The cybernetics of humour: introducing signature analysis to humour research

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Abstract

Purpose – The purpose of this paper is to introduce signature analysis to humour research. Signature analysis is not widely used in the fields of humanities, the introduction of a new technique will invite comparison with the long standing factor analysis method.

Design/methodology/approach – A signature presumes the existence of a model with ideal attributes for the purpose of identification. The model derived from types of humour which describe four types of age dependence. Age dependence contrast sharply with factor analysis which usually ignores age differences in humour. The signatures of four types of humour were calculated from the average scores of all line scores of each type. The Cramer-Rao Bounds were also calculated from the same groups, this defines the centre points and the limits of best type estimators. The age profiles of individual lines were plotted against their type signatures. The error distributions were plotted, with and without offset compensation.

Findings – The error plot with offset compensation showed a spike close to the zero error, indicating the existence of significant matching between profiles and signature.

Research limitations/implications – This is an exploratory analysis of responses from 277 participants in an online long survey. More participation is required/hoped for to confirm these findings.

Practical implications – The graphical identification of context in sentences, humorous and non-humorous.

Originality/value – Signature analysis is well known in the physical sciences, the author knows of no application in psychology or humour research.

Keywords Behaviour, Mathematical modelling, Cybernetics, Artificial intelligence, Experimental psychology

Paper type Research paper

Introduction

Information theory is one of the pillars of early cybernetics research (Shannon, 1948). Signature analysis is a statistical technique based on information theory often used in astrophysics (Albrecht *et al.*, 2006) and in recognizing radar targets (Bell, 1993; Malas and Pasala, 2007).

In its early stages the signatures and distribution of errors were calculated and known in advance (Albrecht *et al.*, 2006). It was not practical to describe the shapes of numerous aircraft in mathematical equations. In practice, an aircraft signature was determined by subjecting a scaled down model to frequency proportional microwave radiation to determine the signature from reflections (Bell, 1993).

The approaches of using predetermined fixed signatures can easily be identified with first order cybernetics, since the observer will not change the signatures or the model of the observed object. The beginnings of viewing humour as a second order

The author is grateful to Professor C.R. Rao whom the author met in 1996 in an ISSS conference in Slippery Rock, PA. Professor Rao advised and encouraged the author to apply signature analysis to psychology; the author regrets it took so long to heed his advice.

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cybernetics phenomenon can be traced to the Macy conferences, when Gregory Bateson (1953) stated that "Every statement we make about the observed derives from premises about the self". Then added that the interaction between the two leads to revision of the premises about the self and suddenly the observer sees the observed in a new light, which leads to paradoxes and to humour if the two are human beings. Clearly, humour is viewed as an interaction between the observer and the observed, not as an isolated behaviour of the observed. In this study signatures are determined by the accumulation of observations, their shapes are continuously updated by new observation, thus forming a feedback path from the observed to the observer who in turn updates the signatures. The combination can be seen as an emergent system where the model of behaviour (the signatures) are continuously being updated by observations, which is the second order cybernetic situation where "All forms of observations and explanation are now expressions of the system's operations with whose production we may now deal" (Maturana and Poerksen, 2004, p. 63). By referencing the classification of humour types, signature analysis is a process of typification or schematism as discussed by Klver and Teuber during the Macy conferences (Bateson, 1953).

Another argument to support the cybernetics roots of this work is in the predictions of age trend classification, which is based on a dual feedback-feed forward model of motivation (Kadri and Duncan, 1995). The model is a nonlinear regulator based on a multiplier, not the ubiquitous negative feedback controller, and identifies four interacting dynamics.

Humour research is a rich field with numerous works on identifying types of humour associated with ethnicity, religion, nationality and profession. These attributes are qualitatively different and without bounds, while age offers a unique advantage for signature analysis; a continuous spectrum of quantitative change which makes it possible to calculate a profile of age dependence. The online survey ran from January 2009 with click-through advertising in order to solicit participation, the total count after removing duplicates and trivial records for the advertising period is 277 participants.

