British Journal of Social Psychology (2008), 47, 497–517
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www.bpsjournals.co.uk

Discovery of the faithfulness gene: A model of transmission and transformation of scientific information

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The purpose of this paper is to study the diffusion and transformation of scientific information in everyday discussions. Based on rumour models and social representations theory, the impact of interpersonal communication and pre-existing beliefs on transmission of the content of a scientific discovery was analysed. In three experiments, a communication chain was simulated to investigate how laypeople make sense of a genetic discovery first published in a scientific outlet, then reported in a mainstream newspaper and finally discussed in groups. Study 1 ($N = 40$) demonstrated a transformation of information when the scientific discovery moved along the communication chain. During successive narratives, scientific expert terminology disappeared while scientific information associated with lay terminology persisted. Moreover, the idea of a discovery of a faithfulness gene emerged. Study 2 ($N = 70$) revealed that transmission of the scientific message varied as a function of attitudes towards genetic explanations of behaviour (pro-genetics vs. anti-genetics). Pro-genetics employed more scientific terminology than anti-genetics. Study 3 ($N = 75$) showed that endorsement of genetic explanations was related to descriptive accounts of the scientific information, whereas rejection of genetic explanations was related to evaluative accounts of the information.

Each week new discoveries are reported in scientific journals. Only a fraction of these discoveries reach laypeople through mainstream media, who then discuss the most intriguing ones with friends, family, and colleagues (Glasser & Salmon, 1995). The way scientific information derived from news media is integrated into common-sense knowledge illustrates how people make sense of unfamiliar scientific phenomena they encounter in their everyday lives. How do individuals understand, interpret, and describe the scientific discoveries they learn about in the news? Which elements do people retain when learning about a discovery? Do pre-existing attitudes shape understanding and transmission of scientific information?

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DOI:10.1348/014466607X248912

The purpose of this paper is to analyse social psychological processes at work in the transformation process of scientific information by observing how laypeople make sense of a genetic discovery first published in a scientific outlet, then reported in a mainstream newspaper, and finally discussed by laypeople. Drawing on both rumour and social representations research, the current paper investigates the role of position in a communication chain and the impact of attitudes towards genetic explanations in the emergence and transmission of scientific discovery. In the following, the relationship between rumour approaches, social representations theory, and the spread of scientific discoveries is outlined. Next, the role of representations in science communication is discussed. The transformation and transmission of scientific discoveries are examined in the light of these approaches. Three studies were designed to investigate transformation and transmission processes.

Rumours and representations of scientific discoveries

The transmission of scientific discoveries and the spread of rumours bear several similarities. Rumours can be conceived as alterations of information that result in an entirely new meaning when passing through chains of people (Allport & Postman, 1947; DiFonzo & Bordia, 2006; Rouquette, 1975; see also Bartlett, 1932). Much like rumours, scientific knowledge spreads and is transformed when people try to make sense of new, surprising, or unusual information. Social representations theory explains processes by which scientific information is integrated into everyday thinking (Bauer & Gaskell, 1999; Doise, Clémence, & Lorenzi-Cioldi, 1993; Moscovici, 1976) and contributes to the creation of common-sense theories (Clémence, 2001).

Moscovici and Hewstone (1983) distinguish scientific thought from representational common sense in terms of form and content, although common-sense theories are increasingly based on scientific information (Moscovici, 1976). Scientific thought is characterized by codes and concepts, and requires empirical validation following formal procedures, whereas representational thought is collectively built on images and symbols. Common-sense knowledge is validated by the acceptance of consensual ideas and norms (Moscovici & Hewstone, 1983), much like trust in rumours that is based on the gradual transformation of information that converges with stereotypes and consensual knowledge (Bangerter, 2000; Bordia & DiFonzo, 2002; see also, Lyons & Kashima, 2003). Social representations emerge when individuals as members of groups develop a shared understanding of scientific discoveries and topics, such as genetically modified foods (Gaskell *et al.*, 2000; Wagner, Kronberger, & Seifert, 2002), AIDS (Joffe, 2003), conception (Wagner, Elejabarrieta, & Lahnsteiner, 1995), or the influence of classical music on the development of intelligence (Bangerter & Heath, 2004).

