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Signals of humor

Encryption and laughter in social interaction

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Laughter and humor often co-occur in social interaction, but their functional relationship is widely debated, and not well understood. The encryption theory of humor (Flamson and Barrett 2008) proposes that intentionally produced humor honestly signals the fact that speaker and audience share information, enabling the assessment of relative similarity and social assortment for compatibility over time. Drawing on relevance theory (Sperber and Wilson 1995) and other forms of post-Gricean pragmatics, humorous utterances and acts are considered encrypted in the sense that what makes them funny is not merely their surface content, but a relationship between the surface content and implied meaning understood by both the speaker and the audience. This theory provides a novel explanation of both the functions and the structure of humor, accounting for many of the characteristic features of humor production including its obliqueness, its subjectivity, and its variation both within and between cultures. While the ultimate function of this system is proposed to be social assortment, the proximate mechanism is seen as exploitable for any number of communicative acts. In addition, many existing accounts of the mechanics of humor production and appreciation are consistent with the encryption model. Laughter is a vocal signal closely related to humor, and can serve to communicate a wide range of intentions. The acoustic forms of laughter signals are intimately related to their particular communicative functions, and these functions can often be understood with reference to how humor is strategically used in any given communicative context. In this chapter, we will explore how the encryption theory of humor can illuminate our understanding of laughter, as well as the interaction between paralinguistic phenomena and the complexities of indirect communicative strategies more broadly. Making references to other models of humor, this chapter offers a theoretical review of the new proposal, based on experimental research findings.

1. Introduction

Humor is ubiquitous in human social life. It occurs not only in the way we talk, but also in how we interpret the world. People find humor in an endless variety of phenomena, and the issue of what makes something funny has intrigued and puzzled scholars since antiquity. Rather than focus on the problem of what makes something funny (as many theorists have done), instead we concern ourselves here with the production of intentional humor as a communicative act. By considering the dynamics of humor production in communicative contexts, we can begin to examine possible signaling functions of humor, and integrate research on associated phenomena such as smiling and laughter. From this perspective, an explanation will emerge of what makes communicative acts funny and why. Our analysis provides a social communication explanation of intentional humor and laughter in ordinary discourse. In the end, we hope to provide a solid theoretical basis for a future research program examining the interrelationships between humor, vocal signaling, and social assortment, with unique empirical predictions, and interdisciplinary applications.

Humor has been the subject of investigation from a variety of disciplinary perspectives, both in the humanities and social sciences (Nissan 2012, Raskin 2008). Research across disciplines reveals that humor is fundamentally social, and plays into social dynamics through both social inclusion and exclusion (Apte 1985, Provine 2000). Yet despite its universality, there is an enormous range of variation in its use. The rules of when and with whom it is appropriate to joke vary both within and between cultures, as does the range of topics that people joke about (Gallivan 1992, Galloway 2010, Parisi and Kayson 1988, Ruch and Hehl 1987). This variation speaks to an apparent paradox of humor: although people everywhere can recognize laughter and the experience of joy (Sauter et al. 2010), most will find the humor of others, even within one's own culture, often difficult to appreciate. The variety of linguistic forms that embody humor, ranging from the carefully prepared jokes of professional comedians to the more spontaneous utterances of everyday speech, to even accidental slips of the tongue, further complicates efforts to generalize across the category. While few would disagree that humor and associated behaviors such as laughter are forms of communication, it is notoriously difficult to determine precisely what is being communicated when someone is being funny (Lynch 2002).

Many of the apparent paradoxes of humor described above are potentially part of its adaptive design. Recently, we have offered a novel approach to understanding the form and function of humor, known as the *encryption theory* (Flamson and Barrett 2008, Flamson et al. 2011). We propose that humor evolved as a means of honestly signaling compatibility within local groups by relying on the detection

of “encrypted” information, the recognition of which is then signaled via honest laughter. In this chapter, we will provide a thorough description of the encryption model, relating it to both signaling theory and pragmatics. Then, we will present new insights into the role of laughter in this process, emphasizing empirical evidence about the signaling properties of laughter and the implications of this for the encryption model. Finally, we will explore the significance of encryption theory for the study of humor and laughter, critiquing some aspects of prior research, offering new interpretations of prior results, and addressing the relationship between encryption and other models of the structure of the humor.

1.1 Culture, cooperation, and signaling

As a species, humans are uniquely knowledge-dependent, reliant on the enormous store of socially-transmitted information known as “culture” (Boyd and Richerson 1996, Tomasello 1999). In addition, people exhibit extensive intra-cultural variation in knowledge, skills, values, attitude, personality, and preferences (Boster 1985, Pelto and Pelto 1975). Extensive reliance on cooperation creates opportunities to strategically engage with this variation in order to reap the fitness benefits of optimal assortment. In some situations, individuals vary along objectively distinguishable continua of quality, and optimal assortment involves competing with peers for access to the highest-quality partner available (Noë and Hammerstein 1994). In other situations, however, the optimal partner is one who is most similar to the seeker. Because people engage in many cooperative activities where coordination is important, we benefit from being able to predict the likely choices others will make – a capacity supported by our ability to make inferences about others’ mental states, known as “mindreading” (Baron-Cohen 1995, McCabe and Smith 2001, Barrett et al. 2010, Nichols 2001, Tomasello et al. 2005). To the extent that mindreading relies on an individual’s ability to create an accurate representation of another’s knowledge, beliefs, attitudes, and goals, it will be easier to represent the minds of those most similar to oneself. These facets of human life combine to create the possibility for cooperative gains when people can assort with others who are more compatible within this range of intra-cultural variation (Clark and Kanbur 2004), which in turn implies that selection would favor a capacity to transmit and detect information about personal qualities.