First signature analysis will be explained briefly and a hypothetical expression for the signatures calculated. The model for deriving the signature is based on a classification of four types of humour based on their change with age (Kadri, 2011). There are numerous definitions of humour, here it is defined as a sudden falsification of perceived threat (Kadri, 2011). This definition makes it possible to identify four types of humour by context; according to the target of the perceived threat. When the context of a joke can be identified with an immediate threat then the joke is classified as emotional. Notice the classification does not depend on the humour intensity; the classification may be applied across different vehicles as well as to non-humorous sentences and object, indeed to any object which can be identified with targeted threat. An example of an emotional joke is: I do not want the cheese; I just want to get out of the trap. Emotional jokes were found to show constant preference across age groups (Kadri, 2011). If the joke can be identified with a perceived threat to feeding resources or turf then the joke is classified in the context of feeding. An example: I love defenseless animals especially in good gravy. Such jokes were found to be highly appreciated by the young with decreasing preference with age. If the object of the threat is so indirect and involves the teller's offspring, society or wider social group then the joke is part of the parenting classification and shows rising appreciation with age, such as: I do not approve of political jokes: I see too many get elected. Here the falsified threat from politicians may be directed at society rather than the joke teller (the joke teller is

defending the others). Sociosexual jokes are not necessarily sexual in context, the target of threat is the communication or media and whose appreciation peaks with adulthood, such as: Sign at the office of a Roman doctor: Specialist in women and other diseases. The humour is in falsifying the threat of the joke teller to the content of the message. Of course if the listener is afraid of women then this is no joke! Similar interpretations are well known in humour research (Martin *et al.*, 2003).

For practical reasons the hypothetical expression for the signatures will be simplified. The simplification involves the derivation of typical signatures from observation data rather than evaluating the expression numerically. The score data is obtained from an online personality and humour appreciation survey which can be retrieved from: www.artificialpsychology.com/HPS08AR.php

Originally, the joke classification was done according to intuitive context/style identification; jokes were selected and sorted in context from emotional/self-assuring, feeding/aggressive, sociosexual/affiliative to parenting/self-defeating classification. Later on (Kadri, 2011), age dependence was found to correlate with the contextual/style classification. Subsequently, the intuitive criteria gave way to statistical criteria derived from the collective scores of all participants. The classification of context is based only on calculations of age trends as read from actual scores of participants. Big 5 personality questionnaire is available online from: http://ipip.ori.org/ipip/index.htm

Defining the signatures of humour

Part of the theoretical basis of signature analysis is the Fisher information matrix, which defines the information content in a group of observations. The observations are classified as observables $n_1, n_2, \ldots, n_i$, with uncertainties $\sigma_1, \sigma_2, \ldots, \sigma_i$ (standard deviations (SDs)). In order to define the information content, the observer relates the observables to a constructed model with certain parameters; each parameter is defined as a function of some or all of the observables.

The Fisher information matrix quantifies the information content of $j \times j$ elements, each element is the sum of partial derivatives over all the observables, generally expressed as inverse terms of the variances $\sigma_1^2, \sigma_2^2, \ldots, \sigma_i^2$. The inverse is known as the covariance matrix, whose elements define the Cramer-Rao Bound (CRB). A simple tutorial with illustrative example can be found online (Wittman, 2012).

Here, the basis of the theoretical model is described by the fuzzy logic probability distribution of humour types in Figure 1 retrieved from the text of a US patent

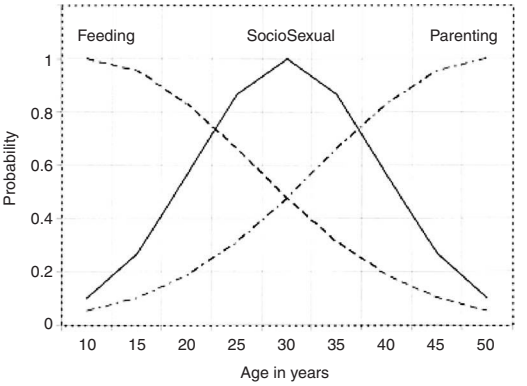


Figure 1.
Fuzzy logic age preference of the artificial psychology dialogue player

(Kadri, 2010), which is suggested by the contextual predictions of an animal motivation model (Kadri and Duncan, 1995).