Social representations and rumour research converge (see Bangerter & Heath, 2004), because both study the dynamic nature of information transmission. Nevertheless, the divergences between the approaches deserve consideration. Social representations theory focuses on the interplay between shared, collective construction of knowledge, and individual attitudes towards this knowledge (Moscovici, 1976). The symbolic production of knowledge is at the core of social representations. Rumour approaches, in turn, concentrate more specifically on individual and contextual factors involved in the transmission and transformation of a relevant, but unverified message (DiFonzo & Bordia, 2006). Rumour content changes are evaluated with respect to veracity and accuracy. Moreover, the approaches differ in the degree and scope of abstractness of the object under scrutiny. Investigating the understanding of complex scientific phenomena or disease like the origins of AIDS belongs to the social representations realm, whereas investigating the diffusion of a specific event delimited in time such as a particular individual or group spreading AIDS falls under rumour research.

Science communication and social representations

Science communication is traditionally perceived as a linear diffusion of scientific facts translated by the media for the general public (Bucchi, 2004). The dominant view regards genuine scientific knowledge as objective and pure which becomes distorted along the way when transmitted to an irrational public. These distortions are the cause and the consequence of an informational gap between experts and the public. This deficit model has nevertheless been frequently criticized (Bauer & Gaskell, 1999; Hilgartner, 1990; Joffe, 2003; Wagner, 2007). First, this view provides scientists a disproportionate authority to determine which simplifications are distorted and which in turn appropriate (Hilgartner, 1990). Second, it seems unrealistic to draw a clear-cut boundary between ‘real’ and popularized science insofar as scientific knowledge is communicated in diverse contexts varying from scientific journal articles, conference talks, grant proposals, policy reports to mass media (Hilgartner, 1990). Third and most importantly for the purposes of this paper, the deficit model downplays the specificity of the knowledge construction process among lay audiences which has been highlighted by social representations theory.

In social representations theory, transformation of scientific information is regarded as creative reconstruction, where the public’s images are not construed as false or biased representations but as corresponding to reality (Bauer & Gaskell, 1999). In this view, symbolic and emotional aspects, in addition to factual knowledge, contribute to the collective meaning making of scientific phenomena (Joffe, 2003; Wagner *et al.*, 2002). Moreover, lay thinking is shaped by pragmatic concerns such as being able to communicate by following news reports and by discussing with fellow citizens (Wagner, 2007).

Transmission and transformation processes of scientific discoveries in communication

Research has shown that the spread of rumours is dependent upon the characteristics of the message (e.g. ambiguity), its subjective importance to receivers, and the emotions (e.g. anxiety) aroused by it (Rosnow, 1988, 1991). Affective elements, in particular, intensify the spread of and trust in rumours. Heath, Bell, and Sternberg (2001) showed that disgust intensified the spread of urban legends, a form of information akin to rumours. Rumour processes are induced when individuals selectively generate knowledge that is consistent with prior information, thereby increasing its accessibility (e.g. Mussweiler & Strack, 1999). As a result, when people read of a scientific discovery, they focus on information that confirms their prior beliefs and construct a coherent representation of the discovery (e.g. Graesser, Singer, & Trabasso, 1994). The scientific news is elaborated and fitted into an existing cognitive framework. In contrast to individual perspectives in rumour research and cognitive approaches, which investigate coding and selective retrieval of information, our approach focuses on the social sensemaking of a scientific message, a core process in social representations theory (Purkhardt, 1993). This process takes place when laypeople communicate with each other in the attempt to make sense and collectively cope with ambivalent feelings induced by encountering new technology like genetically modified food technology

(Wagner *et al.*, 2002). Insofar as the social nature of rumours arises from communication (Bordia & DiFonzo, 2002, 2004; Shibutani, 1966), rumour mongering is also a form of social sensemaking.