This kind of capacity constitutes a signaling system. Unlike a “cue,” – a feature of the world that can be exploited by an organism to guide behavior – a “signal” is a trait that evolved specifically to influence the behavior of target organisms, to the benefit of the sender and typically the target as well (Maynard Smith and Harper 2003). Signaling systems generally evolve through selection processes acting on

both senders and receivers, shaping capacities to produce the signal and interpret it. Some signals enhance the detection of directly observable characteristics, such as size, and are therefore inherently honest. However, evolutionary theorists have shown that when personal qualities are not directly observable, the door is opened for deception. Under these conditions, communicative signals about personal features can only evolve if there is some means of guaranteeing their honesty. One well-known mechanism for ensuring that honesty is costly signaling (Grafen 1990), where only those with the property being indexed can afford to produce the signal.

1.2 Encryption

Another means of guaranteeing honesty, however, can be found in modern internet communication: encryption. Some forms of computer encryption, known as Public Key Cryptography, rely on informational complexity to ensure both the secrecy and the authenticity of a message, as the nonrandom fit between a given message and the information needed to produce or interpret it guarantees that only authorized parties are involved (Piper and Murphy 2002). While most people think of this system (if they do at all) as a means of keeping their credit card numbers secret while making online purchases, it also provides a means for verifying that the person sending a message is who he or she claims to be. Through what is called “asymmetric” cryptography, individual interactions are centered around two sets of distinct keys: a public key, provided to anyone who is interested, and a related private key, held only by the individual. These are generated through a complex mathematical process that derives a public key from a pair of large prime numbers, which constitute the individual’s private key. While anyone can know the public key, it is impossible to derive the components of the private key (at least with current computing resources). When an individual wishes to send a secret message, they look up the receiver’s public key and encrypt their message – only that receiver will then be capable of decrypting the message. In addition, the process can be inverted: the individual can use her private key to encrypt the message that anyone can decrypt by looking up her public key. This creates a kind of “digital signature,” verifying that only the person attached to the public key could have produced the message by using her private key.

It is this latter form of computer encryption that is analogous to the model of humor presented here. While computer encryption was developed as a means of reliably producing codes that guarantee sender authenticity, we have proposed that natural selection has developed a comparable mechanism for honest communication in the form of humor. Here, it is not the identity which is being verified, but

the possession of implicit information. The apparent lack of structure in form and content represents the random outcomes of a system designed to honestly produce signals of personal qualities that are in turn differently received by similar and dissimilar audiences. The main point of humorous communication is typically neither the content itself, nor the details of how it is structured, but rather the fact that in successful instances both the speaker and the audience share a point of similarity in the vast array of intracultural variation. In other words, by producing a joke that only certain people get, we can ascertain who has the knowledge needed to get it, and potentially who does not.

2. The encryption theory of humor

We propose that what appear to be paradoxical features of humor – being universally identifiable, while also being exceptionally variable in both form and content – actually reflect underlying adaptive design. Humor often seems to violate basic principles of communication, such as the expectation that communicative acts should convey useful information, and they should do so in a maximally efficient way. As Grice (1975) pointed out, an intentional violation of these principles often serves to suggest a meaning beyond what is expressed or strictly entailed, known as an *implicature*. Although implicature is not a communicative device unique to humor, we maintain that there is a specific variant of implicature that is.

According to the encryption model, a necessary component of humorous production is the presence of multiple, divergent lines of inference of speaker meaning, some of which are dependent on access to implicit information on the part of both the speaker and the audience. In humor, as in formal computer encryption, there is a public product (the “joke” in the case of humor, the encrypted message in the case of cryptography) whose intended meaning can only be detected if the audience has possession of a “key.” In the case of computer encryption, this “key” is typically a string of numbers derived by means of a complex computation. Formal encryption theory has shown that with a sufficiently complex key or encryption algorithm, only audiences with access to the key can decrypt the message, and audiences can be essentially certain that the speaker also has access to that key.

In the case of humor, this “key” is the background information needed to derive implicatures present in the utterance. In a successful joke, both the speaker and the audience share access to that key, and the utterance has been produced in such a manner (via mechanisms such as incongruity) that there is a nonrandom fit between the utterance itself and the hidden information derived by those holding the key. This information can be propositional knowledge, such as an

item of popular culture, or it can be any of a variety of other personal features, such as personality traits, cognitive styles, aesthetic preferences, attitudes toward particular people or practices, adherence to values or norms, or a negative stance towards any of those.

