

THE ENCRYPTION THEORY OF HUMOR: A KNOWLEDGE-BASED MECHANISM OF HONEST SIGNALING

THOMAS FLAMSON^{1*} AND H. CLARK BARRETT^{1,2}

¹Center for Behavior, Evolution, and Culture, Department of Anthropology, UCLA

²FPR-UCLA Center for Culture, Brain, and Development

Abstract. We propose that intentionally produced humor is a form of communication that evolved to broadcast information about the self and to obtain information about others by honestly signaling the fact of shared common knowledge. According to this model, humorous utterances and acts are encrypted in the sense that what makes the joke funny is not merely its surface content, but a relationship between the surface content and one or more unstated implicatures which are known by both the sender and the receiver. It is the non-random nature of the match between this unstated knowledge and the surface content which provides evidence that the producer possesses that knowledge, and that those who appreciate the joke do as well, thus rendering humor a means of assessing shared underlying knowledge, attitudes, and preferences. We present evidence from two experimental studies of humor evaluation in support of the encryption theory.

Keywords: humor, honest signaling, encryption, assortment, relevance theory

1. INTRODUCTION

There are few phenomena in the human repertoire as consistently and reliably universal as humor (APTE 1985; BROWN 1991). The work of ethnographers has shown that humor is predominantly a social activity, often thought to encourage social bonding, and the topics of humor encompass almost every human activity (summarized in APTE 1985). Yet despite the universality of humor, formal expla-

* Corresponding author: THOMAS FLAMSON Center for Behavior, Evolution, and Culture, Department of Anthropology, UCLA, 341 Haines Hall, Box 951553, Los Angeles, CA 90095-1553.

nations of humor remain in their infancy. While there are many theories of humor, they tend to focus either on specific content (such as sexual and scatological activity) or to focus exclusively on a proximate or ultimate level of explanation. While many of these theories – such as incongruity resolution and others (see below) – capture important aspects of humor, none has yet identified a common proximate mechanism that can be tied to an ultimate evolutionary explanation for the fitness value of producing and appreciating humor.

This paper proposes and offers an initial test of an evolutionary theory of humor, the encryption theory, which hypothesizes that humor functions as an honest signal of the fact of common knowledge, attitudes, and preferences. This model hypothesizes that the universal capacity for humor ultimately evolved as a means of broadcasting information about the self and acquiring information about others to aid in determining which peers would be most compatible as long-term partners, such as friends or mates. We propose that this signaling of common knowledge is done via a novel type of information-based mechanism, *encryption*, which (by analogy to encryption in human-designed codes) makes use of the non-random match between the surface features of jokes (encrypted messages) and the underlying knowledge necessary to produce and understand them (the “key”). This mechanism, we believe, is not separate from other humor mechanisms such as surprise and incongruity, but rather, uses those (and other) phenomena as means of encryption. Thus, while the encryption theory is intended to be complementary to other theories of humor, we believe that it is the encrypted aspect of humor which explains both a pervasive proximate aspect of humor (the nonrandom fit between the explicit information in jokes and the implicit background knowledge they refer to) and its ultimate function as a social assortment device.¹

1.1. The Encryption Model of Humor

On the face of it, humor appears to have puzzling features as a form of communication. In particular, what is common to almost all forms of humor is that it is something hidden or non-obvious that makes a joke funny. While it is true that virtually all propositional communication in humans makes use of implicit information, or “implicatures” (SPERBER and WILSON 1995), there is something special about humor in that the discovery of these implicatures in jokes, and the clever nature of the fit between explicit and hidden information in a well-crafted joke, is the whole

¹ One problem that bedevils theories of humor is that it (like language and religion) is a complex multifaceted phenomenon that takes many forms and variations. No theory of humor that attempts to identify a single core function will be able to explain all of its facets, and we have no illusions that our theory will do so. Instead, we propose that signaling and detecting shared knowledge and attitudes is a core feature of humor that runs through most of its manifestations, but we do not propose that this exhausts all there is to explain about humor.

point of them. In other words, compared to standard communication, jokes are purposefully oblique.

Perhaps this aspect of humor points to an underlying design: the peculiar obliqueness of jokes might indicate a special form of communication. We suspect that the key lies in the nature of the incredibly complex, non-random, yet idiosyncratic nature of the knowledge that humans everywhere possess. Humans are a knowledge-using, and in fact, knowledge-dependent, species (BOYD and RICHERSON 1996; TOMASELLO 1999). We have culture: an enormous store of transmitted information. We also exhibit extensive inter-individual variation within cultural groups in knowledge, skills, and attitudes. This creates the possibility for mutual benefit when individuals can assort with others on the basis of the information they possess (MCELREATH, BOYD and RICHERSON 2003), which in turn means that humans might benefit both from transmitting information about their personal qualities and receiving information about the personal qualities of others.

However, when individual properties are not directly observable – as is the case for privately held information – this opens the door for deception. If I can convince others that I have valuable skills, knowledge, or other resources, I might convince them to do things for me and to associate with me, potentially reaping the benefits of cooperation illicitly. Under such conditions, game theorists have shown that communicative signals about hidden personal attributes can only evolve when there is some mechanism ensuring their *honesty* – that they accurately index unobservable properties in a way that cannot be faked – which in turn gives the receiver reason to believe the signal (MAYNARD SMITH and HARPER 2003). One well-known means of ensuring honesty is signal cost (GRAFEN 1990). However, encryption theorists have demonstrated another means of ensuring the honesty of signals: informational complexity, i.e., the nonrandom fit between a message and the information needed to produce it, which guarantees that the sender must have had that information (PIPER and MURPHY 2002). While encryption theory was developed as a means of reliably producing human-made codes that guarantee honesty, we believe that nature might have hit upon an analogous honest signaling mechanism in the form of encrypted humor.²

² Encryption theory was also developed as a means of ensuring the secrecy of messages. We wish to stress that the point of humor is not the secrecy of the overt message (the explicit information in the joke is available to all listeners), but rather, the fact that the hidden implicature of a joke will be understood only by those with the relevant background knowledge. It is the fact that this background knowledge is not revealed that maintains the honesty of humor as a gauge of knowledge possession.