Our study focuses on the communication process resulting from a scientific discovery that starts from a scientific publication and then continues in regular media outlets, eventually ending as everyday discussions (e.g. Sommer, 1998). Rumour research investigates how messages are transformed through levelling and sharpening of information (Allport & Postman, 1947; DiFonzo & Bordia, 2006). Accordingly, a message gets shorter, simplified, and more concise the further it moves along a communication chain. Moreover, striking, bizarre, or counter-intuitive aspects of the message are emphasized (see also Barrett & Nyhof, 2001). In social representations theory, levelling and sharpening have been understood as part of the objectification process through which individuals provide abstract and precise scientific information with a figurative and concrete meaning (Moscovici, 1976). When scientific discoveries are diffused to the public sphere, expert terminology used in scientific articles is replaced by everyday terminology necessary for the comprehension of newspaper articles. News articles feature metaphors that allow the reader to visualize a scientific phenomenon (Kua, Reder, & Grossel, 2004) and create new meanings of it (e.g. Lakoff & Johnson, 1980). For example, in the context of genetic engineering, ‘Dolly the sheep’ objectified cloning (Gaskell, 2001). In a similar vein, Wagner *et al.* (1995) showed that popular thinking about conception is based on sex role and sexual metaphors (see also Bangerter, 2000). Sperm was characterized with stereotypically active behaviour of men whereas the ova were described with passive female traits. Studies 1 and 2 analyse the objectification that takes place when laypeople encounter a genetic discovery.

In parallel to objectification, information is incorporated into pre-existing knowledge, beliefs, and attitudes. This assimilation (rumour research) or anchoring (social representations theory) of information in pre-existing shared social knowledge is a social act (Baumeister, Zhang, & Vohs, 2004; Bordia & DiFonzo, 2002; Heath *et al.*, 2001; see also Smith & Semin, 2004; Staerklé & Clémence, 2004). Individuals actively process information by participating in discussions on the topic. As a result, interpretation and transformation of information is shaped by contextual norms determined by group membership as well as by pre-existing beliefs and attitudes (Lorenzi-Cioldi & Clémence, 2001; Moscovici, 1976). Studies 2 and 3 explore the impact of pre-existing attitudes on the transformation and diffusion of a scientific finding.

The current research draws on both social representations and rumour research when investigating the transmission and transformation processes related to the communication of a scientific discovery. Adopting a social representational view, we conceive the differential use of expert and lay vocabulary in accounting for scientific discoveries as a reconstruction of information and not a deterioration of information. Rumour models, in turn, illustrate the chain-like serial transmission of a scientific discovery moving from a scientific source to laypeople.

Communicating the discovery of a faithfulness gene

In the present research, we study the communication of an unfamiliar, yet intriguing genetic discovery. The transformation during this communication process occurs in two steps (Durant, Hanson, & Bauer, 1999). First, information is transformed when a daily newspaper publishes an article originating from a scientific journal. Next, transformation continues when laypeople read this newspaper article and describe its content to others. The three studies presented in this paper concentrate on the latter part of the communication chain. The first step is only briefly outlined.

From a scientific journal to a daily newspaper

The original scientific article 'Increased affiliative response to vasopressin in mice expressing the V_{1a} receptor from a monogamous vole' (Young, Nilsen, Waymire, MacGregor, & Insel, 1999), published in *Nature*, described the impact of a hormone called vasopressin in two species of voles, prairie and montane voles. The two species differ on certain cerebral areas that are linked to the reception of vasopressin. An increase of this hormone was shown to 'increase affiliative behaviour in the highly social, monogamous prairie vole, but not in the relatively asocial, promiscuous montane vole' (Young *et al.*, 1999, p. 766). Young *et al.* studied the molecule structure of the receptor gene of vasopressin and found that the DNA sequence of monogamous and promiscuous voles differs. They further showed that mice that were transgenic for the prairie vole receptor gene 'exhibited increased affiliative behaviour after injection with arginine vasopressin' (p. 766).

Two days later the results were reported in a highly respected French newspaper, *Le Monde* (Bursaux,1999) with the title 'Polygamous by nature, the mouse has become faithful due to a gene inserted by American researchers' (our translation). The original article reported a discovery of a gene linked to temporary affiliative tendencies of laboratory voles, whereas the article of *Le Monde* speculates on human applications concerning faithfulness in intimate relationships and on transformation of behaviour. A complex scientific discovery on rodents is given a concrete meaning – sexual faithfulness (see Green & Clémence, 2002 for an account on transformations that occurred when the discovery published in *Nature* was reported in *Le Monde*).

