Support Information for "Human behavior complexity peaks at age 25"

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S1. Screenshots

Fig. 1 displays screenshots of the five RIG tasks as they appeared on the participants' screen.

S2. Principal component analysis

Table 1 displays the correlation matrix of task-wise complexities and CTs.

Since the complexities are only moderately correlated across the different tasks, we performed an unrotated principal component analysis of the five task complexities, using the R-package FactoMineR [1]. Two eigenvalues are greater than 1, and we shall consider the two-dimensional solution, which accounts for 54.07% of the total variance (the first dimension accounts for 33.52% of the variance).

Table 2 displays the task complexities' coefficient on the two dimensions (all p-values $< 10^{-8}$).

Because dimension 1 is mostly positively linked to all tasks except the "filling the grid" task, we interpret it as a global randomness production factor. The second dimension is mostly determined by the grid tasks and we interpret it as a randomness perception factor, for reasons exposed in the paper.

The lifespan evolutions of these two factors (namely, randomness production and randomness perception according to our interpretation) are slightly different. With our interpretation, randomness production shows a trajectory similar to crystallized intelligence, with a long period (25-60) in which the score remains high, whereas randomness perception follows a pattern we would expect from fluid mechanics measures, with a steady decay from 25 on (see Fig. 2).

These analyses confirm that RIG tasks capture several cognitive components and that some features of the tasks, notably the possibility to change a previous choice, are crucial to determine what exact cognitive component is predominantly involved.

S3. Entropy

Entropy is still widely used to reflect complexity, which it does in a very limited way. The entropy of a sequence s of symbols is defined as $H(s) = -\sum_i p_i \log(p_i)$ where p_i refers to the proportion of symbol i within the sequence s. Entropy thus only depends on the zero-order frequencies (i.e. the frequency of each symbol within the sequence) and not on the way they are arranged. For instance, the binary strings 0101010101 and 0010111010 have the exact same entropy, whereas the second would be consider more complex from an algorithmic complexity point of view. Basically, entropy is a measure of uniformity rather than of complexity. Theoretical arguments for the caveats of using entropy (as well as second-order entropy) have been set out elsewhere [2], especially when it comes to short sequences of less than a few tens of symbols.

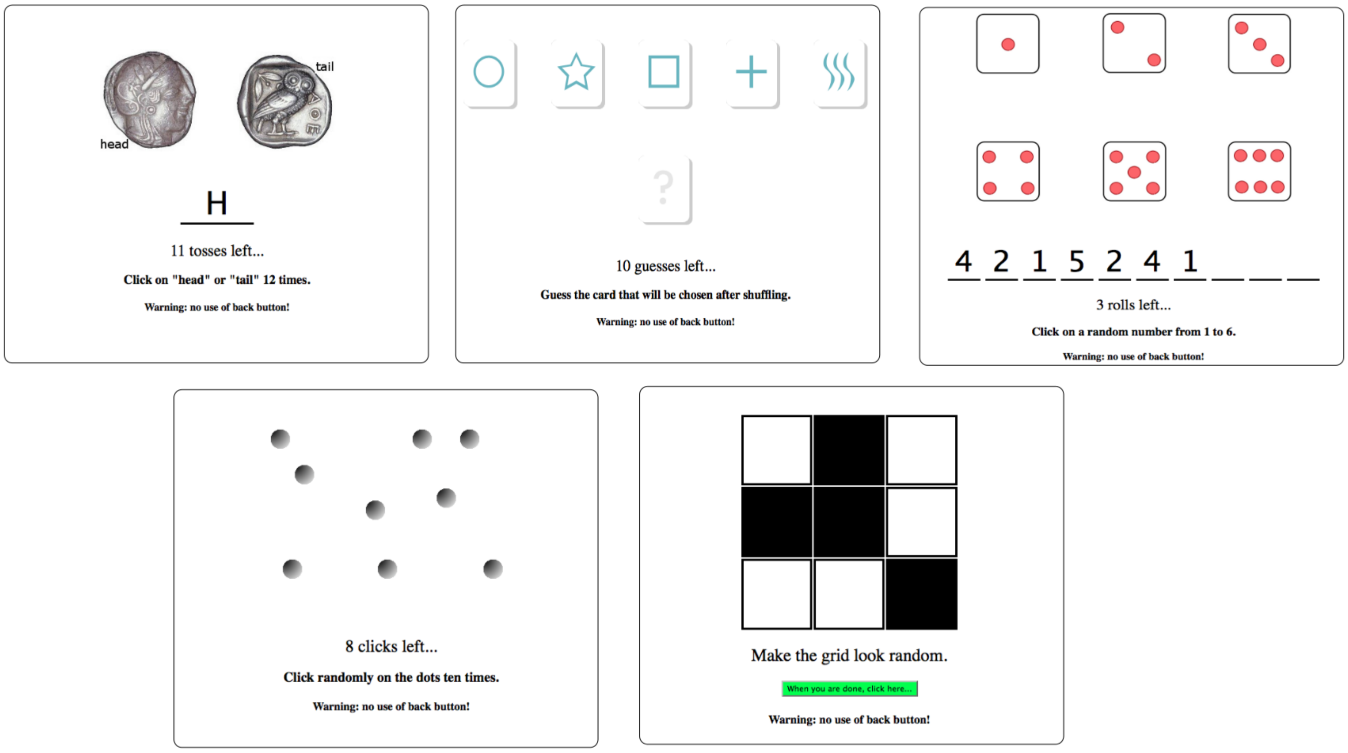
Our data provide further empirical evidence that entropy is irrelevant at least with very short sequences. Indeed, the lifespan trajectory of entropy or second-order entropy shows no clear pattern across the tasks, as shown in Fig. 3.