By smoothing the distribution curves using normal distributions instead of the piecewise linear profiles of Figure 1, the proposed general model of humour scores (Hr) is expressed as the sum of contributions from all age trend classifications:

$$\mathrm{Hr} = \alpha_0 e^{-\alpha 2} + \alpha_1 e^{-(\alpha+1)2} + \alpha_2 e^{-(\alpha+2)2} + C_{of} \quad (1)$$

where α is the age variable with bounds between ten and 50 years, α_0 the falling constant, α_1 peaking constant, α_2 rising and C_{of} is the constant Line offset.

When a mathematically rigorous Fisher's matrix representation is derived, all its terms would contain interactions between the different age trends, which constitutes a complication with uncertain justification at this exploratory stage. Assuming interaction is negligible, a simplification will be adopted where all interaction terms are zero. The model therefore simplifies to:

$$\mathrm{Hr} = \alpha_{\mathrm{i}} \mathrm{e}^{-\alpha 2} + C_{of} \quad (2)$$

where the subscript i identifies one of the three non-constant age trend groups, and the Fisher matrix for each age trend is expressed as a 6×6 matrix whose diagonal elements are the inverse of σ_1^2, σ_2^2, σ_3^2, …, σ_6^2. The subscripts denote the index of the observables (the six age groups) and the sigma squares are the variances of each age trend. The inverse of the matrix, which denotes the CRB's, is therefore the same size matrix with diagonal elements of σ_1^2, σ_2^2, σ_3^2, …, σ_6^2 and all other terms are zeroes. The average values of trend age groups define the four signatures of humour, around which the CRB's pass.

A further simplification was adopted in order to classify the age trends; the score profiles are tested for linear regressions instead of normal distribution curves. Peaking trend was considered a two-line shape, rising pre- and falling post-adulthood.

Calculating the profiles of joke lines

While the four signatures of humour are calculated from the averages of trend groups, line profiles are averaged over the scores of individual lines. The scaled scores of individual lines are averaged for the six age groups producing 96 age profiles; each profile identifies a joke line. The profiles are plotted against the signature of the trend group to which it belongs. As an example, Figure 2 shows the profiles of jokes calculated as having falling age trend, missing numbers belong to other trend classifications. The *Y*-axis indicate units of SD of offset distribution from the mean (zero). Positive SD means higher appreciation or funnier in the eyes of the participants, negative means low appreciation or not funny.

The graphical representations show remarkable agreement between the age trend profiles of individual joke lines and group signatures. It is immediately possible to see which line has typical and which has an atypical age profile. And where typical values are identified then the proximity to meeting the CRB (best estimator limits) is often systematic and strikingly small. Figure 3 shows examples of profiles from the four trend groups and group signatures.

Clearly, there is uniformity in the distribution of profile values; there are common offset values and many profiles are images of the signatures.

The distribution of error of Figure 2 will be plotted twice, first as is, then with offset compensation. The results are shown in Figure 4(a) and (b). Figure 4(a) is the classic statistical display of error without resorting to signature analysis. Factor analysis