From a daily newspaper to lay thinking: Overview of studies

Three studies were carried out to examine the onward communication of the article published in *Le Monde* (hereafter the reference text). Our focus is upon the transmission of the meaning of this article. Studies 1 and 2 were designed to simulate a communication chain. The participants were randomly assigned to the role of a reader or a listener. The former read the article published in *Le Monde*, whereas the latter read a text that was unrelated to genetics. Then the readers described the text to the listeners. The main objective of this procedure was to examine the changes in the central terminology first employed in *Le Monde*, then in oral accounts given by readers of the text, and finally in written accounts by the readers as well as by the listeners. On the basis of the general predictions outlined above, we expect that the information about the genetic discovery will be simplified and summarized around a core idea, by giving it a concrete and figurative meaning (*objectification hypothesis*). Specialized terminology used in scientific domains should disappear gradually when the information moves along the communication chain. However, the information should be conserved in the form of everyday terminology in the listener's accounts. Therefore, readers are expected to employ both expert and lay vocabulary, whereas listeners should focus on lay vocabulary. We consider that lexical transformation involves a transformation of the specific sense of the discovery when employed in another narrative area (Lakoff, 1987; Lakoff & Johnson, 1980; Potter, 1996). Narrow empirical hypothesis testing described in the scientific area of genetics, becomes a possible explanation of human behaviour in a mundane area.

Participants should also extend their accounts of the discovery with new terms to the extent that interpretation and diffusion of the genetic discovery depends on an individual's attitudes towards genetics. The objective in Studies 2 and 3 is to investigate the role of pre-existing attitudes on the transmission and transformation of the discovery (*anchoring hypothesis*). Insofar as individuals hold diverging pre-existing attitudes, they will focus on different elements when reading or hearing about the genetic discovery. Therefore, the accounts should differ as a function of these attitudes. The participants endorsing genetic explanations of behaviour are expected to preserve more expert terminology from the reference text and be more descriptive in their accounts than individuals unfavourable to genetic explanations. Those favouring genetic explanations should pay more attention than others to the scientific demonstration of the experiment, because they find support for their attitudes. Those with unfavourable views concerning genetic explanations, in turn, should be more inclined to search for arguments and evidence that disqualify the initial message.

STUDY 1

Method

Participants and procedure

Forty persons (20 women; age range 19–45 years) from a Swiss town in the French speaking region participated in the study. The study, introduced as research on the understanding and diffusion of news messages, had four phases. First, participants completed a questionnaire assessing their knowledge of genetic experiments and interest in scientific topics. In the second phase, participants were organized into groups of four with two 'readers' ($N = 20$) who read the reference text on the genetic discovery, and two 'listeners' ($N = 20$) who read an unrelated article. The participants were told that they would be discussing their texts with other participants. The texts were removed and, in the third phase, the readers presented the content of the article to the listeners and they discussed the topic. At the final fourth stage, all participants wrote a description of the article they had read (readers) or had been presented to them (listeners). Readers and listeners did not differ in self-evaluated knowledge of genetic experiments or in interest in scientific information, measured with answers on 5-point scales to questions such as 'How would you evaluate your knowledge in the domain of genetics?' or 'Are you in favour of genetic research?'.

Dependent variables: Expert and common-sense terms

Eighteen terms from the narratives, crucial to the understanding of the finding, were used to investigate the development of expert and lay terms (see Table 1). A textual data-analysis programme (*Alceste*) was employed to initially select the terms as a function of their frequency in the original *Le Monde* article and the final written accounts. Words needed for syntactic construction (i.e. articles, prepositions, pronouns), not recognized by a French dictionary (i.e. numbers, unknown words, onomatopoeia), or cited less than four times in the entire corpus were discarded automatically. The 18 retained words represented approximately a third of each text corpus. Frequently occurring terms that did not contribute to the understanding of the finding, such as *experiment* or *behaviour*, were excluded.

Table 1. Frequencies and percentages of expert and lay terms in the communication chain

		Study 1			Study 2		
Term	Reference text (*N*)	Presentation (%)	Readers' account (%)	Listeners' account (%)	Presentation (%)	Readers' account (%)	Listeners' account (%)
Expert							
Vasopressin	8	45[a]	35	0[b]	40[a]	37	6[b]
Receptor	9	55[a]	40	5[b]	46[a]	49	11[b]
Arginine	2	0	0	0	6	3	0
Vole	9	100[a]	80	55[b]	77[a]	71	43[b]
Prairie	6	55[a]	50	15[b]	51[a]	34	6[b]
Montane	2	80[a]	35[b]	15[b]	57[a]	37[b]	17[b]
Mammal	4	10	20	0	29[a]	37	6[b]
Monogam -ous, -y	5	80	70	50	80[a]	74	46[b]
Polygam -ous, -y	4	80	55	50	66	80	49
Lay							
Hormone	7	80	60	50	57	43	31
Gene	10	100	65	65	80	69	57
Rat	0	35	5	15	3	3	15
Field	0	45[a]	5[b]	40	20	5	14
Mouse	6	90	85	65	89	86	69
Animal	0	100[a]	20[b]	15[b]	17	23	17
Faithful –ness	4	80	45	50	74	63	63
Unfaithful –ness	0	35	10	10	14	3	14
Man – human	2	100	100	70	80	67	46

Note. Percentages within studies marked with different characters differ at $p < .05$ McNemar test.