S4. Sex differences in CTs

Fig. 4 displays the developmental trajectory of CT split by sex. Women took more time on average, especially in and after the 60ies.

1. Lê S, Josse J, Husson F (2008) FactoMineR: An R Package for multivariate analysis. J Stat Software 25:1-18.
2. Gauvrit N, Singmann H, Soler-Toscano F, Zenil H (2015) Algorithmic complexity for psychology: A user-friendly implementation of the coding theorem method. Behav Res Meth.

Reserved for Publication Footnotes



H

11 tosses left...

Click on "head" or "tail" 12 times.

Warning: no use of back button!

10 guesses left...

Guess the card that will be chosen after shuffling.

Warning: no use of back button!

4 2 1 5 2 4 1 _ _ _

3 rolls left...

Click on a random number from 1 to 6.

Warning: no use of back button!

8 clicks left...

Click randomly on the dots ten times.

Warning: no use of back button!

Make the grid look random.

Warning: no use of back button!

Fig. 1. Screenshots of the different tasks used in the study. From top left to bottom right: tossing a coin, guessing a card, rolling a die, pointing to circles, filling a grid.

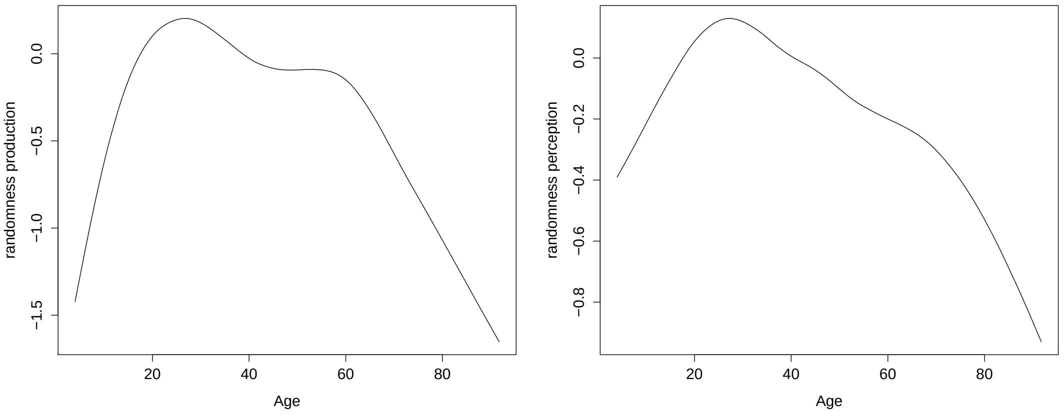


Fig. 2. Lifespan evolution of the two factors extracted with PCA. The left plot shows the smoothed evolution of Dimension 1 (randomness production) as a function of age. The right plot displays the smoothed evolution of Dimension 2 (randomness perception). A loess smoothing was used, with $df = 7$.

Table 1. Correlation coefficients between complexity measures across the different tasks and between time-on-task measures. Correlations of response complexities are given above the diagonal; correlations of CTs below the diagonal.