**1.1.1. The proximate mechanism of humor:
Encryption-decryption as a cognitive process**

The encryption theory of humor is best understood within a formal theory of communication known as Relevance Theory (SPERBER and WILSON 1995). Relevance theory, building on the work of early theorists of pragmatics such as GRICE (1957), focuses on the fact that communication in humans is inherently inferential. While communicative acts have a surface or explicit content, such as the statement “it’s cold in here,” the intended meaning is virtually never carried exclusively by the surface content itself. Rather, the surface content generates a series of inferences in the mind of the receiver, such as “he’s cold; he must want me to close the window.” These intended meanings, or implicatures, are inferred by the listener via a process that takes the surface content of the utterance as input and makes inferences about the intentions and knowledge of the speaker (SPERBER and WILSON 1995).

We propose that the encryption-decryption process of humor is a special form of relevance (following SPERBER and WILSON 1995). Here we make an explicit analogy to the formal theory of encryption (see PIPER and MURPHY 2002 for a useful summary). This analogy is intended loosely, and not all of the elements have a strict mapping from humor encryption to formal encryption. What we intend to capture is that in both humor and formal encryption, there is a publicly available utterance or production (the “joke” for encrypted humor; the encrypted message in formal encryption) whose intended meaning cannot be understood without possession of a key. In the case of humor, the “key” is the background knowledge needed both to produce and to understand the joke. Formal encryption theory shows how, given a combination of a sufficiently complex key and/or encryption algorithm, a message can be essentially guaranteed to have been produced only by someone in possession of the key/algorithm, and readable only by someone with the same key and algorithm.³ The analogy to humor is that in a successful joke, both the producer and the receiver share common background knowledge – the key – and the joke is engineered in such a way (including devices like incongruity) that there is a nonrandom fit between the surface utterance and this background knowledge that would only be apparent to another person with the background knowledge. Humor therefore guarantees or makes highly likely that specific, hidden knowledge was necessary to *produce* the humorous utterance, and that the same knowledge is present in anyone who *understands* the humor. The encryption theory bears a strong resemblance to what are commonly known as “inside jokes”: jokes that only those “in the know” can produce and get. However, we propose that in almost all cases, production and enjoyment of jokes depends on and indexes hidden, shared background knowledge, and a much larger swath of humor consists of “inside jokes” than is generally rec-

³ Strictly speaking, the need to possess the exact same key and algorithm is only true for symmetric encryption / decryption processes (PIPER and MURPHY 2002). Here we assume at least some degree of shared knowledge, or a common “key”, in both producer and receiver.

ognized. The function of encrypted humor is not secrecy *per se*, but rather, honestly indexing the presence of shared background knowledge in an efficient way that does not give away the background knowledge itself. It is thus a guarantee of authenticity on the part of the sender.

**1.1.2. The ultimate function of humor:
signaling internal similarity**

Via encryption, the fact of shared knowledge can be made mutually manifest through humorous utterances, without ever making explicit the background knowledge itself. This is how it guarantees the honesty of the signal, because if the relevant background information were made clear in the joke, the value of the knowledge test would be lost. Moreover, jokes can efficiently reference large amounts of background information at once, adding to the improbably complex fit between key and encrypted utterance, which encryption theory shows is important to maintaining the authenticity of the encryption (PIPER and MURPHY 2002). The more cleverly and non-randomly a humorous utterance dovetails with hidden background knowledge to produce an intended meaning, the more the receiver can be sure that the intended meaning was not produced by coincidence, and, therefore, the more he can be assured that the sender possesses the background knowledge in question. To those that do not hold the key, however, the utterance will simply appear to fail to conform to the principle of relevance; it may have meaning, but the meaning will be puzzling, irrelevant, or non sequitur.⁴

According to our theory, “getting” a joke – successfully applying a key to draw encrypted implicatures – guarantees or makes highly likely that producer and receiver share hidden background knowledge. We are not saying, however, that either producer or receiver need be aware of this explicitly. The sense of funniness, or mirth, that results is an internal pleasurable affective signal that indexes shared underlying knowledge and attitudes, and produces a positive evaluation of the producer, though the true reasons for this positive evaluation might not be known to the parties involved (much as the pleasurable taste of food indexes its nutritional quality in ways not explicitly known to the taster). Further, the receiver’s laughter can

⁴ CLARK and SCHAEFER (1987) have made a similar suggestion that certain kinds of covert communication can occur by reference to a shared “key”. Our encryption model is similar to Clark and Schaefer’s in the relationship between hidden implicatures and a shared key, but Clark and Schaefer focus on a slightly different form of *overt* reference to a shared key, which functions to specifically hide meaning from overhearers, as opposed to the *covert* reference to shared keys that we propose is a feature of humorous productions. Our suggestion, while similar to Clark and Schaefer’s in many ways, is that humor specifically makes manifest the *fact* of shared knowledge only to those who share that knowledge. When you make a joke and others get it, a mental connection is made, but if they do not get it, that absence of shared knowledge is not necessarily manifest. However, we agree that shared knowledge, once recognized, can be used as a means of exclusion via an encryption-like process.

reliably indicate his access to that same key, making encrypted humor not just a means to advertise one's access to background knowledge, but also a means to assess the level of access in one's audience. Although people can laugh at a joke they do not get, reducing its utility as a probe of audience knowledge, recent evidence suggests that there are several detectable differences between honest and fake laughter (so-called "DUCHENNE" and "non-Duchenne" laughter, e.g., BACHOROWSKI and OWREN 2001; KELTNER and BONANNO 1997; VETTIN and TODT 2004).

With iteration, repeated instances of mutually appreciated humor will provide agents with a reliable index of the relative degree of shared cognitive environments, styles, attitudes, and backgrounds between themselves and various other agents. Humor works, in a sense, as a mind reading spot-check, "pinging" various minds in the environment and discovering those which are most compatible.