Consider the following example, observed during ethnographic research on a collective farm in northeastern Brazil. This recording was made in late January of 2007, after several months of drought. Four women, including the speaker, were discussing the drought, when the following utterance elicited howls of laughter from the others:

- (1) *Se fica fevereiro não chueu, vou embora de novo*
If stays February not rained, I go away of new
“If it doesn’t rain all February, I’ll go away again”

To understand this utterance as a simple statement, the audience needs to apply some general assumptions, available to anyone:

- (A1) It has not rained in a while
(A2) Success in farming is dependent on rain

The audience will also derive the generalized (i.e., logically-derived) implicature:

- (I1) She had left before

To find the utterance funny, however, the audience also needs to have access to additional information, not generally available (and, in fact, only known to the authors because of post-hoc questioning of one of the audience members):

- (A3) She had left before because of dissatisfaction with her husband, who had been morose and inattentive¹

This implicit assumption, which we refer to as the “key,” was ostensibly evoked by her use of “again,” and generates an additional, encrypted implicature:

- (I2) A failing farm would make her husband morose and inattentive again

Embedded with this simple utterance, therefore, are multiple lines of inference. One, generally available to any audience, is a straightforward statement, unlikely to evoke mirth. But for those audience members with access to the key, her statement also alludes to implicit background information about the history of her marriage and the qualities of her husband. This is why the other women, all familiar with

1. Although not explicitly stated, it was strongly implied that her dissatisfaction was partly sexual.

that background, erupted in laughter, while the ethnographer, unfamiliar with these details, did not see what was funny, and only understood it after obtaining the background information from one of the audience members.

What ultimately matters in the interaction is not the specific bit of information used by the speaker to craft the joke and the audience to understand it, but the fact that both speaker and audience share access to the same bit. They do this by ensuring it is clear that specific, hidden knowledge was necessary to produce the humorous utterance, and that the same knowledge is present in anyone who understands the humor. Encryption, we argue, is a special case of inferential communication that can be proximately described through relevance theory (e.g. Sperber and Wilson 1995, Wilson and Sperber 2012), an inferential model of communication that we will now briefly describe.

2.1 Relevance theory

Relevance theory assumes fundamentally that interlocutors are engaged in a mutual effort to uncover intentions through inferential processes. The theory is rooted in two central ideas: the cognitive and communicative principles of relevance. The cognitive principle presumes that the search for relevance is a basic goal of human cognition, and that communicative efforts by others exploit that fact. The communicative principle assumes that ostensive communicative acts convey a presumption of their own relevance. By producing any behavior designed to communicate with another, speakers implicitly convey that the act is worthy of attention and is relevant to receivers. According to relevance theory, speakers attempt to maximize the effects of their communicative acts and simultaneously minimize the cognitive efforts needed to recover intentional meanings, engaging in a joint effort to provide maximally effective behavioral evidence of their intentions. The greater the cognitive effects of this evidence, the greater the relevance.

Sperber and Wilson (1995) proposed that individual agents exist in idiosyncratic “cognitive environments,” comprised of “manifest” facts:

A fact is manifest to an individual at a given time if and only if he is capable at that time of representing it mentally and accepting its representation as true or probably true... a cognitive environment of an individual is a set of facts that are manifest to him. (Sperber and Wilson 1995: 39)

A key point in this formulation is that we need not yet concern ourselves with the question of whether a given individual has attended to a given fact, only whether it is possible that he or she can do so. Manifestness is a property of the environment, interdependent with but not contingent upon the specific details of a given

individual's current thoughts. For instance, a comatose individual has no discernible cognitive environment, but a sleeping person does, as he should be capable of representing a sufficiently loud noise or sharp poke.

Some facts may be more manifest than others, based on how easy it would be to enact the potential representation (currently represented facts are, of course, maximally manifest in that particular representation). In addition, when a manifest fact is represented, one's awareness of that fact is another manifest fact. While awareness of this metarepresentation is in turn another manifest fact, and so on ad infinitum, the simple second-order manifestness is all that typically bears on communicative considerations (Sperber and Wilson 1995). Although cognitive environments are idiosyncratic, there is enormous potential for overlap. When in close proximity to another individual, all visible objects and all audible sounds that are manifest to one, for example, should be manifest to the other, barring specific obstructions or deficiencies. Similarly, facts about a language's lexicon and syntax should be (perhaps less certainly) manifest to any speaker of that language. Norms and symbols of a particular culture are (perhaps even less certainly) manifest to any member of that culture. When a fact is manifest in two or more cognitive environments, it is said to be "mutually manifest" to the agents at hand. Again, mutual manifestness does not necessarily imply mutual awareness of the fact or of the fact that it is available to both agents. Thus, communication is the process of exploiting mutually manifest facts – a particular ostensive act will make some facts more manifest by virtue of drawing attention to their manifestness. This will simultaneously strengthen the manifestness of the fact of their assumption. Because mutually manifest facts provide a baseline for inferences, speakers can craft utterances strategically with confidence that addressees will infer the intended meanings. Listeners, in turn, can be reasonably confident that the meanings (i.e., implicatures) they infer were intended by the speaker. Because people have a rich model of the thought processes of others, individuals are able to use these mind reading powers to predict the cognitive effects on an intended addressee.

An efficient utterance maximizes its contextual effect by only providing "useful" information that is neither already known nor completely inapplicable. Producing relevant utterances can have one or more of three effects upon the audience's information: implicating new assumptions, strengthening existing assumptions, or eliminating false assumptions. The interpretation of an utterance that maximizes these effects is the most relevant one, and this merits its adoption as the correct inference.

2.2 Relevance and encryption

Let us now turn to the question of how relevance theory can help us understand the production of humor as an honest signal. When a speaker produces an utterance of any kind, she² produces explicit content and ostensive behavior implicating unstated information. Humor, we propose, is a special “encrypted” form of ostensive behavior that relies on principles of relevance to produce certain cognitive effects, but in such a way that some effects will only be made manifest to those who have a sufficiently similar cognitive environment to derive that implicit content. Audience members that do not share the cognitive environment with the speaker will derive more mundane inferences of speaker meaning, unaware of the encrypted information that has been conveyed. However, while they will be unable to uncover the fully intended meaning of the speaker, they might recognize the presumption of relevance for others. In other words, they don’t get the joke, but they may know there was a joke.