Support for the distinction of expert and lay terms was sought by comparing citation rates in three on-line databases (see Appendix). Lay terms are words commonly used in everyday communication; therefore they should occur frequently in these databases aimed for a general public. Expert terms, in turn, are used more restrictedly in scientific communication by a small circle of specialists and thus should be cited on the internet more rarely than everyday terminology. Comparisons of the 18 expert and lay terms were made with genetic (arginine, vasopressin, receptor, gene), animal (vole – montane and prairie; mammal; mouse; rat; and animal) and affiliation (monogamy, polygamy, faithfulness, infidelity) related terms. Nine of the eighteen terms qualified as expert terms and eight were lay terms. The term *human* was included separately. Lay terms were cited substantially more than expert terms, despite the considerable variation in the citation frequencies. Animal-related words were the most cited. Though *mammal* was considered an expert term it was cited frequently in the headings of French websites. Nevertheless, the term *animal* was cited over 60 times more frequently than *mammal*.

Results

As the scientific discovery moved along the communication chain, its subsequent versions contained less and less words and details. The *Le Monde* article contained 694 words, the written accounts of readers contained on average 125 words and the written accounts of listeners 93 words. Our focus was on the evolution of the 18 words retained from the reference text to the listeners' accounts and the relative use of expert and lay terminology (Table 1). The comparison of the readers' presentations with the reference text revealed that four expert terms were focused upon (*vole*, *montane*, *monogamy*, *polygamy*) and two terms disappeared or decreased (*arginine*, *mammal*). For lay terms, in turn, four terms of the reference text were retained (*hormone*, *gene*, *mouse*, *faithfulness*). Four new terms (terms absent from the *Le Monde* article) also emerged (*rat*, *field*, *animal*, *unfaithfulness*). McNemar tests (see Table 1) revealed that differences between readers' presentations and their written accounts were small, though the new lay terms that emerged in presentations disappeared again in the written accounts. However, considerable evolution between the presentations and the listeners' accounts was observed. With the exception of the word *vole* and *faithfulness* related terms, expert terminology decreased drastically in accounts written by participants that only heard about the discovery. The lay terms of the reference text, in turn, remained consistent in the accounts of listeners. The term *human* had a substantial presence in the accounts, though it was cited only twice in the reference text. The repetition of a term in the reference text did not contribute to its use in the subsequent presentations or written accounts.

For a more comprehensive test of our prediction that expert terminology disappears as a scientific message moves along a communication chain, the evolution of the number of expert and lay terms between readers' and listeners' written accounts were investigated. A 2 (position in chain: reader vs. listener) × 2 (use of expert vs. lay terms in account) analysis of variance was performed with repeated measures on the last factor. A main effect in position of chain was yielded $F(1, 38) = 7.15$, $p < .05$; $\eta^2 = .16$. Readers ($M = 7.40$, $SD = 2.11$) used more words in the accounts than listeners ($M = 5.80$, $SD = 1.64$). This effect was qualified with an interaction, $F(1, 38) = 8.79$, $p < .005$; $\eta^2 = .19$. In line with our prediction, readers used more expert terms than listeners, $F(1, 38) = 10.96$; $p < .005$, whereas position in the communication chain did not influence use of lay terms, $F(1, 38) < 1$, (Figure 1).