What would be the evolutionary advantage of being able to honestly signal the possession of shared information? We suggest that the major fitness benefits of humor would have come in the form of identifying individuals with shared attitudes, interests, backgrounds, and goals, for the purposes of social affiliation and assortment. In other words, humor could have evolved as a tool that allowed "cognitively similar" individuals to identify each other and assort, leading to the fitness benefits that accrue to individuals that successfully solve problems of coordination and cooperation (MCELREATH et al. 2003). It is widely held in the literature on cooperation in economics, game theory, and evolution that individuals who are able to solve problems of coordination are able to reap social benefits that others cannot. Encrypted humor, as a reliable indicator of shared knowledge, values, attitudes, and other mental traits, could serve as an assortment device, allowing like-minded individuals to identify each other and assort within the local group. The fact that encryption relies on shared knowledge "keys" means that shared knowledge and attitudes can be reliably inferred in ways that cannot be faked by those who do not share the key, barring individuals from illicitly reaping the benefits of cooperation.

Here, we will present an initial test of the encryption hypothesis, in the form of two studies testing the effects of encryption on people's evaluations of humor. These studies only address the first component of the encryption hypothesis: the proximate process of encryption/decryption which predicts that the relationship between background knowledge and surface content is the key to a joke's funniness. Studies addressing the assortment function of humor are underway.

2. EXPERIMENT 1

In order to test the first component of the encryption hypothesis, we designed an experiment to manipulate the level of encryption in humorous materials by making relevant implicit knowledge explicit in some conditions, and to control for participant familiarity with the topic of that material. Our hypotheses were as follows:

I. Overall, people with greater prior knowledge of the material should find a joke funnier than those unfamiliar with the topic, as they have greater access to the information necessary to derive the encrypted inference.

II. People with more prior knowledge of the material will find a joke funnier when necessary information is not made explicit, as the provisioning of this information reduces the encryption of the inference.

III. Conversely, people with less prior knowledge of the material will find a joke funnier when the necessary information is made explicit, as this enables them to more easily decrypt the inference.

2.1. Methods

2.1.1. Participants

Participants were recruited through postings to psychological websites and discussion boards (list available upon request) between July 2005 and February 2006. Participation was anonymous, and no compensation was offered.

382 participants initially completed the study. Each participant was randomly assigned to 1 of 6 counter-balanced presentation orders. The smallest of the 6 presentation order groups contained 57 subjects. Therefore, to make the number of participants from each set equal, we included only the first 57 subjects from each set, resulting in an initial pool of 342 subjects. Our data analysis required that each subject have results for all possible combinations of encryption and prior knowledge (see details of experimental design below). 194 subjects met this criterion, and were included in our final sample ($N = 194$, 128 female, 66 male, age range = 18 to 80 years, $M = 30.0$, $S.D. = 12.2$).

2.1.2. Materials

Twenty-one narrative style jokes were selected from online jokes databases. The punch lines of these jokes referred to a discrete cultural item such as a celebrity, film, or catchphrase. Five of these jokes were presented first in their original form to all subjects as controls; the remaining 16 were presented in either a “high encryption” or a “low encryption” format to each subject. The “high encryption” jokes were presented in their original form. The “low encryption” jokes were created by adding relevant information about the cultural item to which the joke’s punch line refers, within the text of the joke (*Table 1*).

Table 1. Sample high and low encryption jokes and familiarity questions

<p>Sample High Encryption Joke</p> <p>In the confusion of the early days of the Iraq War, many of the smaller stories were missed and are only now being told. On the eve of the war, a bunch of Saddam Hussein's body doubles were waiting in a lounge. They turned on the TV and heard on the news that Saddam's palace had been bombed. One of Saddam's advisors called them and said he had good news and bad news.</p> <p>The doubles said they wanted the good news first, so the advisor said that Saddam had survived the blast. The doubles were greatly relieved.</p> <p>"Then what's the bad news?" they asked.</p> <p>"Saddam lost one of his arms," the advisor replied.</p>
<p>Sample Low Encryption Joke[#]</p> <p><i>Until recently, Saddam Hussein was the brutal dictator of Iraq. Constantly fearful of assassination attempts, Saddam Hussein acquired a number of men to serve as body doubles and make public appearances on his behalf, so they would be the targets.</i> A bunch of his body doubles were waiting in a lounge when they heard on the news that Saddam's palace had been bombed. One of Saddam's advisors called them and said he had good news and bad news.</p> <p>The doubles said they wanted the good news first, so the advisor said that Saddam had survived the blast. The doubles were greatly relieved.</p> <p>"Then what's the bad news?" they asked.</p> <p>"Saddam lost one of his arms," the advisor replied, "<i>So we'll have to cut one off of each of you.</i>"</p>
<p>Sample Familiarity Questions</p> <p>Please think back carefully for each item, and recall if, before reading the joke, you were familiar with the following:</p> <p>(Please check all that apply)</p> <p><input type="checkbox"/> Saddam Hussein</p> <p><input type="checkbox"/> Saddam Hussein had body double</p>

[#] Note: additional information added to low encryption jokes that is not present in high encryption jokes is indicated by italics. Note that text was not italicized in the versions given to participants.

2.1.3. Procedure

Subjects participated in an online questionnaire designed with RiddleMeThis software (<http://loewald.com/RiddleMeThis/>), which was configured to prevent participants from going back and modifying previous answers. Participants were randomly assigned to 1 of 6 materials presentation sets, which were counterbalanced to ensure that every subject evaluated 8 high encryption and 8 low encryption jokes, and that each joke was presented in high encryption and low encryption versions to an equal number of subjects. Each subject only saw 1 version of each joke, either high or low encryption. The order of presentation was randomized within each set. After providing their age and sex, subjects were presented with the 5 control jokes, followed by the 16 high and low encryption jokes of their set. For each joke, participants were asked to rate how funny they found that joke on a 9-point Likert scale ranging from "Not at all funny" (1) to "Extremely funny" (9). After evaluating all of the jokes,

participants were presented with a list of each of the cultural items from the preceding jokes, and asked to indicate their prior knowledge of that item (for an example, see *Table 1*).

2.2. Results

The overall mean rating for all jokes (pooled across high and low encryption levels) was 4.66 (SD = 2.60; range 3.37 to 6.09). High encryption jokes had a mean rating of 4.80 (SD = 2.66), while low encryption jokes had a mean rating of 4.52 (SD = 2.53). Jokes about which the participant did not have prior knowledge received a mean rating of 3.93 (SD = 2.48), while jokes about which the participant did have prior knowledge received a mean rating of 4.92 (SD = 2.59).