These implicatures can be considered “encrypted” because they are hidden within a set of plausible inferences of speaker meaning, and can only be detected by those audience members who have access to the “key,” or the set of implicit information necessary to draw the relevant implicatures from the facts made manifest in their cognitive environments. Moreover, speakers intentionally structure utterances and ostensive behaviors in such a way as to make those implicatures *easily* manifest to those in possession of the key, while not making manifest the need to have those propositions and assumptions in order to derive some implicatures from the utterance. The degree to which the encrypted set of implicatures seems non-random to key-holders strengthens the manifestness of the speaker’s possession of the key. In this way, ostensive phrasing – choosing particular words and structures that can be assessed as simply a failure to be optimally efficient by those without the key, but that strongly suggest an additional line of inference to those with the key – serves to make manifest both the encrypted assumptions and the fact of an intention to make said assumptions manifest.

A humorous utterance, then, is (at least) doubly relevant: in the first case marginally relevant to any audience member by virtue of its modest contextual effects on their cognitive environment, and in the second case strongly relevant to that subset of the audience whose cognitive environments contain the key. Members of that subset are able to draw both (or more) inferences, and further infer that the

2. For ease of exposition, we refer to the speaker as “she” and the audience as “he” when employing pronouns.

speaker intended that both lines of inference would be followed. The fact that the encrypted implicatures require recourse to information that is not obviously active but is manifest in the decrypting receiver's cognitive environment implies that the speaker has better-than-average access to a true representation of the audience's cognitive environment, which is most parsimoniously explained by assuming that the speaker has a similar cognitive environment in that regard.

Intra-culturally variable personal features can be advertised and detected in this way without making the background information explicit. This ensures the signal is an honest one, as overtly stating the relevant background information would remove the value of the test. Further, jokes can add to the informational complexity by efficiently referencing large amounts of background information simultaneously, thus increasing the improbably complex fit between key and utterance. Greater cleverness and non-randomness in the fit between the utterance and the background information will further assure the audience that the presence of the encrypted implicatures was not coincidental, adding confidence that the speaker has access to that information. Those audience members who do not have access to the key, however, will simply infer the surface interpretation, perhaps finding the meaning to be puzzling, irrelevant, or non sequitur, but not necessarily incomprehensible.

The encryption model generates testable predictions about (1) the structure of humor as an encryption-decryption process and (2) that humor can function to facilitate social assortment. In a series of studies, Flamson and Barrett (2008) found that evaluations of jokes (i.e., judgments of funniness) were a function of both prior knowledge and the degree of encryption in the presentation. In addition to rating jokes as funnier when they had prior access to the relevant information, participants also responded to a manipulation of the encryption level, where those in the "low-encryption" condition had some of the information needed to understand the joke provided for them while those in the "high-encryption" condition did not. Those participants who did not already have access to the prior information responded more strongly (i.e., rated jokes as funnier) to the low encryption condition than those who already did. In one of the studies, relying on jokes about widely-known bits of popular culture, this interaction was strong enough to lead to a crossover effect, where those who did already have the information rated the high encryption version funnier than the low encryption. This demonstrated that having the "key" was important for judgments of humor, and that providing the key in the joke significantly reduced how funny the joke was. This is consistent with the well-known phenomenon of how explaining a joke

ruins it. In the second study, which used more obscure material, the crossover effect did not appear (i.e., low-encryption versions were funnier for both kinds of participants), but the effects were much stronger for those without prior knowledge of the material, again supporting the prediction that prior knowledge will interact with the degree to which this knowledge is encrypted as implicatures of the jokes. These findings were replicated in an ethnographic study conducted on a collective farm in rural northeastern Brazil (Flamson and Barrett 2013a), where it was also shown that dyadic similarity in funniness ratings was correlated with social affiliation. The relationship between humor and implicit preferences predicted by encryption theory has also been demonstrated by Lynch (2010) in audience responses to derogatory comedy, where it has also been shown that people high in self-deception laugh less than others (Lynch and Trivers 2012).

The assortment function of humor has been shown in an analysis of social networks and interpersonal evaluations on the Brazilian collective farm mentioned above, where ratings of how funny participants considered another member of the collective predicted social closeness (Flamson and Barrett 2013b). In addition, this was shown to be related specifically to evaluations of dyadic similarity between participant and target. Further, an analysis of the prosody of conversational humor at this site showed that in contexts favoring the reinforcement of existing social ties (i.e., through signaling the possession of knowledge), humor is not acoustically marked, relying instead on the evocation of shared information with existing allies (Flamson et al. 2011). Curry and Dunbar (2013a) also demonstrated that similarity in humor preferences was associated with both higher levels of affiliative preferences and of altruistic behavior, and was not simply a result of an overall “halo effect” of generally positive assessments. Similarity in humor preferences was also the best predictor of self-reported altruism and emotional closeness among existing friends (Curry and Dunbar 2013b).

Encryption theory has also been productively applied to the analysis of specific instances of comedy and spontaneous humor, such as examining the background knowledge relied upon by the stand-up comedian Chris Rock (Kuhle 2012), or the use of humor in signaling positions and attitudes by presidential candidates during the 2008 primary debates (Stewart 2012). In an unexpected turnaround of inspiration, encryption theory has also contributed to the development of an innovation in computer cryptography that relies on shared knowledge to enhance communication and security in ad-hoc, decentralized computer networks. This innovation is being pursued as a component in a collaborative cyber-defense system at Los Alamos National Laboratory (Kent and Liebrock 2011).

