10	6.02	2.180
Self-Regulation ability	135	1	10	6.00	2.324

68% of the sample are between -1 to +1 standard deviations from the avg. score.

Some observations

Verbal-comprehension-knowledge is the highest ‘multiple intelligence’ score. This is ‘comprehension & verbal reasoning abilities, vocabulary and verbal knowledge, literacy.’

Self-regulation ability is the lowest ‘multiple intelligence’ score. This is ‘controlling one's attention, thoughts, moods and behaviour to regulate disruptive emotions, rumination, distractions, addictions, impulses, stress, insomnia, in a way

that promotes your long-term goals.’

Encoding/learning efficiency scores highly. This is ‘the ability to learn, store and consolidate new information over time measured in hours, days, and years.’

Social-cultural intelligence scores highly. This is ‘your ability in perspective-taking - to understand other people’s points of view with different values, intentions and interests, and understand cultural groups, symbols, institutions and practices.’ Despite this, **social-political intelligence** has a relatively low score. This is ‘your ability to perceive and understand political dynamics, and to promote your own interests (in economic, power, influence or status terms) in a social and political context, negotiating power-relations through cooperative affiliation and/or self-assertive competition.’

Practical-mechanical intelligence has a relatively low score. This is, ‘the ability to diagnose, understand, build, or repair mechanical or physical devices using spatial and psychomotor ability and an understanding of basic causal-physical principle’.

In terms of ‘executive functions’ (of interest to brain training), the highest scorers are (1) **meta-monitoring and control** (‘Your ability to introspect and reflect on your own thinking processes or skilled strategic actions as you are engaged in them and use this awareness to change your strategies or focus or how you are attending.’); and (2) **emotional-motivational engagement** (‘This is how emotionally and motivationally invested you are in your own thinking processes. For example, your experience of pleasure when you solve a problem, or your feeling of motivation through the anticipation of shortly reaching a solution.’)

Working memory & internal task management are in the lower half of scores.

The Positive Manifold

g (psychometric general intelligence) can be understood as the ‘positive manifold’ – the matrix of **positive correlations** between a wide range of cognitive task measures.

Every one of the survey’s ‘multiple intelligence’ items (processing speed, quantitative ability, emotional intelligence, self-actualization, etc) measured in this survey is positively correlated (associated) with every other item. There are no exceptions. This is shown in Table 1.

We can infer from this positive manifold here that there is a **general intelligence factor (*g*)** underlying all scores.

Zoom in to see the correlations!

Correlation Matrix

	Processing speed (Gs)	Visuospatial processing (Gv)	Auditory processing (Ga)	Verbal Comprehension-Knowledge (Gc)	Quantitative Ability / Numeracy (Gq)	Psychomotor Ability (Sensorimotor Skill) (Gpm)	Practical-Mechanical Intelligence (Gkm)	Episodic processing (EP)	Emotional Intelligence (Gei)	Self-Regulation ability (SR)	Social-Cultural Intelligence (Gsc)	Social-Political-Intelligence (Gsp)
Processing speed (Gs)	1.000	.473	.424	.437	.451	.341	.354	.475	.250	.297	.399	.354
Visuospatial processing (Gv)	.473	1.000	.547	.458	.426	.212	.337	.549	.198	.352	.308	.303
Auditory processing (Ga)	.424	.547	1.000	.483	.496	.331	.401	.468	.331	.309	.418	.341
Verbal Comprehension-Knowledge (Gc)	.437	.458	.483	1.000	.473	.355	.327	.488	.342	.410	.484	.438
Quantitative Ability / Numeracy (Gq)	.451	.426	.496	.473	1.000	.380	.405	.306	.366	.327	.371	.309
Psychomotor Ability (Sensorimotor Skill) (Gpm)	.341	.212	.331	.355	.380	1.000	.515	.305	.347	.342	.385	.494
Practical-Mechanical Intelligence (Gkm)	.354	.337	.401	.327	.405	.515	1.000	.403	.367	.288	.289	.401
Episodic processing (EP)	.475	.549	.468	.488	.306	.305	.403	1.000	.325	.334	.431	.505
Emotional Intelligence (Gei)	.250	.198	.331	.342	.366	.347	.367	.325	1.000	.531	.535	.438
Self-Regulation ability (SR)	.297	.352	.309	.410	.327	.342	.288	.334	.531	1.000	.414	.481
Social-Cultural Intelligence (Gsc)	.399	.308	.418	.484	.371	.385	.289	.431	.535	.414	1.000	.584
Social-Political-Intelligence (Gsp)	.354	.303	.341	.438	.309	.494	.401	.505	.438	.481	.584	1.000
Self-Actualizing intelligence (Gsa)	.381	.485	.441	.461	.381	.375	.324	.504	.559	.623	.475	.549
Working Memory (WM)	.526	.510	.472	.391	.533	.407	.395	.475	.256	.332	.445	.373
Internal task management	.504	.467	.477	.500	.468	.429	.448	.539	.399	.477	.515	.522
Disengagement Ability	.435	.333	.457	.496	.431	.409	.437	.381	.409	.412	.526	.418
Resolving conflict or uncertainty (ACC)	.437	.366	.410	.455	.391	.320	.439	.399	.537	.457	.537	.420
Emotional-motivational engagement	.316	.375	.234	.283	.307	.313	.258	.348	.401	.419	.476	.469
Meta-monitoring & control	.362	.340	.434	.420	.437	.279	.272	.452	.432	.406	.475	.387
Encoding/Learning efficiency	.406	.508	.491	.565	.538	.453	.450	.628	.366	.379	.522	.496
Retrieval fluency (Gr and Gs)	.453	.525	.487	.464	.454	.411	.524	.549	.360	.397	.453	.456
Unconscious incubation	.247	.416	.528	.381	.404	.278	.510	.468	.418	.332	.438	.411
Cognitive resilience	.444	.475	.422	.401	.462	.388	.373	.442	.465	.580	.445	.454

Table 1. Correlation matrix of multiple intelligence abilities

3 Underlying Factors of Intelligence

I did an exploratory factor analysis with our data to uncover underlying unobserved ('latent') factors that cause a lot of the variation in the survey scores¹. These are the 3 factors underlying all the 'multiple intelligences' we have.

The 3 underlying intelligence factors are revealed:

- 1) **Fluid intelligence**. This depends on working memory and memory learning/retrieval as defined in my 'Vectorizing IQ' eBook.
- 2) **Social-emotional IQ & self-regulation**. This is closely related to cultural and political intelligence and self-actualization.
- 3) **Psychomotor ability** (sensorimotor skill). This is related to practical-mechanical intelligence, as well as WM and memory learning/retrieval (shared with fluid intelligence).

The 3 intelligence factors that have been extracted using the dataset explain **52%** of the variance in IQ survey item ratings. In other words, more than half of the differences in all the survey scores are caused by individual differences in these 3 factors. The way each item 'loads' (e.g. correlates) with each of the 3 factors is shown in Table 2.

Some items tap 2 or all 3 of the underlying factors – such as **internal task management**, which is defined as 'your ability to keep track and be systematic while working on a cognitive challenge in terms of goals and sub goals, or exploring options, - e.g. holding pending goals in mind while performing subtasks or considering alternative courses of action before deciding, or imagining hypotheticals or possibilities while problem solving. It's your ability to work with background 'problem spaces' and keep track of where you are as you work through.'