For each subject, we computed an index of mean funniness ratings for each of the four combinations of high and low encryption and presence and absence of prior knowledge. We then used a 2×2 repeated measures ANOVA to examine effects of prior knowledge and encryption level on subjects' judgments of funniness. Sex and age were included as between subjects variables. There was a main effect of prior knowledge ($F(1,190) = 99.69$, $p < 0.001$, $\eta^2 = 0.34$), but not of encryption level ($F(1,190) = 1.53$, $p = 0.22$). However, encryption level did significantly interact with prior knowledge ($F(1,190) = 17.02$, $p < 0.001$, $\eta^2 = 0.08$). There was no significant main effect or interaction with sex. Effects of age were assessed by making an approximate median split to group subjects into two age categories: younger subjects (18 to 25 years, $N = 94$, $M = 20.95$, $SD = 2.43$) and older subjects (26 to 80 years, $N = 100$, $M = 38.59$, $SD = 11.55$), and using age category as a between-subjects variable. This analysis revealed a main effect of age ($F(1,190) = 7.24$, $p = 0.008$, $\eta^2 = 0.04$), such that older participants had lower mean ratings (4.45, $SD = 2.68$) than younger participants ($M = 4.89$, $SD = 2.49$) but there were no significant interactions of age with encryption level, prior knowledge, or sex.

This ANOVA revealed that prior knowledge had a significant effect, and interacted significantly with encryption level (see *Figure 1*). To examine the specific nature of these effects, we conducted a series of paired sample t tests, each examining a single factor while holding the others constant. Because we had prior hypotheses about the direction of effects we expected to observe (see above), one-tailed tests were used.

First we tested ratings within prior knowledge conditions. As predicted, participants with prior knowledge of the joke topic rated the high encryption jokes higher ($M = 5.19$, $SD = 1.67$) than the low encryption jokes ($M = 4.68$, $SD = 1.66$; $t(1,193) = 5.543$, $p < 0.001$). Participants without prior knowledge rated the low encryption jokes higher ($M = 4.02$, $SD = 2.17$) than the high encryption jokes ($M = 3.72$, $SD = 2.18$; $t(1,193) = 1.823$, $p = 0.035$).

Next, we tested ratings within encryption conditions. For high encryption jokes, participants rated those for which they had prior knowledge higher ($M = 5.19$, $SD = 1.67$) than those for which they did not ($M = 3.72$, $SD = 2.18$; $t(1,193) =$

10.33, $p < 0.001$). For low encryption jokes, this effect held as well, but the difference in mean ratings of prior knowledge jokes ($M = 4.68$, $SD = 1.66$) versus no prior knowledge jokes ($M = 4.02$, $SD = 2.17$) was not as great ($t(1,193) = 5.19$, $p < 0.001$).

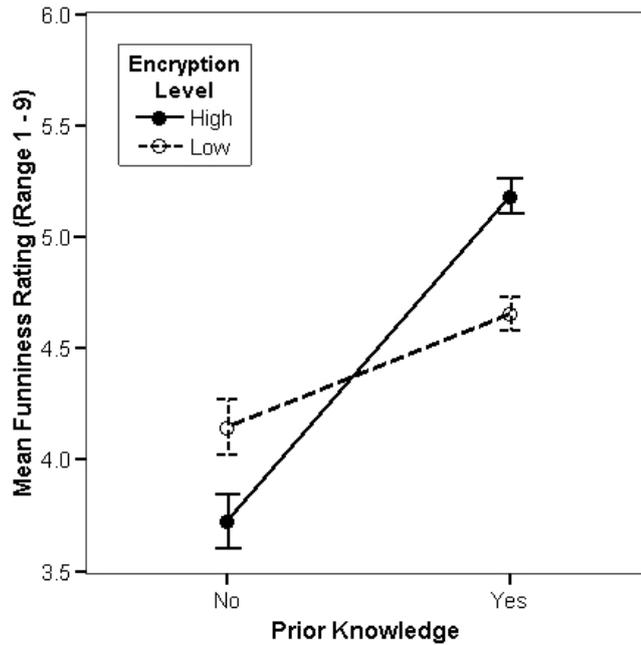


Figure 1. Two-way interaction between prior knowledge and encryption level (means \pm S.E.)

2.3. Discussion

The strong main effect of prior knowledge supports the encryption hypothesis that the funniness of a joke is contingent on the availability of the relevant knowledge on the part of the receiver. The lack of a main effect for encryption level shows that the manipulation of encryption within the text of the jokes did not significantly impact the ratings of jokes in and of itself. However, the significant interaction of encryption and prior knowledge supports the hypothesis that individual evaluations of the funniness of a joke are influenced by the prior knowledge of the receiver in interaction with the provision of that knowledge in the presentation of the joke.

The specific differences between the various conditions analyzed by the t tests further support many of the predictions of the encryption hypothesis. Participants who already possess the relevant information would be expected to rate high encryption versions higher than low encryption versions, as the low encryption version provides redundant or unnecessary information, “over-explaining” the joke.

Conversely, participants without the requisite prior knowledge should prefer low encryption versions, as the extra information better enables them to understand the joke. Within the set of participants exposed to a high encryption joke, those with prior knowledge would be expected to find it funnier than those without, as the requisite knowledge is not being provided. Within the set of participants exposed to a low encryption joke, however, the provisioning of requisite knowledge reduces the difference in funniness ratings between those who are and those who are not already familiar with the material, as the difference in capacity to understand the joke has also been reduced. Prior familiarity, however, continues to increase funniness ratings, even with information provisioning. This may in turn explain the age effect of older participants rating jokes as less funny overall, as they might be less familiar with the people and events to which the jokes referred.

3. EXPERIMENT 2

Given the importance of prior familiarity in participants' evaluations of jokes, we decided to explore that effect with a set of humorous materials that delved into that prior knowledge more deeply. In experiment 2, we replaced the "yes/no" familiarity check of experiment 1 with a more rigorous test of participant's prior knowledge than self-report. As discussed below, in this experiment we assessed participant's knowledge objectively, prior to any exposure to humorous materials, allowing for a more reliable assessment of the information participants have available while evaluating jokes.