	1	2	3	4	5
1. Toss		.12	.13	.19	.10
2. Guess	.49		.28	.23	.01
3. Roll	.51	.60		.33	.08
4. Point	.43	.43	.51		.05
5. Grid	.33	.37	.45	.38	

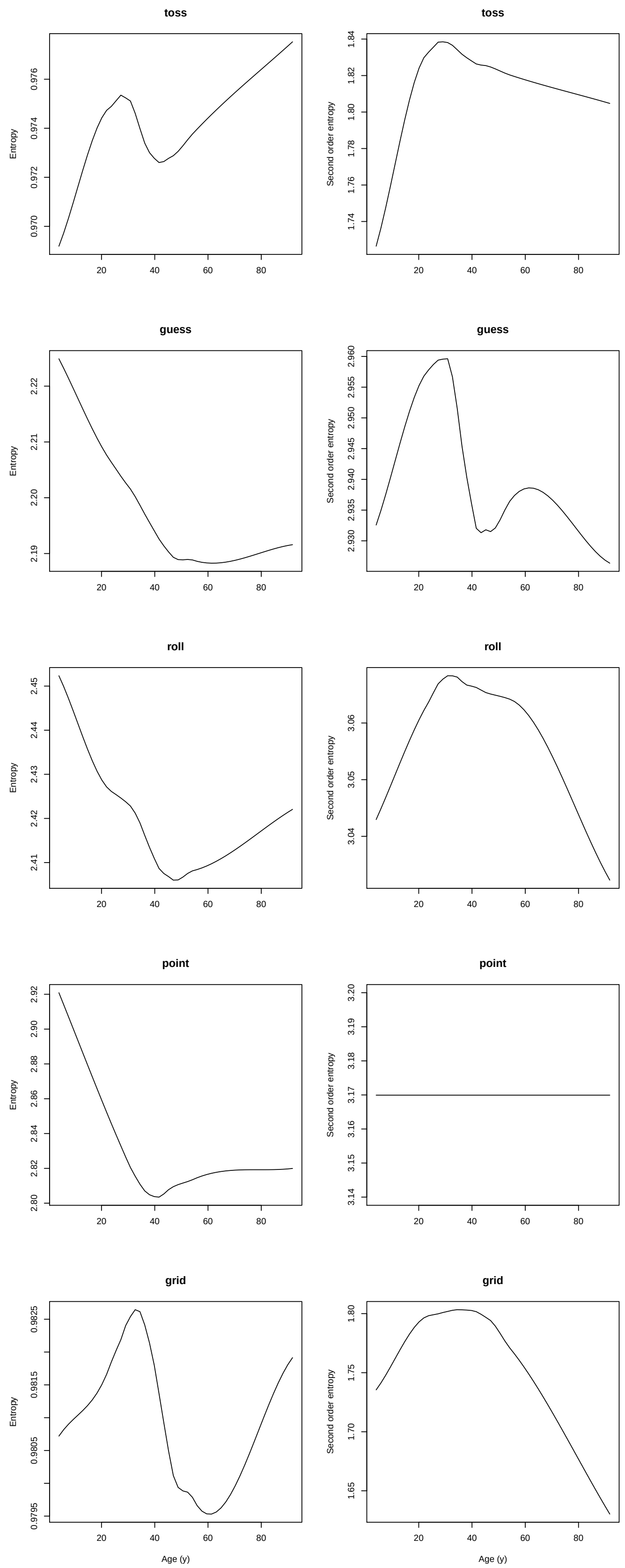


Fig. 3. Lifespan evolution of entropy and second-order entropy by task (loess smoothing with $df = 7$). The left column displays the evolution of first-order entropy for each task, the right column shows the trajectories of second-order entropy for each task.

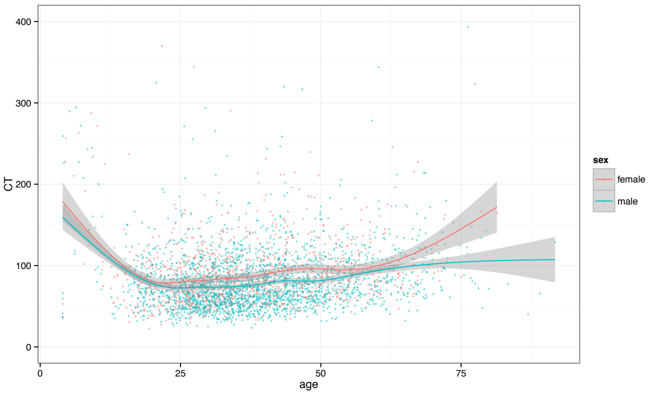


Fig. 4. Lifespan evolution of CTs split by sex.

Table 2. Task complexities coefficients in the two-dimensional solution of the CPA. All coefficient are significantly different from 0 ($p < 10^{-8}$). Coefficients with absolute values above .4 are given in bold.

Task	Dim. 1	Dim. 2
Tossing a coin	**.48**	.40
Guessing a card	**.62**	$-.34$
Rolling a die	**.72**	$-.13$
Pointing to circles	**.71**	$-.10$
Filling a grid	.22	**.85**