¹ Statistical resources for this are found [here](#) and [here](#). Our data meet the assumptions needed for factor analysis.

Rotated Factor Matrix^a

	Factor		
	1	2	3
Processing speed		.503	
Visuospatial processing		.783	
Auditory processing		.572	
Verbal-Comprehension		.462	
Quantitative Ability-Math		.461	
Episodic processing		.584	
Working Memory		.606	.461
Learning efficiency		.572	.421
Retrieval fluency		.585	.423
Unconscious Incubation		.438	.429
Psychomotor Ability / Skills			.538
Practical-Mechanical Ability			.581
Emotional Intelligence	.638		
Self-Regulation ability	.656		
Social-Political-Intelligence	.528		
Self-Actualizing intelligence	.763		
Resolving conflict or uncertainty	.572		
Emotional-motivational engagement in thinking	.587		
Meta-monitoring & control	.544		
Internal task management	.442	.479	.417
Cognitive resilience	.591	.419	
Social-Cultural Intelligence	.536		.408
Disengagement Ability	.428		.485

Item loadings on the 3 factors. Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

Table 2: Factor Analysis of Multiple Intelligence Items

IQ Abilities of Interest

We can do a general multiple-regression analysis² to determine what cognitive abilities best predict/explain eight intelligence-demanding cognitive abilities of interest.

These abilities of interest are:

1. Fluid intelligence (culture fair IQ tests)
2. Quantitative intelligence (math)
3. Memory retrieval ability
4. Psychomotor ability / sensorimotor skills
5. Self-regulation
6. Emotional intelligence
7. Political intelligence
8. Self Actualization

These are the predictor variables I am using in the analysis:

Working memory capacity is ‘your capacity to (a) hold relevant information, rules, contexts in mind for cognitive tasks, shielded from distractions or automatic responses (like a mental workspace or whiteboard); and (b) your ability to actively process/update this information 'offline' by following new instruction sets, reasoning, problem solving, comprehending, decision-making, finding patterns or manipulating the physical world.’

Internal task management – is your ability to keep track and be systematic while working on a cognitive challenge in terms of goals and sub goals, or exploring options, - e.g. holding pending goals in mind while performing subtasks or considering alternative courses of action before deciding, or imagining hypotheticals or possibilities while problem solving. It's your ability to work with background 'problem spaces' and keep track of where you are as you work through.

Disengagement ability is ‘your ability to flexibly clear information, release from associations, or abandon rules or sub-goals in working memory when no longer relevant in your task. It's your ability to 'wipe the slate' while working on something, to focus on a new task or adapt the rules you are working with. Lack of this ability shows itself as interference from what you've already held in mind or been processing, that is no longer helpful but which might get mixed up with what you're doing now.’

² I am using SPSS's Automatic Linear Modelling method., with bagging (bootstrap aggregating).

Resolving conflict/uncertainty is ‘your ability to recognize when there is a conflict between e.g. following instructions and when you make mistakes because your attention has lapsed, and quickly double-up with your focus and efforts to not make another mistake. Also your ability to respond flexibly to unexpected changes in the situation as it evolves, that motivates you to re-prioritization what you are doing. Also your ability to deal with trade-offs where there is uncertainty - such as between knowing whether to keep considering different options or commit with a particular decision.’

Emotional-motivational engagement - This is how emotionally and motivationally invested you are in your own thinking processes. For example, your experience of pleasure when you solve a problem, or your feeling of motivation through the anticipation of shortly reaching a solution.

Meta-monitoring & control (metacognition) -This is your ability to introspect and reflect on your own thinking processes or skilled strategic actions as you are engaged in them and use this awareness to change your strategies or focus or how you are attending.

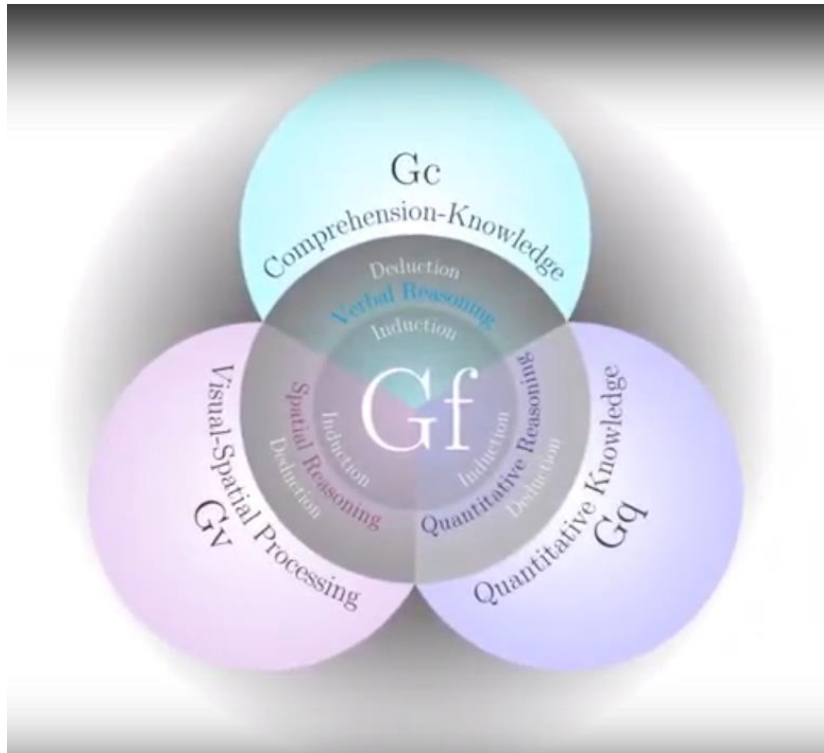
Encoding/Learning Efficiency is ‘your ability to learn, store and consolidate new information over time measured in hours, days, and years.’

Episodic processing is ‘your ability to remember personal experiences, create 'daydream' or imaginary scenarios from a first-person point of view & visualize what you will be doing in the future.’

Cognitive resilience is ‘your ability to overcome negative effects of stress or setbacks/failure on cognitive functioning.’

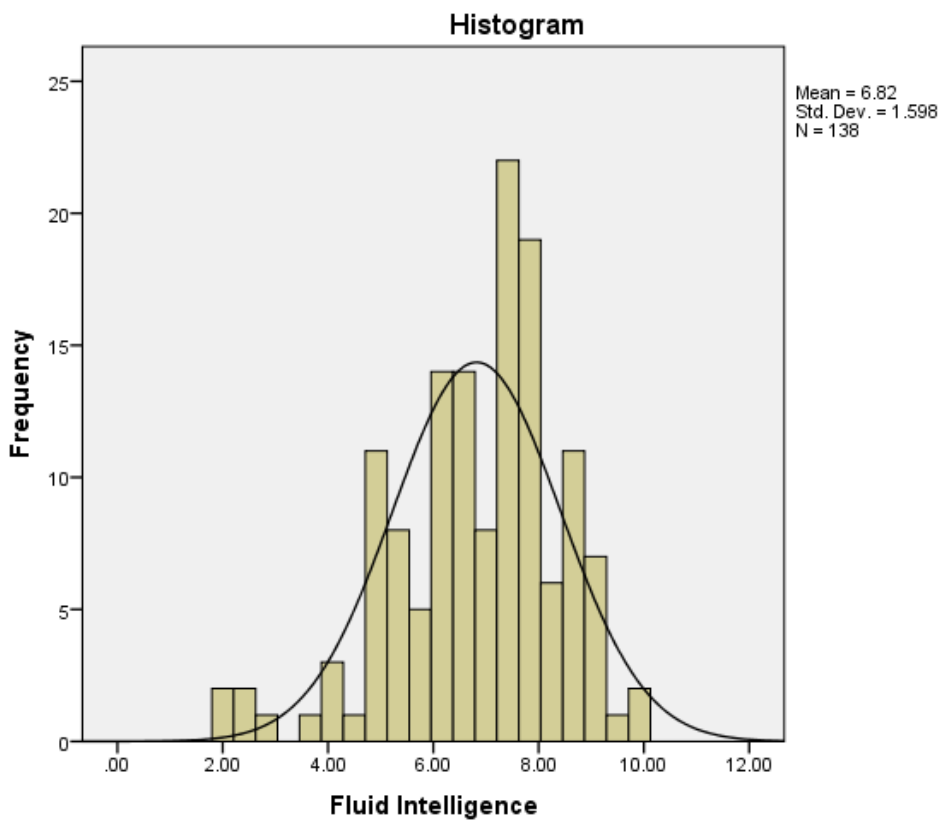
Fluid Intelligence (Gf)