In experiment 1, where the jokes were drawn from internet databases of widely-circulated narrative-style jokes, large majorities of participants reported familiarity with the relevant "keys" of nearly all the jokes. In order to assess evaluations of jokes about which more participants were unfamiliar, we decided to use a more obscure corpus of humorous material. This was accomplished by using a set of humorous mock headlines from *The Onion* (www.theonion.com), a satirical news outlet. All of these jokes were comprised of an image and an accompanying caption, and were selected for the relative obscurity of their "keys" by a pre-test.

Finally, in experiment 2 we changed the means of manipulating encryption from a direct change in the text of the joke itself, as in experiment 1, to an introductory paragraph that varied in the provisioning of relevant information immediately prior to evaluating a given joke. In other words, rather than providing the "decrypting" information in the joke itself – which, arguably, led to added clunkiness in the decrypted jokes – we provided an introductory paragraph prior to the joke which either provided decrypting information (low encryption condition), or length-balanced information that did not decrypt the joke (high encryption condition), leaving the joke (headline plus picture) itself constant across conditions. This was expected to preserve the manipulation of information while eliminating any manipulation of the presentation of the humorous stimuli itself.

Again, in this experiment we predicted that the prior knowledge of participants will be the primary determinant of ratings; i.e., those who already know what a joke is referring to will find it funnier than those who do not. When that prior knowledge is lacking, providing it will increase the evaluations of participants, as this provides them with the necessary information to derive the encrypted meaning. Conversely, provisioning should not increase the ratings of those already familiar with the topic, as this makes the joke less encrypted in that context, reducing the value of it as a signal of shared knowledge.

3.1. Methods

3.1.1. Participants

Participants were recruited through postings to psychological websites and discussion boards (list available upon request) through the month of May 2006. Participation was anonymous, and no compensation was offered.

218 participants initially completed the study. Each participant was randomly assigned to 1 of 6 counter-balanced presentation orders. The smallest of the 6 presentation order groups contained 30 subjects. Therefore, to make the number of participants from each set equal, we included only the first 30 subjects from each set, resulting in an initial pool of 180 subjects. As in experiment 1, our data analysis required that each subject had results for all possible combinations of encryption and prior knowledge. 175 subjects met this criterion, and were included in our final sample ($N = 175$, 115 female, 60 male, age range = 18 to 73 years, $M = 31.7$, $S.D. = 11.9$).

3.1.2. Materials

25 photo-and-caption jokes were selected from *The Onion*. These jokes referred to a discrete and obscure cultural item such as a celebrity, film, or catchphrase. 5 of these jokes were presented first to all subjects as controls; the remaining 20 were presented as test jokes in random order. For each test joke, 2 short paragraphs were prepared: a “low encryption” version which contained information directly relevant to understanding the subsequent joke, and a “high encryption” version, containing information that was irrelevant to the joke. In order to assess participant’s prior knowledge about the cultural item, a “Pop Culture Trivia Quiz” was created which asked participants to correctly identify the item from a set of plausible alternatives (*Table 2*).

Table 2. Sample joke, high encryption and low encryption paragraphs, and familiarity quiz[§]

Sample Joke	
	
<p>Frank Gehry No Longer Allowed To Make Sandwiches For Grandkids</p>	
Sample High Encryption Paragraph	
<p>Born in Toronto, Frank Gehry moved at age 17 to California, where he studied at Los Angeles City College before graduating from the University of Southern California. He is today a naturalized American citizen and lives in Los Angeles.</p>	
Sample Low Encryption Paragraph	
<p>Frank Gehry is an architect known for his sculptural approach to building design. He is best known for building curved, unevenly-shaped buildings covered in reflective metal, such as the Guggenheim Museum in Bilbao, Spain or the Disney Concert Hall in Los Angeles.</p>	
Sample Familiarity Quiz	
<p>Which architect is renowned for his curved and unevenly-shaped buildings?</p> <p>a Philip Johnson b Frank Lloyd Wright c Frank Gehry d Le Corbusier e Don't know</p>	

[§]Note: Samples are presented here in the order referenced in the text. Actual presentation to participants was in reverse order.

3.1.3. Procedure

The overall procedure was the same as in Study 1, except in this study participants were first presented with a series of 6 web pages each containing 5 quiz items, for a total of 30 questions. Then, after completing the quiz, participants were presented with the jokes, each preceded by a high or a low encryption paragraph. After evaluating all of the jokes, participants completed a brief questionnaire about their background (e.g., age, sex, education level, familiarity with *The Onion*). Finally, participants were provided with a number of links pointing them to the original content and providing the correct answers for the quiz.

3.2. Results

The overall mean rating for all jokes (pooled across high and low encryption conditions) was 4.87 (SD = 2.72, range 3.05 to 6.26). Jokes preceded by high encryption paragraphs had a mean rating of 4.69 (SD = 2.75), while jokes preceded by low encryption paragraphs had a mean rating of 5.05 (SD = 2.69). Jokes about which the participant did not have prior knowledge received a mean rating of 4.33 (SD = 2.72), while jokes about which the participant did have prior knowledge received a mean rating of 5.43 (SD = 2.61).

For each subject, we computed an index of mean funniness ratings for each of the four combinations of high and low encryption conditions and presence and absence of prior knowledge. We then used a 2×2 repeated measures ANOVA to examine effects of prior knowledge and encryption level on subjects' judgments of funniness. Sex and age were included as between subjects variables. There was a main effect of prior knowledge ($F(1,171) = 77.58, p < 0.001, \eta^2 = 0.31$), and of encryption level ($F(1,171) = 20.64, p < 0.001, \eta^2 = 0.11$). In addition, encryption level significantly interacted with prior knowledge ($F(1,171) = 5.81, p = 0.017, \eta^2 = 0.03$). There was no significant main effect of sex, or interaction of sex with prior knowledge or encryption.