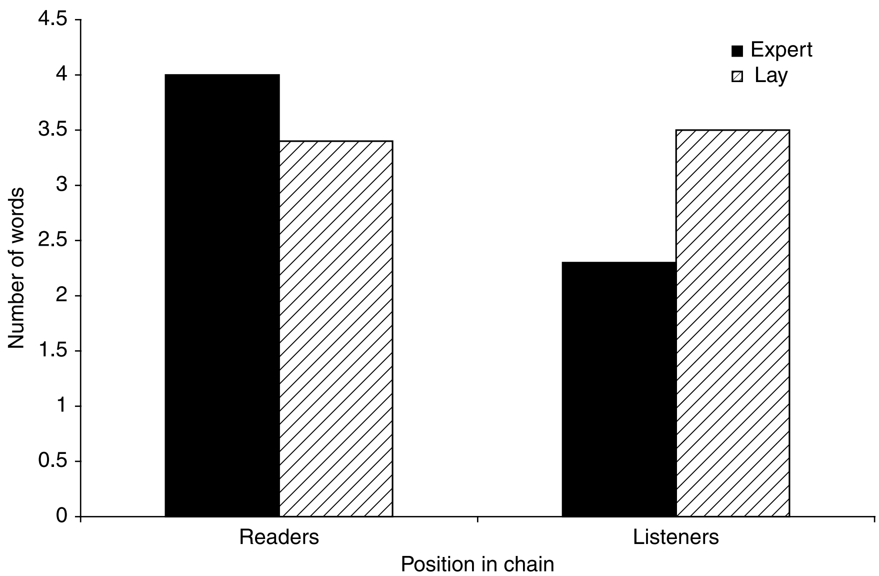

Figure 1. Mean frequency of expert and lay terms as a function of position in communication chain (Study 1).

Discussion

This study demonstrated, as expected, a transformation of information when the scientific discovery moved along the communication chain. The successive narratives evolved in a disappearance of scientific expert terminology and in the persistence of scientific information associated with lay terminology. Corroborating the objectification hypothesis, the remaining terms made the scientific information concrete. First, scientific (*monogamy*, *polygamy*) and lay (*faithfulness*) terms related to faithfulness persisted through the communication chain. Second, new terms emerging in the presentations related everyday knowledge to the scientific message. For example, prairie voles were in some cases substituted by field rats. When the diffusion of the scientific message progressed along the communication chain, it became a schematic story of the discovery of a faithfulness gene, extracted from a vole or rat species, with questions raised about gene transfer to humans and with few elements remaining from the reference text. The following is a typical account of the article published in *Le Monde* (our translation):

> This text is about a genetic discovery. American researchers put a chip (a gene) in field voles to see if these voles become faithful or not. They did experiments with rats and voles. They reacted differently depending on where they came from (country or city). Some became polygamous, other monogamous. The main question is: can this gene be put into humans. Would humans suddenly become faithful? One cannot really draw conclusions from this experiment because depending if it was a rat, a mouse or a vole, the species reacted differently despite the same gene that was put in all of them. [Listener nr. 8]

STUDY 2

The first aim of the second study was to replicate the transformation of information demonstrated in Study 1. The same procedure and lexicon measure was used but, in addition, a more rigorous control of the transformation process was provided by a word selection task. Comparing the lexicon employed in participants' written accounts with the word selection task allows assessing the extent to which the communication of a message differs from its encoding in memory. While choosing a word used in the initial text is a recall task for the readers, it should be considered an inference task for listeners who were expected to derive missing textual elements to understand the discovery (see also Graesser *et al.*, 1994; Sperber & Wilson, in press). In line with the objectification hypothesis, words reflecting a simplified concrete account of the discovery should be selected. Moreover, listeners should prefer words from the lay realm over expert terminology in accounting for the discovery. The participants' written accounts were also content coded by independent judges. Thereby, the results showing a transformation of information along the communication chain based on the 18 expert and common-sense terms derived in Study 1 as well as the word selection task could be externally validated. The texts were coded to reveal central themes of the reference text (e.g. transforming a polygamous mouse to monogamous) and recurring topics that emerged in participants' written accounts (e.g. faithfulness gene).

The second aim was to investigate how participants' initial attitudes towards genetic explanations of behaviour intervened in the transformation and diffusion process. In the presentation and discussion phase of Study 1, a number of participants expressed the difficulty to understand why some people, in particular males, were faithful to their partners while others were not, despite similar sociocultural backgrounds and cognitive development. A genetic explanation of faithfulness provided a possible clarification to these inquiries. Other participants, in contrast, did not accept attributing genetic reasons for social behaviours. This difference in initial positions is expected to moderate the transformation and transmission of the original scientific message. The initial message converges with the positioning of those favourable towards genetics. They should, more than participants critical of genetic explanations, evoke the expert information when describing the text that they are exposed to. This lexical variation suggests that those in favour and those against genetic explanations select a narrative area allowing them to express their point of view (Potter, 1996).