Gf is defined our ability to reason, infer relations and spot patterns on problems that draw on minimal prior knowledge and expertise. It overlaps with verbal, visuospatial and quantitative ability as shown here:

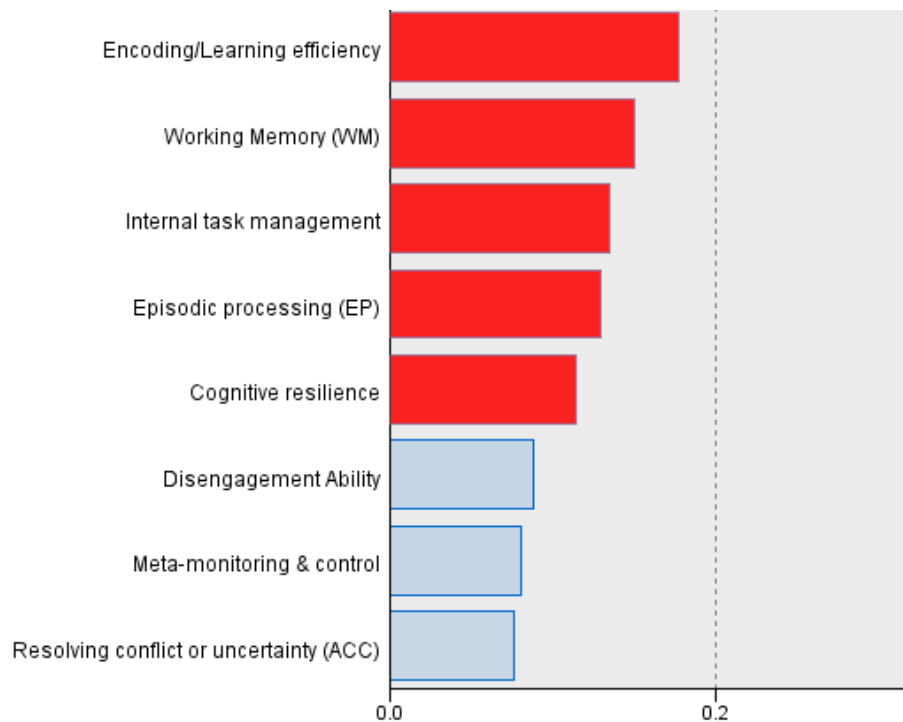


Fluid intelligence (Gf)

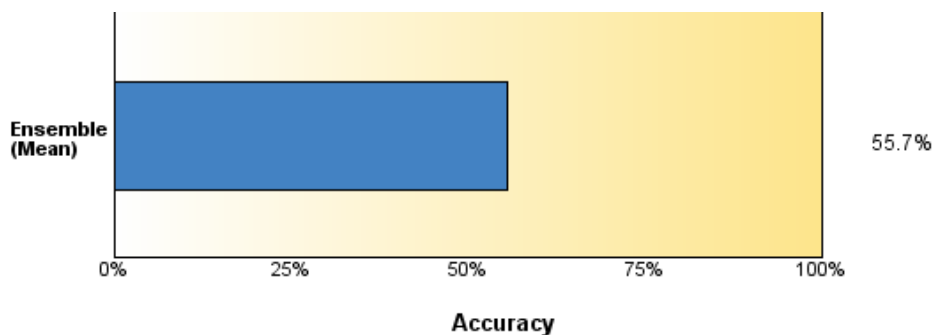
How is fluid intelligence (average of quantitative, spatial, verbal & auditory ability) distributed in the sample?



What predicts fluid intelligence?



How much of fluid intelligence do these cognitive abilities explain?

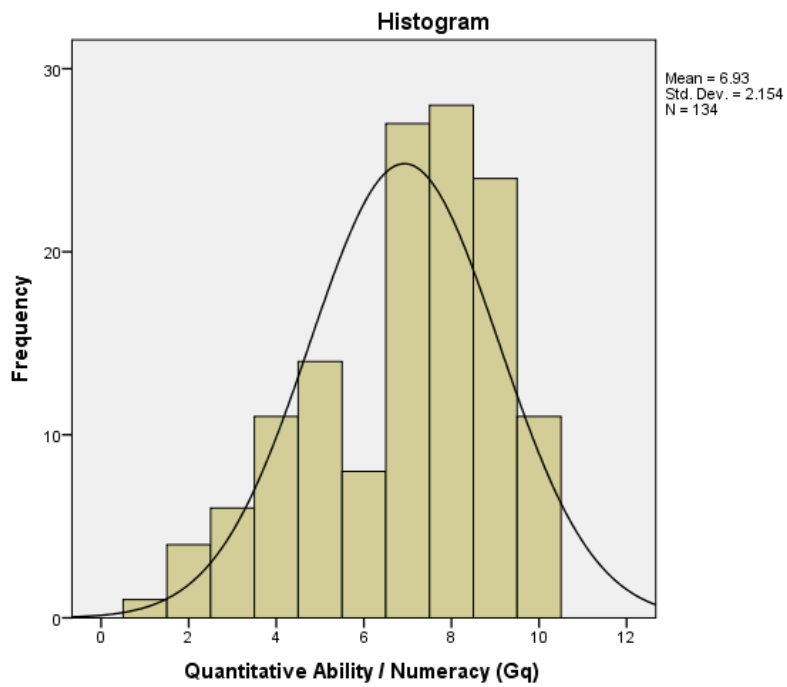


Brain Training Hypothesis: If you train encoding/learning efficiency, working memory, internal task management, episodic processing, and cognitive resilience you will increase your fluid intelligence.