Effects of age were assessed by grouping subjects into two age categories: 18 to 27 years ($N = 90, M = 23.12, SD = 2.89$) and 28 to 73 years ($N = 85, M = 40.84, SD = 11.85$), and using age category as a between-subjects variable. This analysis revealed that there was no main effect of age, or interaction of age with prior knowledge or encryption. However, there was a marginally significant interaction of sex and age ($F(1,171) = 4.27, p = 0.04, \eta^2 = 0.02$), such that, for males, the mean ratings for older participants ($M = 5.08, SD = 1.86$) were higher than those of younger participants ($M = 4.51, SD = 1.71$), while for females, the mean ratings of older participants ($M = 4.56, SD = 1.78$) were lower than those of younger participants ($M = 5.16, SD = 1.64$).

This ANOVA revealed that prior knowledge and encryption both had significant effects, and interacted significantly (see *Figure 2*). To examine the specific

nature of these effects, we conducted a series of paired sample *t* tests, each examining a single factor while holding the others constant. Because we had prior hypotheses about the direction of effects we expected to observe (see above), one-tailed tests were used.

First we tested ratings within prior knowledge conditions. Participants with prior knowledge of the joke topic rated jokes preceded by high encryption paragraphs slightly lower ($M = 5.23, SD = 2.00$) than jokes preceded by low encryption paragraphs ($M = 5.42, SD = 1.90; t(1,174) = 1.746, p = 0.04$). Participants without prior knowledge also rated the high encryption jokes lower ($M = 4.22, SD = 1.92$) than the low encryption jokes ($M = 4.80, SD = 1.97; t(1,174) = 5.631, p < 0.001$), but to a greater extent.

Next, we tested ratings within encryption conditions. For jokes preceded by high encryption paragraphs, participants rated those for which they had prior knowledge higher ($M = 5.23, SD = 2.00$) than those for which they did not ($M = 4.22, SD = 1.92; t(1,174) = 9.028, p < 0.001$). For low encryption jokes, this effect held as well, but the difference in mean ratings of prior knowledge jokes ($M = 5.42, SD = 1.90$) versus no prior knowledge jokes ($M = 4.80, SD = 1.97$) was not as great ($t(1,174) = 5.231, p < 0.001$).

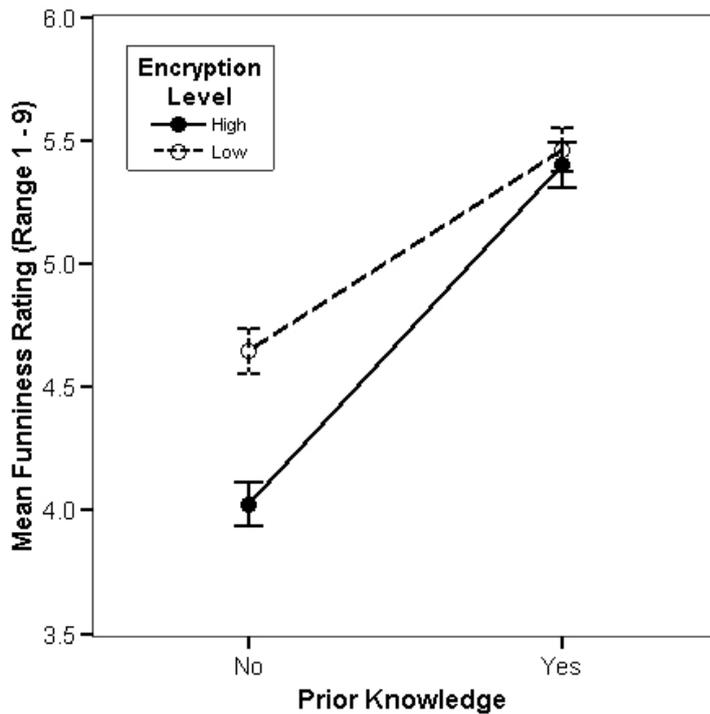


Figure 2. Two-way interaction between prior knowledge and encryption level (means \pm S.E.)

3.3. Discussion

The strong main effect of prior knowledge supports the encryption hypothesis that the funniness of a joke is contingent on the availability of the relevant knowledge on the part of the receiver. Further, the significant interaction of encryption and prior knowledge again supports the hypothesis that individual evaluations of the funniness of a joke are influenced by the prior knowledge of the receiver in interaction with the provision of that knowledge in the presentation of the joke. In this study, unlike experiment 1, encryption level also had a significant main effect, as all subjects rated jokes preceded by a low encryption paragraph higher than those preceded by a high encryption paragraph. While the interaction with prior knowledge greatly reduces this effect for participants familiar with the content, this does contrast with the complete reversal observed in experiment 1.

Upon closer examination of the specific differences between the various conditions, we find that this effect of encryption differs from that of experiment 1 in only one of the four contrasts examined by the *t* tests. Again, within the set of participants exposed to a joke preceded by a high encryption paragraph, those with prior knowledge find it funnier than those without, as the requisite knowledge is not being provided. Within the set of participants exposed to a joke preceded by a low encryption paragraph, the provisioning of requisite knowledge also reduces the difference in funniness ratings between those who are and those who are not already familiar with the material, as the difference in capacity to understand the joke has also been reduced. Further, participants without the requisite prior knowledge rate jokes preceded by low encryption paragraphs higher than those preceded by high encryption paragraphs, as the extra information better enables them to understand the joke. Participants who do have the requisite prior knowledge, however, also rate the jokes preceded by low encryption paragraphs higher than those preceded by high encryption paragraphs, albeit to a greatly reduced extent (about 0.2 points, on average, on a 9 point scale). This is the only significant difference between the results of experiment 1 and experiment 2, despite substantial differences in methodology. We discuss possible reasons for this difference below.

Finally, the interaction between age and sex in the ratings is puzzling, but also very small. As in experiment 1, it may reflect variation in the familiarity with the topics of the jokes, or it might be an idiosyncratic effect of the specific materials used.

4. GENERAL DISCUSSION

4.1. Evidence for the Encryption Hypothesis

The results of experiments 1 and 2 provide support for the encryption hypothesis. They show, as required by the theory, that a person's prior familiarity with the topic of a joke plays an important role in how funny he or she finds the joke. More im-

portantly, they show the key interaction effects proposed by encryption theory. Experimentally manipulating encryption by providing participants with more of the background information necessary to derive the encrypted meaning clearly increases funniness ratings for participants without prior knowledge in both experiments, and, in the case of the more obscure jokes of experiment 2, for participants who were familiar with the topic, as well. It is interesting that in this experiment, where the encryption manipulation was external to the text of the joke itself, encryption had a main effect in its own right.