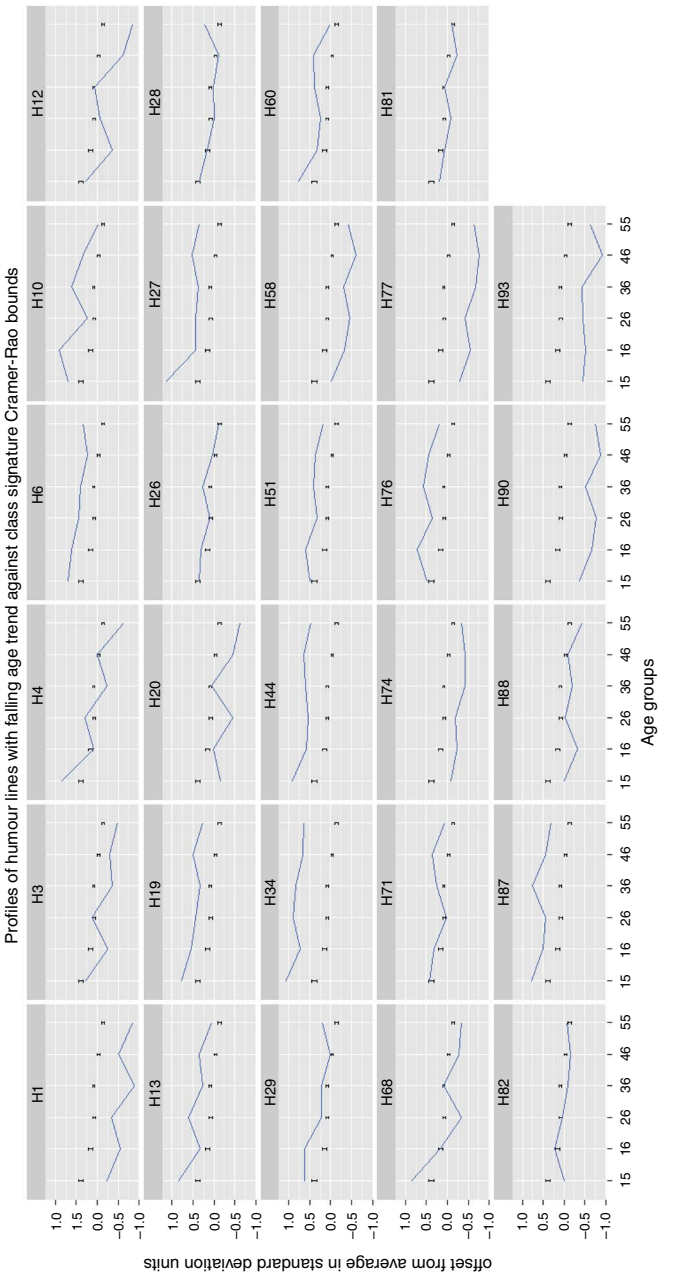


Figure 2.
Profiles of humour lines with falling trend classification and trend signature