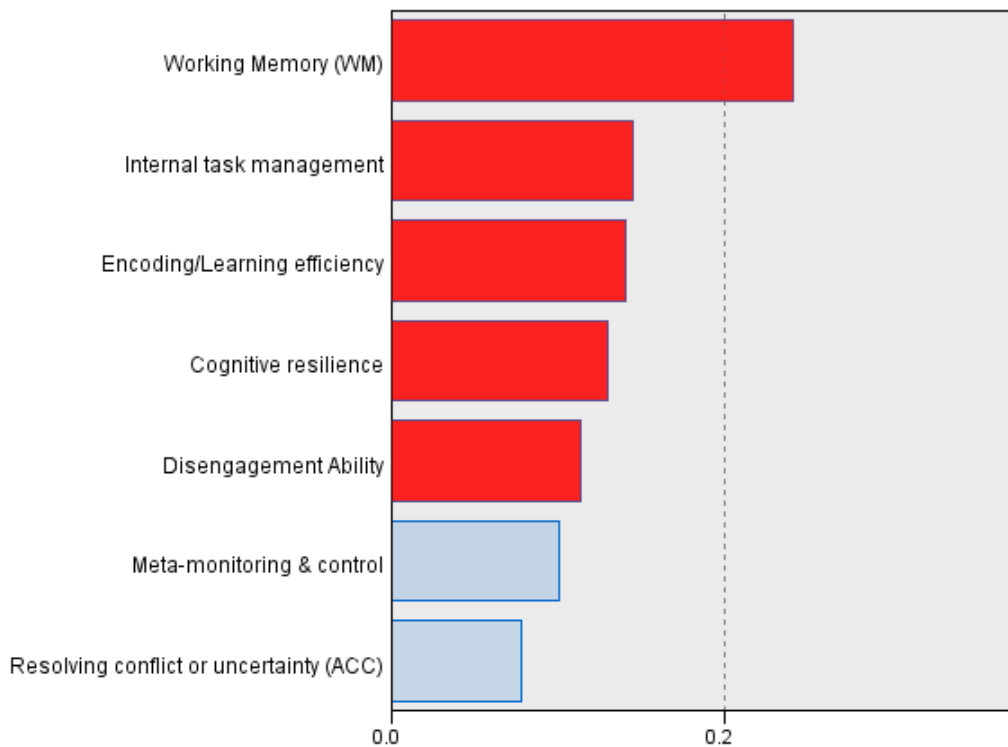
Quantitative Ability (Gq)

Gq is the ability to comprehend quantitative concepts and relationships and to manipulate numerical symbols; math ability.

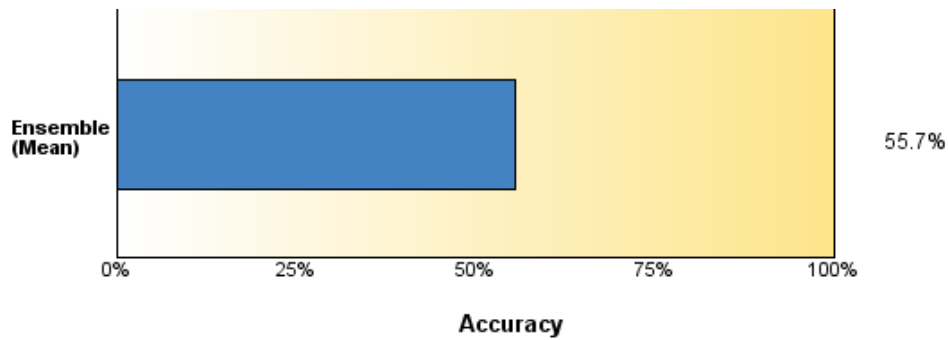
How is quantitative intelligence distributed in the sample?



What predicts quantitative ability / math ability (one measure of fluid intelligence)?



How much of quantitative ability do these cognitive abilities explain?

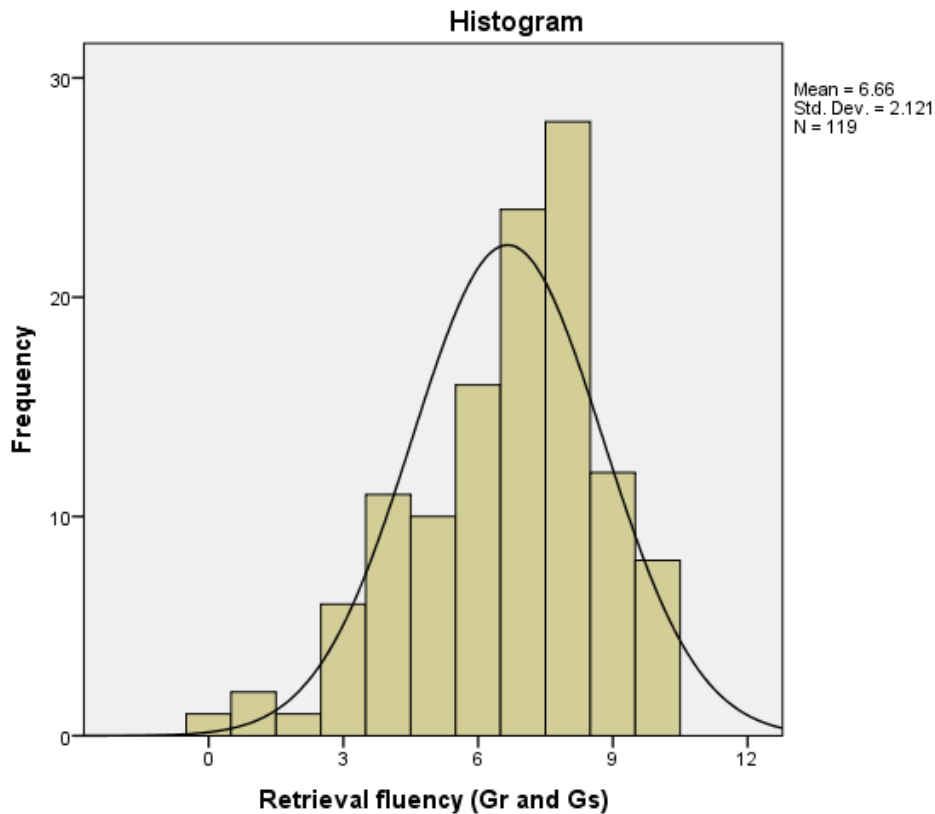


Brain Training Hypothesis: If you train working memory capacity, internal task management, encoding/learning efficiency, cognitive resilience, and disengagement ability you can improve your quantitative ability.

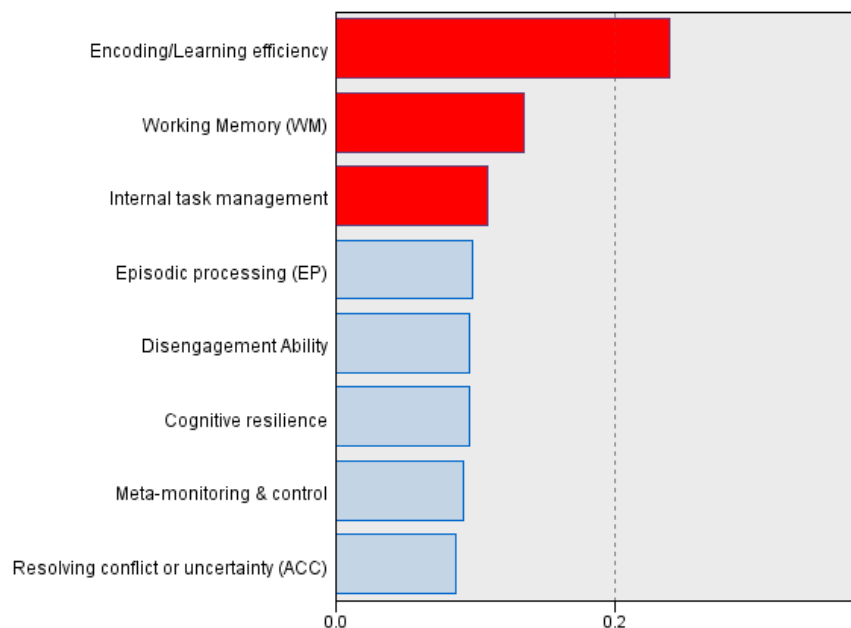
Memory Retrieval Fluency (Gr)

Gr is the rate and fluency you can produce or retrieve information from your long-term memory in the service of the task at hand.