This might be accounted for by one (or both) of two hypotheses. First, it might be the case that not provisioning the information within the text of the joke itself in experiment 2 reduced the apparent redundancy for participants with prior knowledge of the content, such that those participants did not experience jokes in the low encryption condition as “over-explained” as they did in experiment 1. Second, it might also be the case that the greater obscurity of *The Onion* materials in experiment 2 made it such that even participants with prior knowledge gained further understanding of the jokes in the low encryption conditions. Both of these hypotheses are supported by noting that the only qualitative distinction between the paired comparisons in experiments 1 and 2 is within the set of subjects with prior knowledge of the joke content. The difference in the second experiment could be due to differences in presentation format, the fact that the second set of jokes were extremely obscure and referenced multiple obscure encrypted items, or both. In any case, the predicted interaction between background knowledge and encryption occurred in both experiments.

These experiments, then, provide initial support for some key aspects of the encryption theory of humor. The funniness of a joke is critically contingent on background knowledge not possessed by all potential listeners. The relationship between the surface structure of a joke and background knowledge is also critical: jokes are funnier to those with the requisite background knowledge when that background knowledge is not made explicit, and the opposite is true for those not in the know. The fact that our knowledge probes were not sufficient to completely decrypt jokes – especially in experiment 2, where particularly heavily encrypted jokes were used – suggests that large amounts of background knowledge can be efficiently encrypted in a joke, consistent with the theory.

We mentioned above that we believe the encryption theory of humor dovetails nicely with other existing theories of humor, rather than replacing them. Next we consider the relationship between encryption theory and other theories of humor, and finally we turn to some considerations for future work.

4.2. Other Theories of Humor

Like the encryption theory of humor, many cognitive theories of humor focus on the purposeful relationship between the surface features of humor and unstated

background knowledge or assumptions. These include models of humor that involve violating the expectations of the audience (WILLMANN 1940), such as incongruity-resolution (RUCH, ATTARDO and RASKIN 1993), combining normalcy with a violation of the subjective moral order (VEATCH 1998), shifting semantic “frames” (LATTA 1999), or conceptual blending (COULSON 2001). We suggest that these accounts may represent more specific forms of achieving encryption. For example, “expectations” of the audience often reflect unstated background assumptions, and cleverly playing with these can reveal that the humor producer understands those same background assumptions. Resolving incongruity or relieving tension may also reflect what we see as the final stage of the decryption process, where the encrypted meaning is derived from the more mundane surface meaning. Pleasurable surprise occurs when hidden implicatures are discovered. Phenomena such as frame-shifting and incongruity-resolution might be particularly effective manners of encryption because they make manifest that the relationship between the surface and deep meaning of the humorous utterance is purposefully designed and non-random.

Another class of existing humor theories focuses more on the ultimate function of humor rather than the proximate mechanisms that lead to funniness. These ultimate theories broadly agree with the hypothesis that humor has a predominantly social function. WEISFELD (1993), for example, argues that the function of humor is to encourage the affiliative behavior of social learning. Because encryption assumes shared knowledge, humor for social learning would presumably reflect a different process, although encryption could be involved in guiding social learning, and clearly there is learning involved in the encryption model in identifying the knowledge bases of others. GERVAIS and WILSON (2005) propose that “nonserious social incongruity” reliably indicated times of safety that promoted social play. This is not incompatible with the idea of encryption as an assortment device, though it focuses on a slightly different ultimate function. MILLER (2000) suggests that humor is one of many means of displaying attractive qualities—creative unpredictability, in the case of humor—to potential mates. This also bears resemblance to the encryption model in that it honestly reveals underlying traits, and encryption could indeed be involved in displaying traits like intelligence. Finally, there are theories that propose a competitive, rather than cooperative, role of humor in social situations either as an ostracism mechanism designed to enforce indirect reciprocity (ALEXANDER 1986), or as an anti-dominance mechanism designed to negotiate social relationships (PINKER 1997). While these goals seem non-affiliative, it is possible that they do serve to boost affiliation with those who agree with the negative characterization of the individual in question.

It is also possible, of course, that humor evolved for one reason but can now be put to many uses, much like looming object detectors did not evolve to detect oncoming automobiles, but are nevertheless well-suited to that purpose because of their design features. Because encryption allows for the signaling of shared knowledge and attitudes, it can presumably be put to many uses that have little to do with coordination, such as ostracism or dignicide, or competitively displaying intelli-

gence or cleverness to potential mates. The fact that modern humans are able to exploit this communicative channel for other ends does not necessarily imply that it did not originally evolve as a means of assortment. Rather, this fact may imply that humans are able to expand the application of an adaptation outside of its proper domain.

4.3. Further Studies

These experiments were designed to begin testing the encryption model of humor by manipulating the information made available to participants in decrypting professionally-constructed comedic materials. Obviously, many more avenues need to be explored to fully support the model. To begin with, the role of encryption in the production of humor needs to be investigated, in addition to the role of encryption in humor appreciation tested here. Ideally, these features will also be explored in “naturalistic” humor; that is, the spontaneous production of humorous statements in everyday conversation, which is clearly a form much closer to the kind of humor available in ancestral environments than that produced by professional writers in the modern era. It is notoriously difficult, however, to systematically manipulate a participant’s production of humor in a laboratory setting, as reflected in the overwhelming use of professional comedy in nearly all investigations of the cognition of humor. The collection and analysis of spontaneous humor in everyday settings will contribute significantly to our understanding of how jokes are actually constructed.

In addition, a key part of the encryption theory of humor is that it signals shared beliefs, knowledge, and preferences, and functions as an assortment device by causing like-minded individuals to want to affiliate. This part of the theory is perhaps best tested with naturalistic observations of humor preferences and judgments, and affiliation decisions. Field studies to explore this part of the hypothesis are currently underway.