3. Encryption and laughter

According to the encryption model of humor, “getting” a joke consists of successfully applying a key to draw out encrypted implicatures, consequently making it highly probable that the speaker and the audience share access to the key. This discovery, of course, does not need to be consciously accessible to be functionally important in social interaction. Rather, the sense of funniness or mirth that results from getting a joke is an internal affective signal, indexing a positive evaluation of the speaker. Much as the pleasurable taste of food indexes nutritional qualities that eaters are not explicitly aware of, finding someone funny can serve to increase one’s interest in interacting with the speaker without their explicit knowledge of why it would be useful to cultivate a relationship. Producing an overt response to successful humor, however, can be important in developing and maintaining relationships, making laughter a useful signal of this similarity. Thus, laughter can reliably indicate an audience’s access to a key, making humor both an honest signal of one’s own personal qualities, and a means of assessing the qualities of one’s audience.

Why is laughter in particular so intricately related to humor in this way? The close connection between humor and laughter has been noted by countless scholars, but only recently has the association been grounded in a theoretical framework approaching it as a signaling system. Human laughter is phylogenetically related to a variety of play vocalizations in other primate species (Davila Ross et al. 2009, Vettin and Todt 2005), and as such, not only bears structural resemblance to these other primate vocal behaviors, but provides clues as to its pragmatic functions. The acoustic properties of human laughter manifest with tremendous variety between and within individuals (Bachorowski et al. 2001), but a number of consistent characteristics have driven some researchers to describe it as a stereotyped vocalization (e.g., Provine and Yong 1991). Laughter can be roughly described as a spontaneous vocalization with initial burst amplitude and rhythmic respiratory and laryngeal activity manifesting as separate calls. These calls (together called a bout) often decline in pitch and loudness over time, and while much variation can occur within a bout, there is generally structural consistency within them. The burst-like feature is perhaps the most distinguishing characteristic since many laughs contain only this attribute and end as abruptly as they start. Bachorowski and Owren (2001) described many laughs that contained only unvoiced noise, and lasting less than half a second. Despite this, in context, these noises are easily classified by naïve listeners as laughs, even though they bear almost no acoustic similarity to the typical consonant-vowel sequence “ha-ha-ha” that people stereotypically identify as a laugh.

Different acoustic features have predictable consequences for emotional interpretations of laughs. For example, voiced laughs (i.e., tonal with formant structure) were perceived as relatively more positive and friendly than unvoiced (i.e., atonal) laughs (Bachorowski and Owren 2001). Szameitat et al. (2011) found commonalities between acoustic features of emotional dimensions in laughter and speech. Overall, positively-valenced judgments were associated with faster laughs, more F0 variability, and greater voicing. These findings are consistent with earlier research showing that greater variability was associated with positive judgments of laughers (Kipper and Todt 2001, Vettin and Todt 2004). The ways people laugh have important consequences for how they are received, and we argue that these acoustic features play important roles in the signaling of successful decryption in humor and other indirect speech (Bryant 2011). As we will describe below, honest laughter allows speakers to identify audience members who possess the “key” to decrypt their humor, and third parties can make reliable judgments about those who reveal their connection in such acts.

Recent research has revealed the power of shared laughter to index familiarity between speakers (Bryant 2012). When people laugh together in ordinary conversation, they do so in different ways depending on whether or not they know each other, and how well they like one another. When laughing together (i.e., within 1 sec. of one another), familiar speakers tend to laugh longer, louder, more often with voicing (i.e., vowel-like), and with greater variability in the relative timing (onset to onset) compared to unfamiliar speakers. Not surprisingly, friends also laugh together significantly more often than strangers, and female friends do this the most (Bryant 2012, Smoski and Bachorowski 2003). Speakers also laugh differently when they are engaged in shared laughter compared to non-shared, with shared laughter having acoustic features that suggest a chorusing function (Bryant 2012).

The acoustic differences between friends’ and strangers’ laughter described above are perceptible. Bryant (2012) had participants listen to shared laughs between friends and strangers and found that judgments of familiarity were quite accurate (~70%), especially between female friends (95% accuracy). Moreover, when the laughs were digitally altered to be either faster or slower, the faster versions were thought to be more likely between friends. This finding is consistent with another set of studies examining spontaneous versus volitional (i.e., fake) laughs. Bryant and Aktipis (2013) found that laughs generated in conversations between friends were acoustically and perceptibly different than laughs produced by participants who were asked to laugh on command. In particular, the spontaneous laughs had higher average fundamental frequency (F0), greater F0 variability, and were faster (lower average call duration). When sped up through digital manipulation, the laughter was judged more likely to be “real,” and when slowed down to

the point where it was difficult to identify them as laughs at all, the spontaneous (i.e., real) laughs were indistinguishable from non-human animal calls, but the volitional “fake” laughs were easily identified as being human produced. These results suggest that spontaneous laughter shares some features with animal calls that fake laughs do not, and that volitional laughter as produced by the speech system results in particular acoustic features that mark it as such. These findings are consistent with other work showing that laugh production can originate from different neurological systems (Wild et al. 2003), and can be divided in ways similar to how researchers have distinguished Duchenne from non-Duchenne laughter and smiling (Keltner and Bonanno 1997, Gervais and Wilson 2005, Ruch and Ekman 2001).