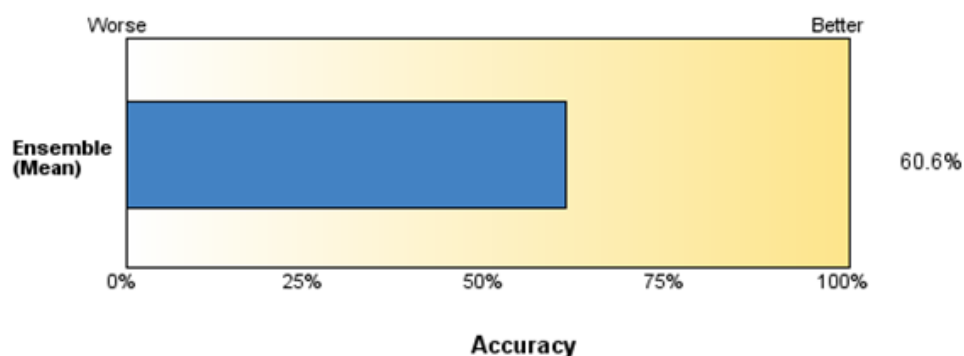
How is memory retrieval fluency distributed in the sample?



What predicts memory retrieval fluency?



How much of memory retrieval fluency do these cognitive abilities explain?

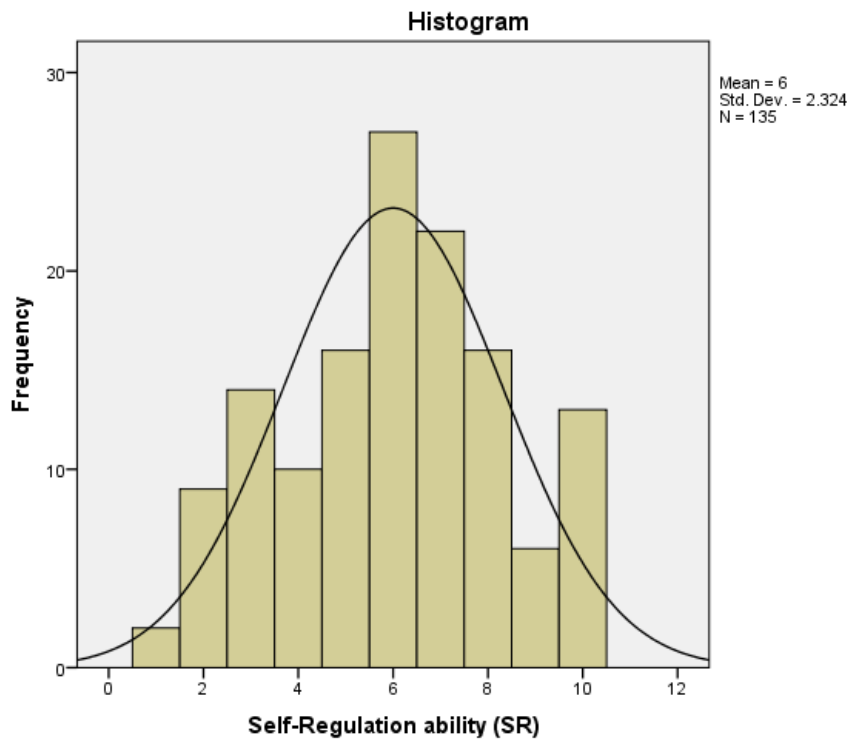


Brain Training Hypothesis: If you train encoding/learning efficiency, working memory capacity and internal task management, you will increase your memory retrieval fluency.

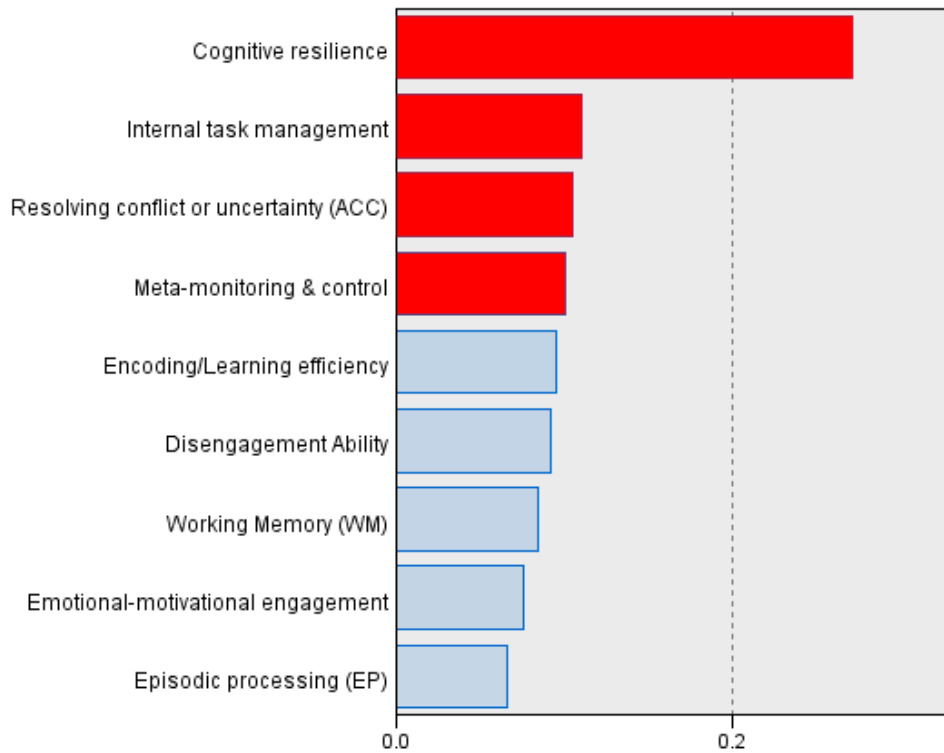
Self-Regulation Ability (SR)

SR is 'controlling one's attention, thoughts, moods and behaviour to regulate disruptive emotions, rumination, distractions, addictions, impulses, stress, insomnia, in a way that promotes your long-term goals.'

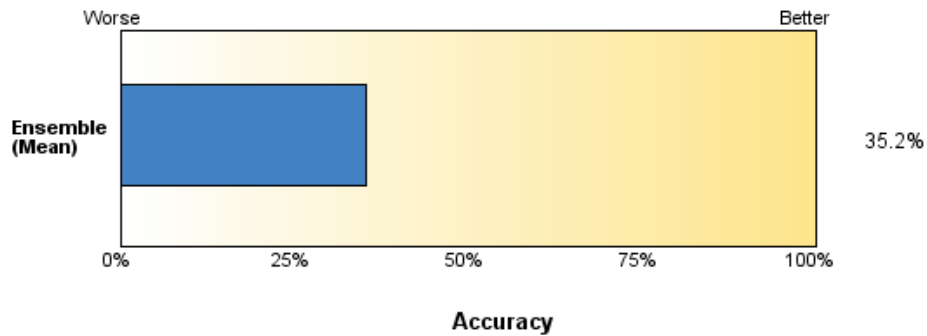
How is self-regulation ability distributed in the sample?