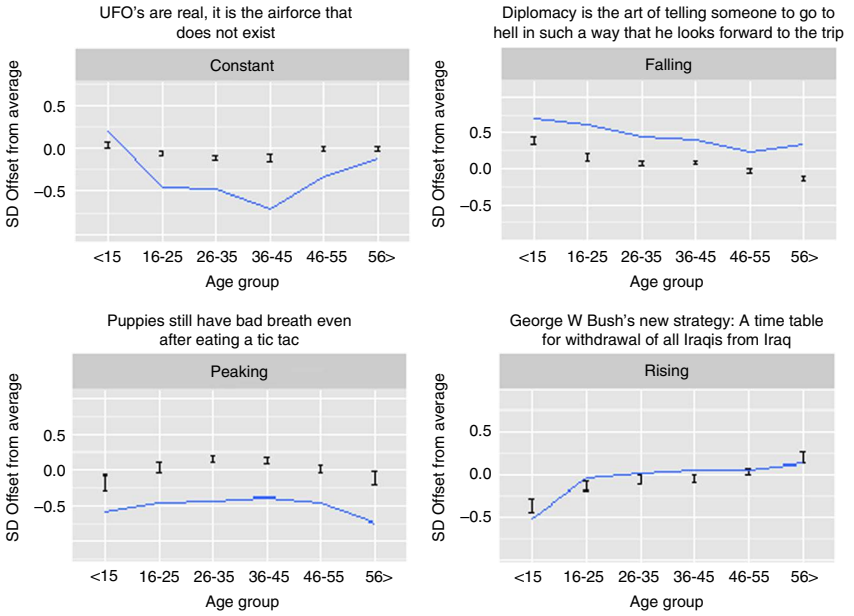


Figure 3.
Examples of profile matching from all trend groups

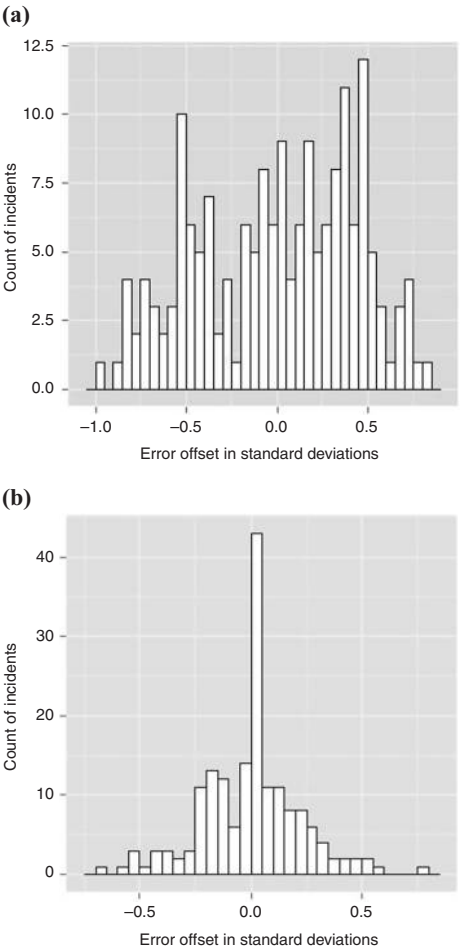
would see this distribution and not expect to find much information from age trend classification. The step of offset compensation adds a crucial element to signature analysis, it implies recognition of age profile as a group subjected to a common bias. Comparing Figure 4(a) and (b) is like comparing the images of a small object with and without a magnifier lens, offset compensation clarifies a trait of the data unseen without signature analysis. The ordinate units are the count of occurrences of error values within the bin. Notice the largest bin count in Figure 4(a) is 12. Applying the Shapiro-Wilk normalcy test to the uncompensated data leads to $p = 0.000312$, or less than 0.0312 per cent probability that Figure 4(a) data are drawn from a normal distribution. The same test produces a value of 0.58 per cent probability for Figure 4(b), which is also small but the major source of non-compliance can be identified graphically as the single spike with a bin count of 42.

The spike signifies perfect matching, which is convincing evidence to support the validity of the age trend classification of humour.

The measures of humour

The uniformity of age trend profiles suggests several ways of measuring humour parameters. The following are proposed measures resulting from signature analysis:

(1) As a measure of general funniness: consider the magnitude of profile offsets in Figure 3, it is suggested that the offset is a measure of the overall funniness of an age-typical joke line; negative offset indicates the line is less funny than average, positive means the line is funnier by the magnitude of the offset. In line 3 the offset is about 0.6 SDs below the signature average funniness. Contrast this with line 2 which shows an offset of about 0.3 SDs above signature. It is clear that this line is funnier than average and much more funny than line 3.



Notes: (a) No offset – signature error distribution of the profiles of falling humour appreciation age trend classification; (b) with offset – error distribution of Figure 4(a) after offset compensation

Figure 4.
Falling humour histogram of error

(2) As an identifier of age-typical humour: when a profile falls within CRB limits of all age groups then the joke line is recognized as a good estimator of its humour class. There is clear similarity for lines 3 and 4 by all age groups, and the shape of profiles mirror the signatures, yet line 3 is outside the CRB limits because of offset. The lines can therefore be identified as good estimator of their trend groups with offset compensation.

(3) As an identifier of atypical age groups: age groups which deviate from the pattern of a profile could mean the same groups contain age atypical participants. This could result from few wild scorers or general consistent scoring by a large

segment of the group. The profile in line 2 shows high average scores for the over 56, which is out of step with the rest of the profile and suggests the existence of random scores, or perhaps a more youthful taste of the joke line by older participants.

(4) Dual context: large swings in profiles can indicate the presence of two age trends on different age groups. For example, line 1 above shows a U-shaped profile, this could be caused by different evaluations by the young and the old. The young may evaluate the line as aggressive, which tallies with the falling trend classification, while the older groups evaluate the same line as self-demeaning, in line with the rising age trend classification.

Conclusions

Factor analysis is a statistical method of expressing the variability of multiple variables in single-term correlation coefficients. It is well suited in searching for hidden factors among cognitive, time invariant variables. In contrast, signature analysis reveals the variabilities of both cognitive age-constant and motivational age-dependent variables. It is a newer method which computes profiles of multiple values and compares them as ensembles with ideal, type representative signatures.

The CRB is the cornerstone of the application of signature analysis; the bounds contain the signature values and define the best estimate range. A profile that passes within all the bounds simultaneously is deemed to meet the CRB criterion for best estimator of the signature, deviations from the CRB are cause for rejecting the profile as a whole or to be investigated as anomalies.

It is possible to use many variables in order to calculate psychological profiles and compare with type signatures, variables such as gender, country, language and ethnic divisions. Such divisions offer qualitatively different types, which may or may not fit as part of a spectrum to create a profile. Age was elected as spectrum variable because it offers clear divisions with quantitative gradation, which makes it ideal to calculate profiles and signatures.