Method

Participants

Eighty-four people ranging from 19 to 50 years from a French speaking Swiss town participated in the study. Fourteen participants failed to complete the entire experiment and were excluded from the analyses leaving us with 70 participants (36 women).

Procedure and materials

As in Study 1, the experiment had four phases. First, participants completed the same questionnaire as in the previous study. In addition, their opinion on a set of explanations for social behaviour was assessed to distinguish participants favouring genetic explanations of behaviour from those rejecting them. The participants indicated to what extent they thought everyday behaviour was determined by genes (1 = *not at all*, 4 = *very much*), if they thought it is possible to modify the behaviour of animals by modifying their genes (1 = *not at all*, 4 = *absolutely*) and if they thought aggressiveness is related to genes (1 = *not at all*, 4 = *absolutely*). In a second phase, half of the participants were randomly assigned to read the article published in *Le Monde* (readers, $N = 35$), while the other half read an article unrelated to genetics (listeners, $N = 35$). In the third phase, readers were paired with listeners to present and discuss the article. In the final fourth stage, participants wrote an account of the article on genetics that they had read (readers) or that had been presented to them (listeners) and then completed a word selection task in which they indicated for a set of terms whether or not they had occurred in the initial reference text. Half of the selected terms were actually present (*vasopressin*, *montane vole*, *sexual faithfulness*, *family behaviour*, *evolution*, *adaptation*) and the other half absent (*testosterone*, *faithfulness gene*, *climate change*, *vaccination*, *field rat*, *questionable result*) from the text. This task as well as the 18 expert and lay terms derived from written accounts in Study 1 were employed as dependent variables to investigate evolution of information.

Defining pro- and anti-genetics

In order to compare those favouring genetic explanations with those rejecting them, a K-means cluster analysis was conducted to group respondents as a function of their positioning towards the three questions on genetic explanations of behaviour. The retained two cluster solution separated individuals agreeing with genetic explanations of behaviour ($N = 45$), called pro-genetics from here on, from those rejecting these explanations ($N = 25$), the anti-genetics. Pro-genetics agreed to a greater extent than anti-genetics that everyday behaviour is determined by genes ($M = 2.65$ vs. $M = 1.48$), that it is possible to modify the behaviour of animals by modifying their genes ($M = 3.20$ vs. $M = 2.24$) and that aggressiveness is related to genes ($M = 2.51$ vs. $M = 1.28$, for all comparisons, $t(69) > 2.45$, $p < .05$). Pro- and anti-genetics were distributed equally among readers and listeners, $\chi^2 = .06$, *ns*.

External validation was achieved with a set of items tapping different explanations of behaviour and genetics (Aldenderfer & Blashfield, 1984). Pro-genetics believed more than anti-genetics that alcoholism and homosexuality can be explained by genetic factors, faithfulness is determined by heredity, and the reported experiment in *Le Monde* demonstrated genetic origins of faithfulness (for all comparisons, $t(68) > 2.45$, $p < .05$). However, pro- and anti-genetics did not differ in self-evaluated knowledge on genetics, nor on endorsement of personality, social, and moral explanations of behaviour, thereby demonstrating that the cluster solution distinguished participants solely as a function of endorsement of genetic explanations.

Coding

To detect five central themes of the reference text and of the participants' discussions, two independent coders indicated the extent to which each text (a) mentioned the discovery of a faithfulness gene; (b) stated that a polygamous mouse became monogamous in the experiment; (c) discussed applying the results to humans; (d) contained scientific terminology used in the reference text; and (e) evoked limits in the realization of the experiment (e.g. failure of experiment, worked only for certain animals). The coders indicated with a 3-point scale if an idea or theme was present (1 = *absent*, 2 = *partially present* or 3 = *present*). They were advised to use the partially present response alternative when the theme or idea was included in a participant's written account, but the employed vocabulary was different. Inter-rater reliabilities based on comparisons of the 70 texts were high (all $\gamma > .85$).

Results

Evolution of terminology in communication chain

Evolution of information (18 terms) from the readers' presentations to the listeners' written accounts followed a very similar pattern as in Study 1. Table 1 reveals that again the use of all expert terms decreased massively, most of them disappearing in the listeners' accounts. Only the word *vole* and the faithfulness related terms (*monogamy* and *polygamy*) remained. The lay terminology, including *human*, persisted.