What predicts self-regulation ability?



How much of memory retrieval fluency do these cognitive abilities explain?

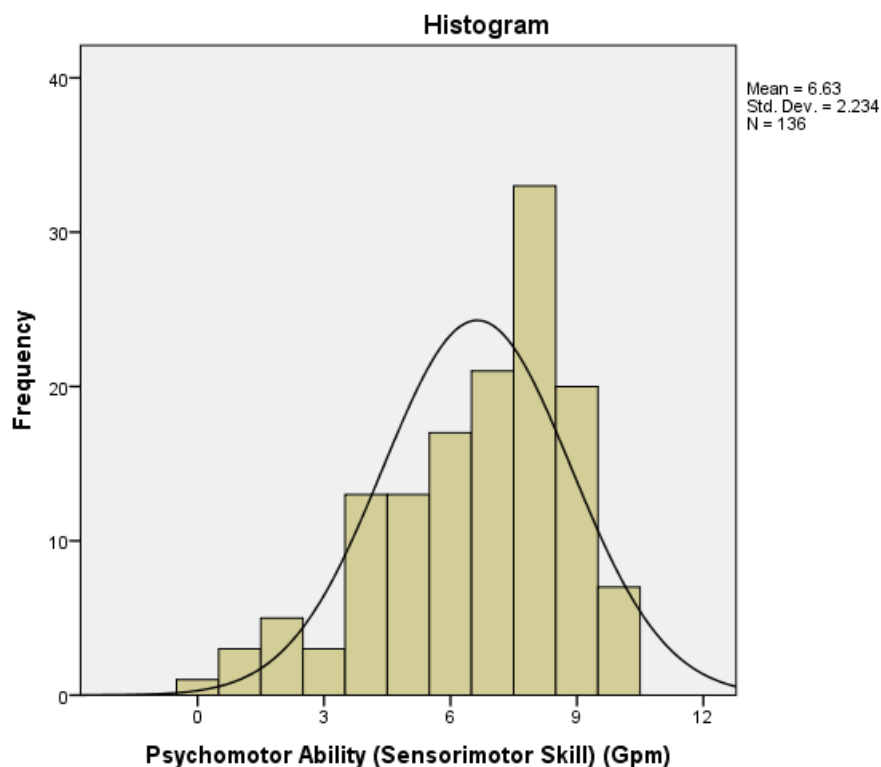


Brain Training Hypothesis: If you train mainly cognitive resilience, internal task-management, resolving task conflict/uncertainty and meta-monitoring and control, you will improve your self-regulation ability.

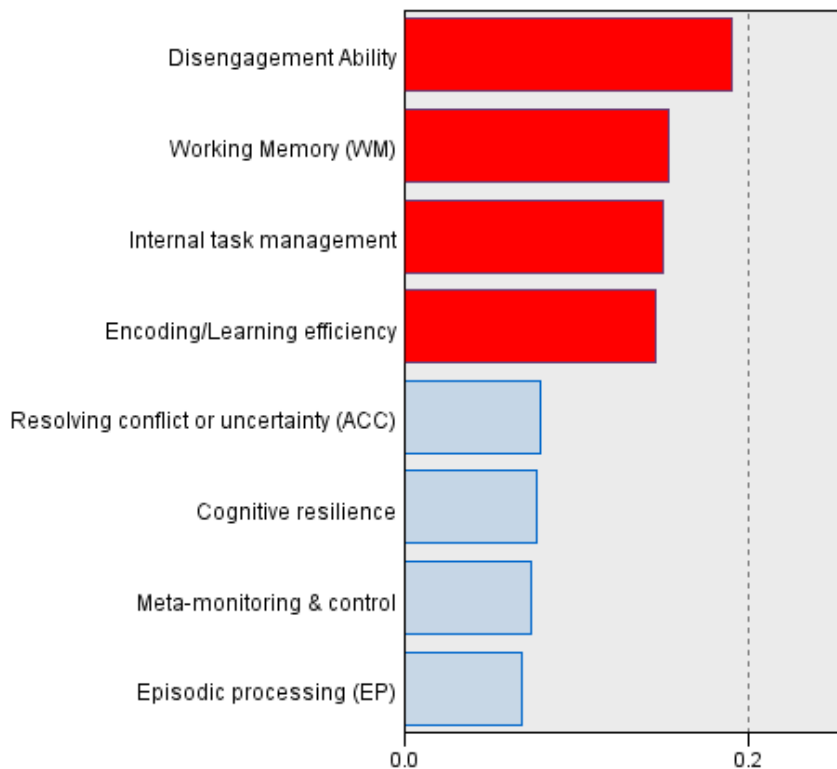
Psychomotor Ability / Sensorimotor Skill (Gpm)

SR is ‘the ability to perform skilled physical body motor movements (e.g., movement of fingers, hands, legs) with precision, coordination, or strength.’

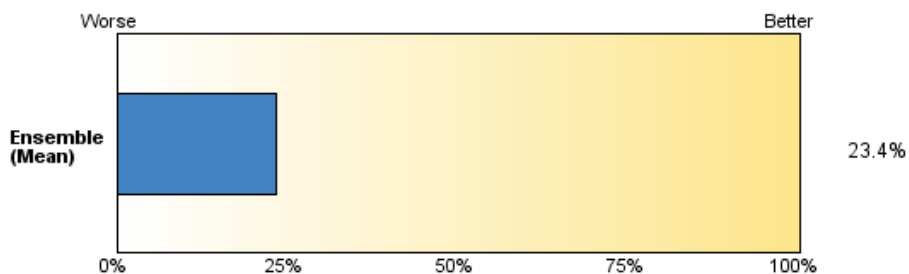
How is psychomotor ability distributed in the sample?



What predicts psychomotor ability?



How much of psychomotor ability do these cognitive abilities explain?

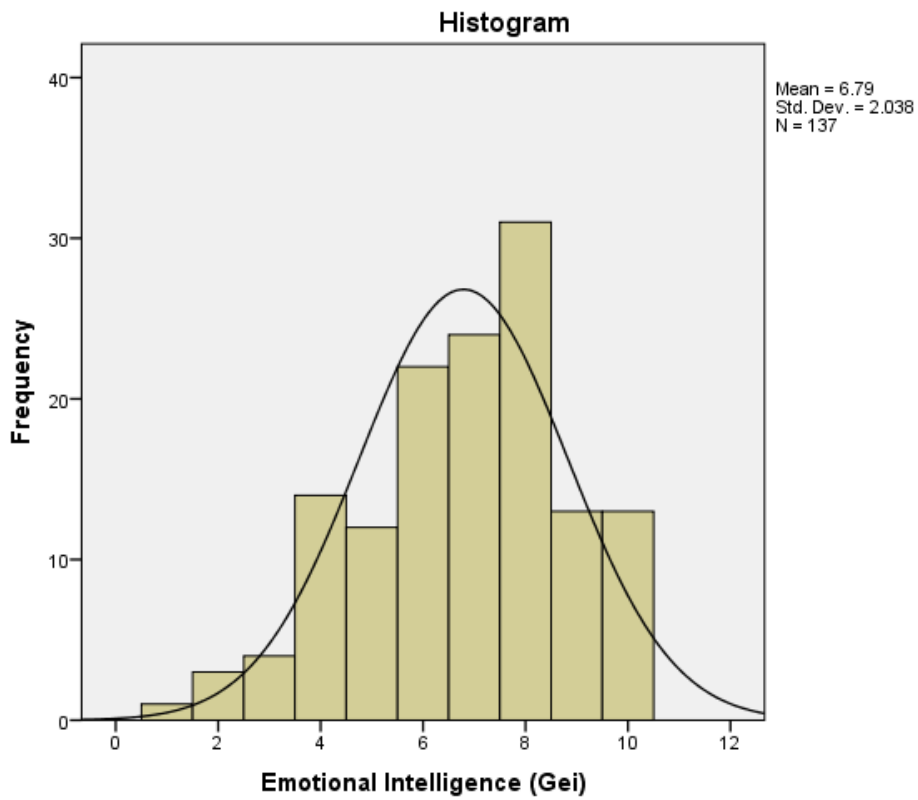


Brain Training Hypothesis: If you train disengagement ability, working memory, internal task management, and encoding learning efficiency, you can improve your sensorimotor skills.