The use of signature analysis in the fields of humanities is a novelty; this work is a mere scratch in the surface of the body of potentials of an approach that is radically different from the ubiquitous factor analysis. The following conclusions can be made:

- The age trend classification is valid: statistical analysis leaves no doubt that age trend profiles are good estimators of types of humour. A large proportion of profiles matched the four trend classification signatures; this is highlighted by the spike in Figure 4(b). The high incidence of exact matching exemplified by the spike supports the validation of the age trend classification.
- Signature analysis is useful: signature analysis offers comparisons with graphic representation of age profiles of joke lines. The comparisons suggest new ways of measuring a line's overall funniness, the extent of age compliance, the identity of age groups with atypical scores and if there are more ways than one to interpret a sentence. The comparisons also show that general funniness does not contribute to the classification of humour, context does. In other words, the graphics show that scores have two distinct contributors: general funniness and the context of the humorous sentence.
- The source of variety in humour appreciation scores is largely deterministic: the existence of offsets shows that there is agreement across age groups over the funniness of many joke lines, confirming that changes in humour preference over

age are systematic and to a considerable extent predictable. The abundance of matching after offset compensation suggests the main source of variability in humour appreciation scores can be deterministic; this is surprising and contrasts with accepted perceptions in humour research, which uses factor analysis extensively in undifferentiated age groups (Ruch, 2008).

- Longer surveys show clearer signatures: the same analysis was applied to shorter humour appreciation surveys with 40 and 16 lines and more participants, it was found that shorter surveys increase the CRB to an extent that could make the age trend profiles unrecognizable. Longer survey participants are apparently more serious in their responses and lead to clearer profiles and signatures.

Humour, like beauty, is in the eye of the beholder. The beholder observes and responds to humour, as in a second order cybernetics sense. It is necessary to represent the subjectivity of humour and relate the observation to the observer, rather than treat humour as a purely objective phenomenon. Current humour research under-represents the observer by not differentiating between the senses of humour of different age groups. By calculating multiple age group parameters instead of single correlation coefficients as in factor analysis, signature analysis succeeds in extracting much more information. Part of the information is in the variability of age trend, the swing in preference is systematic and can be more than 1.5 SDs around the average; the swing translates to about 65 per cent change in type preference between young and old age groups if the distribution in close to normal. The variability of the peaking age trend is smaller and the joke lines are fewer but age dependence is also clear and systematic. This leaves the constant trend joke lines as evidence of constancy over age. Constancy suggests cognition as the main factor in deciding preference, while variability suggests motivation. The scale of variability leads to the conclusion that the strongest contributors to the sense of humour are motivational factors, with cognitive factors playing smaller part.

The selection of joke lines may not be truly random and the number of participants may not be large enough to dispel doubt; these conclusions are final, but the direction these results provide is unmistakable: signature analysis unlocks more information from psychological scores than factor analysis. The implications of extracting more information than the ubiquitous factor analysis are far reaching. The conclusions of this work need to be confirmed with larger and more representative participation before being leveraged in academic and commercial applications. Researchers in the areas of personality psychology, artificial intelligence and education may well-find signature analysis a relevant and useful tool in investigating individual differences. Commercial developers in sales and marketing, software design and man-machine interface may find the information extracted from signatures a profitable resource in identifying customer preferences and needs. The possibilities are boundless but the investigations should start with validating the initial conclusions exposed in this study.

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Further reading

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Dr Faisal L. Kadri is an Independent Scientist with interest in Artificial Psychology. Trained as a control systems engineer, obtained his PhD from the University of Wales Institute of Science and Technology in Cardiff in 1974. Worked in test and measurement as an employee in Hewlett Packard, then as an independent entrepreneur in Egypt. Emigrated to Canada in 1988, now he works in DynamicSignals LLC, a manufacturer of electronic test boards (digitizers). Argued that psychology should be based on animal motivation rather than human cognition, authored and co-authored papers and books in cybernetics, animal behaviour and artificial psychology. Presently interested in researching the link between humour and personality and how emotions are shaped by motivations. Dr Faisal L. Kadri can be contacted at: faisal@artificialpsychology.com

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