Taken together, these data support the notion that laughter constitutes a vocal signaling system designed for affiliative interactions mediated through verbal play, and that volitional laughter represents a kind of vocal imitation of a pre-speech vocal signal. In other words, by producing a copy of an honest vocal signal through the speech system, one can attempt to gain benefits from generating such a signal without the necessary triggering conditions for the honest signal. In the context of encryption and humor, if one recognizes that a joke has been made but one does not actually “get” it due to lacking the key, laugh production is still possible. This creates a situation of a classic co-evolutionary arms race (Krebs and Dawkins 1978) where senders produce signals in an attempt to manipulate receivers who must detect that manipulation (mind reading), and selection pressure is placed on both parties for effective manipulation and mindreading. Put simply in the context of humor: by pretending to get the joke and generating a laugh, one can attempt to gain the benefits of presumed similarity without being similar in the crucial way. By detecting accurately that the laughter is not genuine, joke producers can pre-empt attempts at manipulation, while failures at detecting the volitional nature of the laugh could result in assumptions of similarity and intentions to cooperate that are not warranted.

4. The significance of encryption

Humor and laughter create a channel for signaling intra-cultural similarity: specific, hidden information is necessary for the speaker to produce a humorous utterance, and that same information must be available to an audience member in order get the joke and laugh in response. If a speaker successfully produces an encrypted utterance that an audience can decrypt, *and* the audience emits honest laughter in response, both speaker and audience can jointly draw the inference that the other has access to the same key. In terms of relevance theory, successful humor makes the fact of that shared information mutually manifest, as both

speaker and audience not only know that, given some bit of implicit information, a mundane utterance affords additional, otherwise inaccessible implicatures, but they also know that each other knows that.

This information in and of itself will not likely be an earth shattering revelation, particularly in the homogenous cultures typical of ancestral human populations. That is, a single instance of successful humor does not necessarily imply a great degree of compatibility. Rather, humor and laughter must be iterated (and most likely reciprocated), providing an array of individual instances with which to judge the relative degree of compatibility between various group members. It works, in a sense, as a similarity spot-check, allowing people to “ping” the cognitive environments of their group members and discover which evince the greatest amount of overlap. The relative success rate of matching these “cognitive flashes” will provide agents with a reliable index of the relative degree of shared cognitive environments, styles, and backgrounds with other agents. Over time, spontaneous conversational humor provides a mechanism for within-group assortment, which we propose is its ultimate function, enabling more efficient coordination by cultivating relationships with the most compatible partners (Clark and Kanbur 2004).

Moreover, signaling personal features via encryption solves the particular problems presented by within-group assortment. Anthropologists have long recognized the importance of so-called “ethnic markers” in signaling group membership in order to improve cooperative outcomes (Barth 1969). In recent years, an extensive formal literature has begun to develop exploring the ability of these arbitrary signals of group membership to facilitate assortment for cooperative activity (Castro and Toro 2007, Efferson et al. 2008, Mace and Holden 2005, McElreath et al. 2003). While these overt signals of personal qualities are useful in between-group contexts, where the adaptive problem is delimiting a set of partners who subscribe to the same behavioral norms and avoiding interaction with those who do not share those norms, their “all-or-nothing” character make them inadequate for dealing with assortment *within* the groups bounded by ethnic markers. Because of the fluid nature of social life, the set of valuable interaction partners will vary with context. In some situations, such as long-term cooperative endeavors like child-rearing or frequently-performed group efforts like hunting or foraging, one is best served by assorting with a small set of compatible partners who afford efficient mind-reading – the kind of assortment encryption affords. In other contexts, however, different assortment outcomes may be desired, such as larger-scale cooperation as in communal defense, or vying for the assistance of high-status individuals as in political advancement. Given this diversity of interpersonal evaluations in different contexts, individuals would benefit from not “burning bridges” with less-similar group members in compatibility assortment, so as to be more able to draw on them in other assortment contexts. Rather than

overtly signal one's position within the range of intracultural variation, encryption allows people to covertly signal their qualities in such a manner that, in instances where an audience member is not in fact similar to the speaker, the fact of dissimilarity is not emphasized. That is, rather than go around the village saying "I'm on the red team," which shows team membership to members of both the red team and the blue team, making jokes enables people to only show their membership to other reds, while blues are often left unaware that any declaration has been made.

This is also importantly different from other kinds of honest signals where there is a limited set of conventionalized dimensions of variation to signal (e.g., bigger or smaller tails, louder or softer calls). In those contexts, there are objectively measurable criteria for what constitutes a "good" signal, and features like cost are necessary to prevent deception (Maynard Smith and Harper 2003). The dimensions along which humorous utterances can vary are infinite, which means there is no obvious target for cheaters to mimic. The goodness of a joke is determined by the context, and only people with access to the requisite information can make and understand a joke.