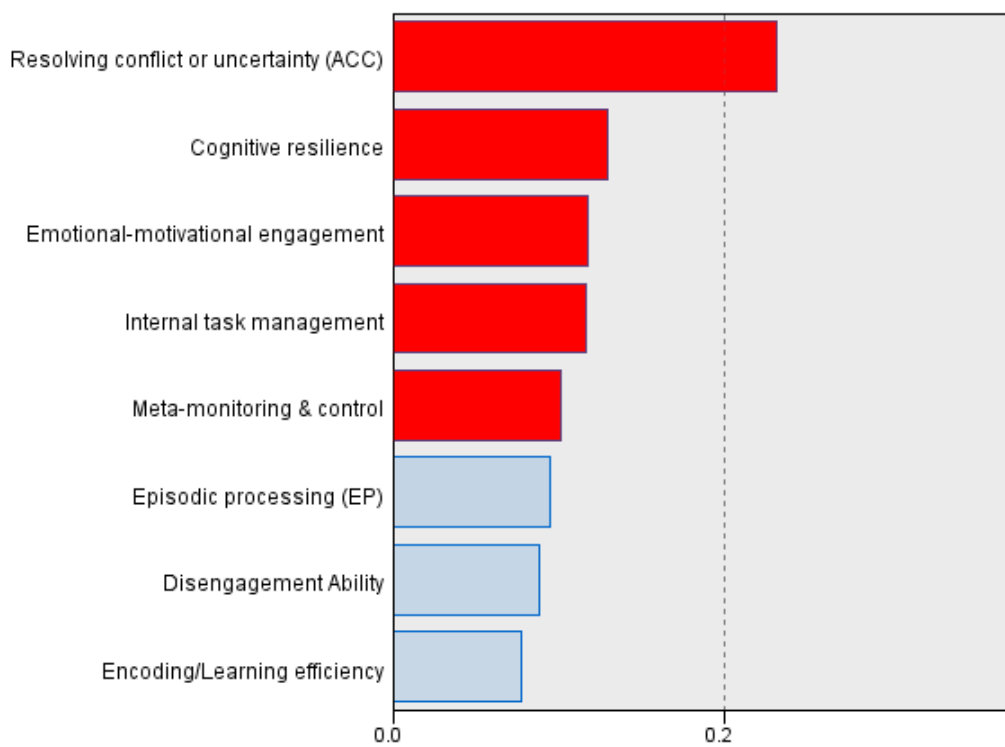
Emotional Intelligence (Gei/EQ)

Emotional intelligence is ‘your overall ability to (1) read/discriminate emotions in yourself and others, (2) understand how they are related or evolve, (3) manage/regulate your emotions and (3) use them for your own goals.

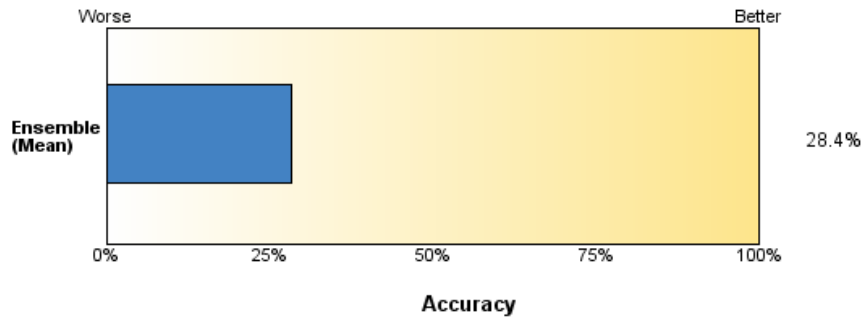
How is emotional intelligence distributed in the sample?



What predicts emotional intelligence?



How much of psychomotor ability do these cognitive abilities explain?

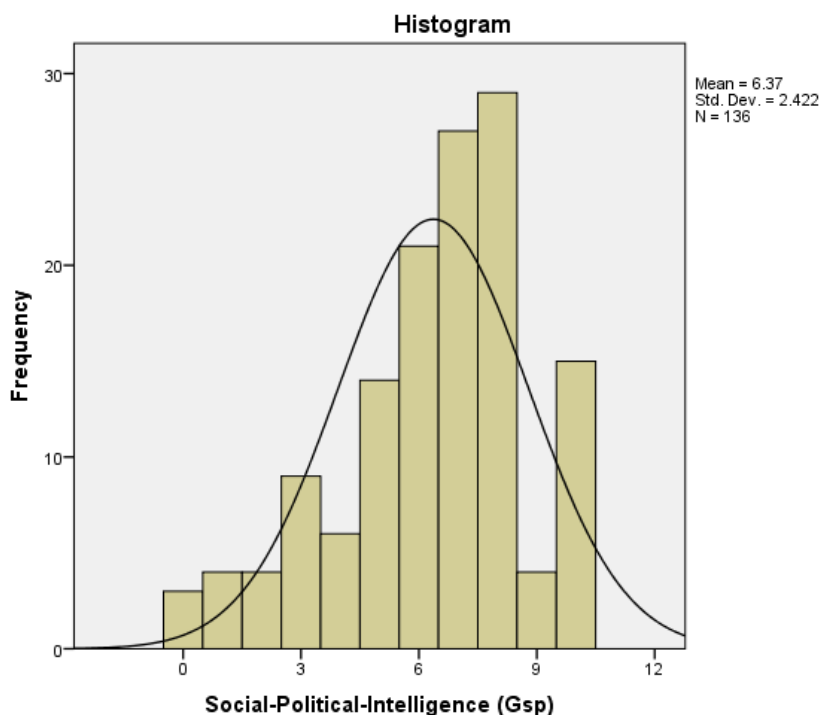


Brain Training Hypothesis: If you train resolving conflict/uncertainty, cognitive resilience, emotional-motivational engagement, internal task-management and meta-cognition, you can improve your emotional intelligence.

Social-Political Intelligence (Gsp)

SR is 'your ability to perceive and understand political dynamics, and to promote your own interests (in economic, power, influence or status terms) in a social and political context, negotiating power-relations through cooperative affiliation and/or self-assertive competition.'