5. CONCLUSION

We believe that the encryption process we have described here constitutes a qualitatively unique mechanism of honest signaling, which does not operate via an asymmetry of costs, but rather, by exploiting the nonrandom nature of the relationship between explicitly available information (the surface utterance, or “joke”) and hidden information (the background knowledge necessary to produce and understand the joke, or the “key”). If our hypothesis is correct, then individuals are able to convincingly signal, via encryption, that they possess some piece of information that is not made manifest by the signal itself. The signal cannot be faked by someone without the proper knowledge. We do expect, of course, fuzzy boundaries to this phenomenon, and there is certainly potential for exploitation at the margins, given,

for example, that some jokes are poorly constructed or ambiguous, and that people might convincingly pretend to get jokes that they do not understand.

However, we think that this mechanism for honestly signaling shared information is a novel one with interesting features. A difference from many forms of conventional signaling is that for many biological signals, there is only one (or a few) conventionalized dimension(s) along which signaling can occur: for example, bigger or smaller tails, or louder or softer calls. This means that it is clear to everyone what a “good” signal is, and features like cost are the only barrier preventing cheaters from making the signal. In contrast, the dimensions along which humorous utterances can vary are infinite, so there is no obvious “target”, and the goodness of a joke is determined in the moment, by context. Only people in the know are in a position to make an appropriate joke. Note that this mechanism does not ensure the honesty of standard propositional communication (e.g., “Trust me, I’ll pay you back tomorrow”) which is notoriously open to transmission of false information, and whose truth content must therefore be assessed by other means. In a joke, the “true” information being conveyed is not the surface content of the utterance at all.

In summary, while humor is a low-cost signal, it is not cheap talk. We suggest that humor is a novel form of honest signaling that is made possible, in turn, by an unusual feature of humans: we have culture, i.e., shared, transmitted knowledge which is highly complex, nonrandom, and yet idiosyncratic and locally variable. Because what is signaled convincingly by encryption is the fact of sharing a particular piece of information, this kind of signaling is only possible because humans are intensely knowledge-dependent, varying substantially in knowledge, preferences, and culture, and capable of communicating about what they know. Not only might culture have set the stage for the evolution of a novel means of honest signaling in the form of encryption, it allowed for previously unprecedented benefits to coordination of activities by individuals who share knowledge and attitudes. These two features, we suggest, are at the heart of the phenomenon of humor. As HALL (1990, p. 51) notes, “if you can learn the humor of a people and really control it, you know that you are also in control of nearly everything else” in that culture.

ACKNOWLEDGMENTS

Thanks to the members of the Experimental Biological Anthropology (XBA) Lab Group at UCLA for helpful discussions of these ideas.

REFERENCES

- ALEXANDER, R.D. (1986): Ostracism and indirect reciprocity: The reproductive significance of humor. *Ethology & Sociobiology*, 7(3–4), 253–270.
- APTE, M.L. (1985): *Humor and Laughter: An Anthropological Approach*. Ithaca, N.Y.: Cornell University Press.

- BACHOROWSKI, J.-A. & OWREN, M.J. (2001): Not all laughs are alike: Voiced but not unvoiced laughter readily elicits positive affect. *Psychological Science*, 12(3), 252–257.
- BOYD, R. & RICHERSON, P.J. (1996): Why culture is common, but cultural evolution is rare. In Runciman, W.G. & Smith, J.M. (eds): *Proceedings of The British Academy: Evolution of social behaviour patterns in primates and man* (Vol. 88, pp. 77–93). London: Oxford University Press.
- BROWN, D.E. (1991): *Human Universals*. Philadelphia: Temple University Press.
- CLARK, H.H. & SCHAEFER, E.F. (1987): Concealing one's meaning from overhearers. *Journal of Memory and Language*, 26(2), 209–225.
- COULSON, S. (2001): *Semantic Leaps: Frame-shifting and Conceptual Blending in Meaning Construction*. New York: Cambridge University Press.
- GERVAIS, M. & WILSON, D.S. (2005): The evolution and functions of laughter and humor: A synthetic approach. *The Quarterly Review of Biology*, 80(4), 395–430.
- GRAFEN, A. (1990): Biological Signals as Handicaps. *Journal of Theoretical Biology*, 144(4), 517–546.
- GRICE, H.P. (1957): Meaning. *The Philosophical Review*, 66, 377–388.
- HALL, E.T. (1990): *The Silent Language*. New York: Anchor Books/Doubleday.
- KELTNER, D. & BONANNO, G.A. (1997): A study of laughter and dissociation: Distinct correlates of laughter and smiling during bereavement. *Journal of Personality and Social Psychology*, 73(4), 687–702.
- LATTA, R.L. (1999): *The Basic Humor Process*. Berlin: Mouton de Gruyter.
- MAYNARD SMITH, J. & HARPER, D. (2003): *Animal Signals* (1st ed.). New York: Oxford University Press.
- MCELREATH, R., BOYD, R. & RICHERSON, P.J. (2003): Shared norms and the evolution of ethnic markers. *Current Anthropology*, 44(1), 122–129.
- MILLER, G.F. (2000): *The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature* (1st ed.). New York: Doubleday.
- PINKER, S. (1997): *How the Mind Works*. New York: W.W. Norton.
- PIPER, F.C. & MURPHY, S. (2002): *Cryptography: A Very Short Introduction*. Oxford/New York: Oxford University Press.
- RUCH, W., ATTARDO, S. & RASKIN, V. (1993): Toward an empirical verification of the General Theory of Verbal Humor. *Humor: International Journal of Humor Research*, 6(2), 123–136.
- SPERBER, D. & WILSON, D. (1995): *Relevance: Communication and Cognition* (2nd ed. ed.). Oxford, UK/Cambridge, Mass.: Blackwell.
- TOMASELLO, M. (1999): The human adaptation for culture. *Annual Review of Anthropology*, 28, 509–529.
- VEATCH, T.C. (1998): A theory of humor. *Humor: International Journal of Humor Research*, 11(2), 161–215.
- VETTIN, J. & TODT, D. (2004): Laughter in conversation; features of occurrence and acoustic structure. *Journal of Nonverbal Behavior*, 28(2), 93–115.
- WEISFELD, G.E. (1993): The adaptive value of humor and laughter. *Ethology & Sociobiology*, 14(2), 141–169.
- WILLMANN, J.M. (1940): An analysis of humor and laughter. *American Journal of Psychology*, 53, 70–85.