This high context-dependence explains why the "objective" assessment of humor is often fraught with difficulty. In a justly famous study of the ethology of laughter, Provine (1993) documented 1200 instances of laughter in naturalistic settings. Examination of the transcripts of the talk in these settings revealed that laughter only occurred as a response to utterances they could identify as humorous in 10–20% of all occasions of laughter. Provine (1993) concluded that laughter is typically not related to humor, and this idea has since become accepted conventional wisdom, with evolutionary psychologists such as Pinker (1997) claiming that the vast majority of laughter is not in response to humor, but to other social pressures. While we are sympathetic to the possibility that not all laughter reflects decryption of an intentionally humorous utterance or act, we feel that this conclusion may have been prematurely derived, based on a misunderstanding of the nature of humor. Provine's findings might suggest, instead, that the bulk of humor produced in naturalistic conversation is not understandable to third parties lacking the requisite background information. Without access to the keys of individual personalities, past histories, known preferences, and shared experiences, people cannot detect the presence of encrypted implicatures that are easily shared between friends and other peers, and are left concluding that there was no humor there. "You had to be there" is not an occasional excuse for failed humor, but an exceedingly common prerequisite for understanding actual humor in naturalistic settings. Moreover, one did not just have to be "there" in the sense of being present for the joke's construction, but one also had to be "there" in the sense of having

access to the cognitive environment where the interactants' personal qualities are represented. Most humor, by design, is an "inside joke," and searching for universal structure in the content will fail to uncover its true basis, which is the fact of similarity between speaker and audience.

This fact is further obscured by the common practice of studying humor by analyzing comedy, or professionally-produced humorous items designed to appeal to a mass audience. While comedy can be a more reliable stimulus source for assessing humor and laughter in a laboratory setting than the kind of naturalistic humor that forms the majority of people's everyday experiences, searching for the underlying structure of humor in these hyper-cognized formats must necessarily lead researchers astray. By analogy, imagine studying human sexual behavior by carefully analyzing pornography. In both cases, a common, everyday human behavior has been carefully designed by professionals to create a hyper-stimulating facsimile of the phenomena our cognitive architecture was designed to assess in more naturalistic settings. Much like pornography, comedy constructs elaborate scenarios where the illusions of intimacy and personal familiarity are generated, providing the audience with an over-abundance of cues that they are engaged in activities that in everyday settings are often much less slickly produced. And although it is possible to identify important features of human mating psychology or cultural variation in sexual activity by analyzing pornography, doing so exclusively will likely generate inaccurate generalizations about naturalistic human behavior. Similarly, humor researchers focusing on the routines of stand-up comedians, the dynamics of television sitcoms, or the text of so-called "canned" jokes (i.e., the kind found in joke books or magazine entries) will necessarily lead to an over-emphasis on rhetorical devices that give audience members the impression they share background information with the comedian. These will make logical devices such as incongruity-resolution, references to widely-known cultural phenomena, and the marking of linguistic features such as homonymy seem much more central to the production of humor than they may actually be (although they may well be central to the production of comedy). The kinds of jokes that everyone has a key for constitute an important area of study, but it is only a subset of the much wider range of actual humor that people encounter in everyday conversation. The bulk of most naturalistic humor (perhaps as much as 90% by a liberal interpretation of Provine's findings) may be so dependent on access to highly-limited information about the knowledge, experiences, personalities, preferences, values, and attitudes of the laugher's immediate peers as to render it impossible for third parties to detect the presence of humor without extensive ethnographic observation and detailed post-hoc interviewing.

4.1 Encryption and other theories of humor

We believe that recognizing the limitations of the traditional emphasis on analyzing the structure of humor in terms of the structure of comedy also uncovers the compatibility between the encryption model and existing cognitive and linguistic models of humor. A number of theoretical approaches to the structure of humor, including expectation-violation (e.g. Willmann 1940), incongruity-resolution (e.g. Shultz 1972, Suls 1972; see Dynel in this volume), combining normality with a violation of the subjective moral order (e.g. Veatch 1998), shifting semantic frames (e.g. Latta 1999), and conceptual blending (e.g. Coulson 2001), have all relied almost entirely on exegesis of comedic materials (particularly “canned” jokes) in their attempts to uncover the underlying patterns of humor production. In studying the professional comedy of Western mass media, there has been great success in documenting large bodies of humorous material that illustrate, for example, incongruity-resolution (Perlmutter 2002), yet critics achieve equal success in chronicling counter-examples that do not exhibit the resolution of any incongruity (Cundall 2007) or even any incongruity at all (Latta 1999).

We propose that this theoretical loggerheads stems from too tight of a focus on proximate mechanisms. That is, questions about structural features of humor examples are examined without a concern for functional explanations of the communicative phenomena. It is undoubtedly the case that incongruity-resolution and other cognitive processes are major means to achieving encryption in the context of professionally-produced humorous material designed for a mass audience. When attempting to evoke a shared cognitive environment for a diverse audience, the most successful avenues will likely rely on the kind of information available to a wide array of people, such as logical structures, wordplay, or reference to culture-wide norms and expectations. These mechanisms may also be a common feature of the kind of spontaneous, conversational humor that we consider the “proper domain” (Sperber 1994) of humor production and appreciation, the contexts in which these capacities evolved, as opposed to the “actual domain” of comedic productions found in the modern Western world. In particular, they are very likely to be common features of the naturalistic humor produced by residents of the modern world, after years of exposure to the model of professional comedy. We do not mean to imply, therefore, that encryption is a more accurate proximate model of the structure of comedy or of some instances of naturalistic humor than are incongruity-resolution, frame-shifting, etc. Rather, we are suggesting that these models are specific instances of the more general phenomenon of encryption that ultimately underlies the human capacity to produce and understand humor. Many existing theories of humor represent the varying means of achieving encryption.