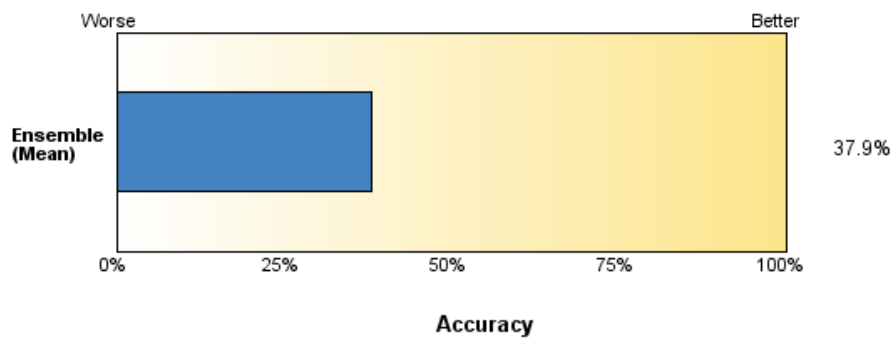
How is social-political intelligence distributed in the sample?



What predicts social-political intelligence?



How much of psychomotor ability do these cognitive abilities explain?

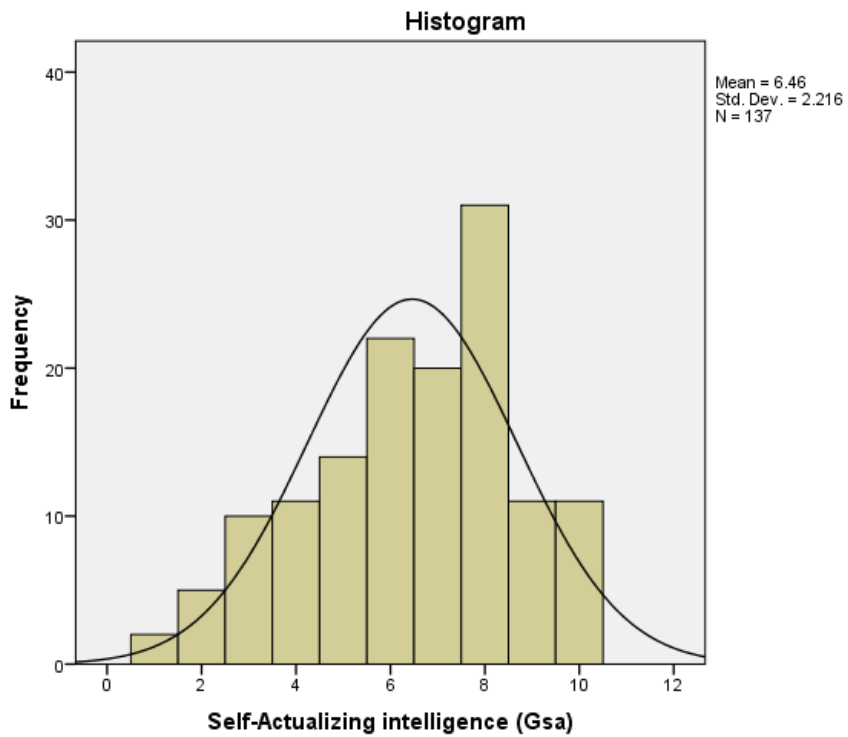


Brain Training Hypothesis: If you train internal task management, episodic processing, encoding/learning efficiency and disengagement ability, you can improve your social-political intelligence.

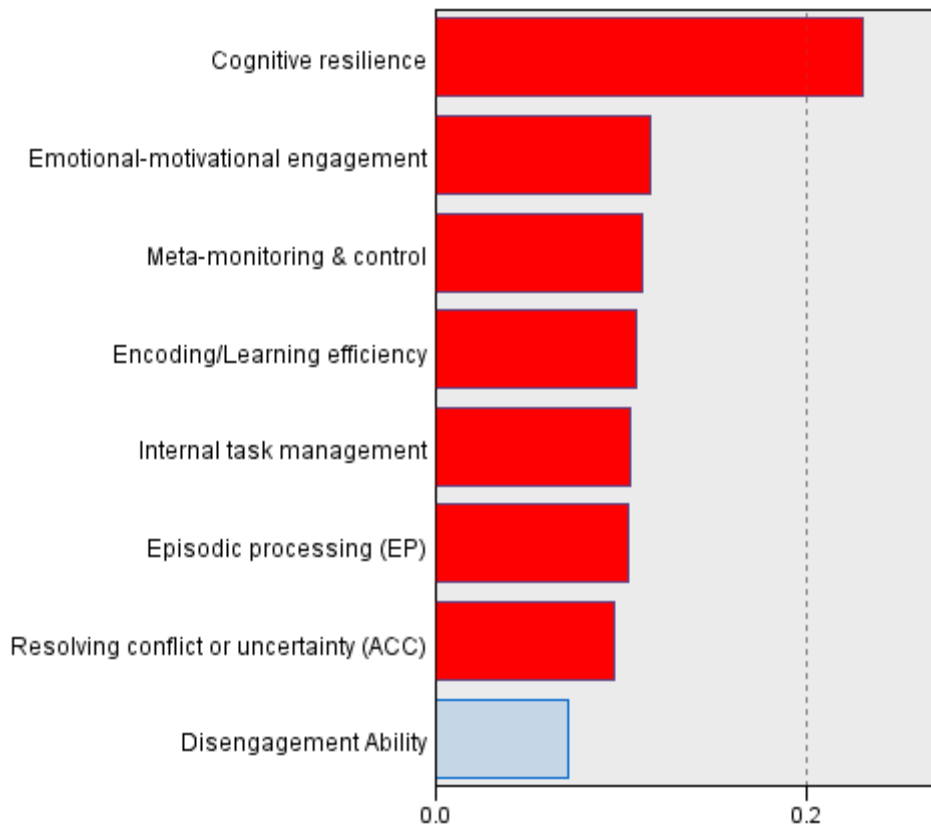
Self-Actualizing Intelligence (Gsa)

Gsa is defined as ‘in terms of your overarching life-goals...the realization or fulfilment of your talents, potentialities, and value-commitments through your own efforts, and life-choices.’

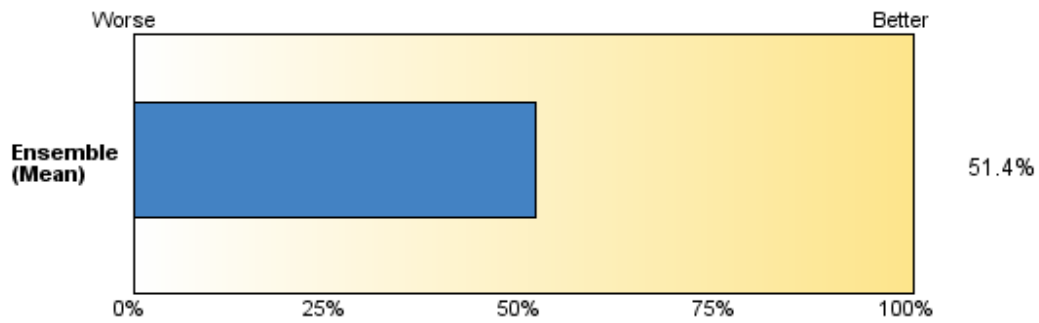
How is self-actualizing intelligence distributed in the sample?



What predicts self-actualizing intelligence?



How much of self-actualizing intelligence do these cognitive abilities explain?



Brain Training Hypothesis: If you train cognitive resilience (primarily) but also emotional-motivational engagement, metacognition, learning efficiency, internal task management, episodic processing, and resolving cognitive conflict/uncertainty, you can increase your self-actualization intelligence.