In contrast to these approaches, largely oriented towards comedy, other linguistically-oriented social scientists have focused their attention more directly on naturalistic humor, analyzing the form and proximate function of humor use in everyday conversation. These researchers often come to conclusions highly consistent with the encryption model. For example, Sacks (1978) analyzed the telling of canned “dirty jokes” among adolescents, and proposed that these constitute tests of the listener’s knowledge about the underlying phenomena. He further suggested that this feature may be extended to all forms of humor, which Sherzer (1985) elaborated to claim that much humor is an aggressive challenge of the audience’s knowledge. Norrick (1993) later proposed that conversational humor allows speaker and audience to determine or maintain solidarity via mutual recognition of common ground. These hypotheses fit squarely within the encryption model, and are in more or less general agreement with the ultimate function of assortment we propose, albeit without the same concern for explaining why such capacities would be possible in the first place.

Evolutionary approaches to humor are typically concerned exclusively with why these capacities exist, often without a great deal of attention to the exact details of how those capacities are structured. Although there is a wide array of functional accounts proposed by evolutionary theorists in recent years, many are in broad agreement with the notion that the ultimate function of humor is predominantly social. Weisfeld (1993, 2006), for example, argues that humor serves to encourage affiliative behavior. Although there is a major contrast between his proposal that humor accomplishes this goal by providing audiences with new information, as opposed to our claim that the relevant information at play is necessarily not new to the audience, we are in agreement that the promotion of social bonds is an essential function of humor. Similarly, Gervais and Wilson (2005) proposed that the laughter and humor complex evolved to promote social play by signaling a safe social environment. We share their emphasis on the underlying fitness benefits of humor involving the enhancement of social bonds, but we maintain that the assessment of a “nonserious social incongruity” (Gervais and Wilson 2005: 399) is but one of many means of producing encryption.

A particularly popular model of the function of humor in evolutionary psychology has been the fitness indicator hypothesis, developed by Miller (2000) and others. This approach posits that the ultimate function of humor is to display attractive qualities, such as intelligence or “creative unpredictability” to potential mates, making humor a sexually-selected signal of an objectively comparable trait. In particular, it is often suggested that there is an underlying sex difference in the production and appreciation of humor, where men signal their mating quality via humorous productions, and women assess that mate quality via humor

appreciation. In support of this hypothesis, researchers point to an array of findings in which sex differences are found in mating contexts, ranging from night-clubs to hypothetical questionnaires (e.g., Bressler et al. 2006, Grammer 1990). We do not question the validity of these findings, but instead suggest that they are subject to a different interpretation. Rather than infer that humor evolved to signal objectively evaluable aspects of mate quality, such as intelligence, we propose that humor evolved to signal interpersonal compatibility, a subjectively-varying feature of dyadic relationships. Within a mating context, it is quite plausible that more general sex differences deriving from differences in parental investment (Trivers 1972) might structure interactions such that men do more displaying and women do more assessing, without necessitating the claim that humor evolved specifically for male displays of quality. Although humor is not cast as a fitness indicator, but a compatibility test, the unique contexts of courtship would be equally predicted to generate the various sex differences that have been found.

Finally, some evolutionary theorists have developed models of the evolution of humor that point more to a competitive, rather than cooperative, function of humor. Alexander (1986), for example, proposed that humor is primarily an ostracism mechanism, designed to maintain indirect reciprocity by providing a means of low-cost punishment. Pinker (1997) also suggested that humor serves as an anti-dominance mechanism to reduce status differences by derogating status-seekers. In both cases, these hypotheses foreground the use of humor in conflict, but also necessarily entail the use of humor to enhance solidarity on the part of the producer and the non-target audience. While the use of humor for ostracism or derogation is not in doubt, we would maintain again that these represent specific instances of the broader application of encryption to signaling similarity (in these cases, in stances towards third parties) in order to develop and maintain cooperative partnerships with compatible group members.

5. Conclusion

The encryption theory of humor is a synthesis of many disparate approaches to humor and laughter, and does not stand necessarily as an alternative framework. The distinction between proximate and ultimate levels of description looms large in our analyses of the relationships between encryption theory and other accounts of humor. By uniting a structural account of the proximate mechanisms of humor production and appreciation with a functional explanation of the fitness benefits accorded by the evolution of these mechanisms, encryption theory is able to bring together a wide array of empirical and theoretical research on the diverse phenomena of humor and paralinguistic signals as a whole. There are many strategic

possibilities for communicating cognitive similarity through encryption (i.e., many proximate systems), and most of these strategies will have an associated subjective sense of being funny to those involved, which plays an important role in its effectiveness. Ultimately, the pleasurable aspects of humor motivate the adaptive function of social assortment, and are associated with complementary signals of affiliation such as laughter and smiling.

Encryption and laughter work together as a communication system designed to solve adaptive problems of coordination in complex social environments. Our approach is derived from fundamental principles of animal signaling and is consistent with the well developed literature on co-evolutionary processes in signaling systems. Laughter is associated with an incredible variety of pragmatic functions, but its role as a signal of understanding in contexts of humor is paramount. We propose that encrypted communicative acts serve to signal the possession of a “key” that provides the triggering conditions for honest laughter in target audiences also possessing the key. This process constitutes a “humor circuit” allowing groups of people to recognize their shared cognitive environment. But this humor circuit is subject to deception through dishonest portrayals of the associated non-verbal signals of laughter and smiling. Research on laughter, smiling, and the social functions of humor should explore specific predictions of how encrypted communicative acts interface with nonverbal signals, and in particular examine the role of alliance formation and social assortment.

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