Anchoring as a function of pre-existing attitudes and position in the communication chain

To understand the degree to which information is incorporated into pre-existing attitudes (anchoring hypothesis) and communication context, the impact of attitudes towards genetic explanations and of position in the chain on the number of expert and lay terms in the accounts was examined. A 2 (position in chain: reader vs. listener) × 2 (attitudes: pro-genetics vs. anti-genetics) × 2 (expert vs. lay terms in account) analysis of variance was conducted, with repeated measures on the last factor. A main effect of the position in chain was revealed, $F(1, 66) = 18.90$, $p < .001$; $\eta^2 = .22$. Replicating the results of Study 1, readers ($M = 7.40$, $SD = 1.96$) used more words in their accounts than listeners ($M = 5.23$, $SD = 1.75$). This reader–listener main effect was again qualified by a within-subject interaction with the repeated measure, $F(1, 66) = 10.29$, $p < .005$, $\eta^2 = .14$, revealing that listeners employed less expert terms than readers, $F(1, 66) = 21.69$; $p < .001$, but position in communication chain had no effect on lay terms, $F(1, 66) = 1.72$; *ns* (see Figure 2). More importantly, in line with the anchoring hypothesis, people endorsing genetic explanations of behaviour preserved expert vocabulary that supported their beliefs when describing the discovery. A within-subject interaction with the repeated measure and attitudes towards genetic explanations, $F(1, 66) = 5.52$; $p < .05$; $\eta^2 = .08$, demonstrated that pro-genetics employed expert

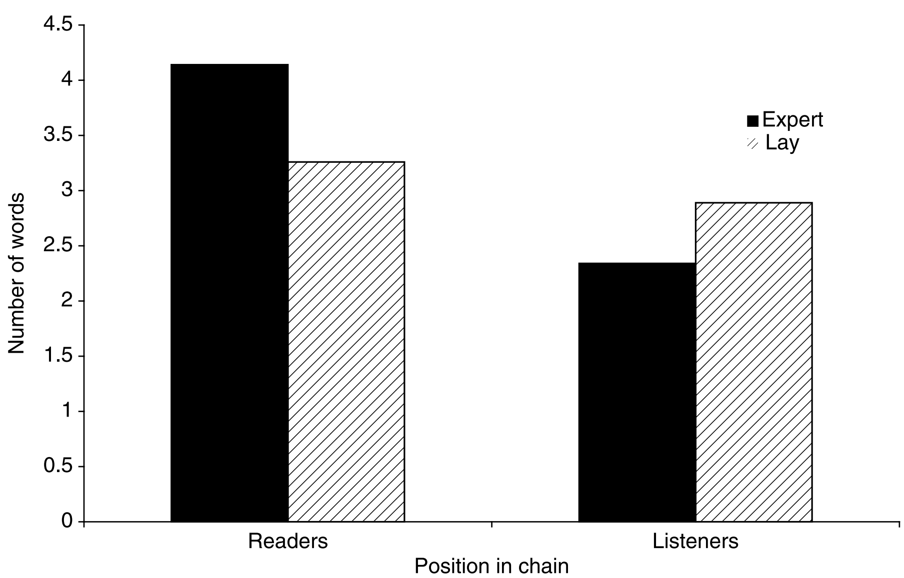

Figure 2. Mean frequency of expert and lay terms as a function of position in communication chain (Study 2).

terms more frequently than anti-genetics, $F(1, 66) = 5.38$; $p < .05$, whereas the mean number of lay terms did not differ between both groups, $F(1, 66) < 1$ (Figure 3). No other main effects or interactions reached significance.

Reader–listener difference in word selection
Selection of terms present in the reference text was accessed. Unsurprisingly, readers ($M = 8.97$, $SD = 1.98$) gave more correct answers than listeners ($M = 6.83$, $SD = 2.20$), $F(1, 68) = 18.34$, $p < .001$; $\eta^2 = .21$. This result simply reveals that the listeners needed to infer terms that were not evoked by the reader who presented the text to them. However, the relevance of the comparison of word choice between the groups is threefold. First, we verified that the original scientific information was transformed into a simplified schematic idea. Eighty per cent of readers and 83% of listeners affirmed that a faithfulness gene was mentioned. Moreover, both readers and listeners cited correctly family behaviour (74 and 71%, respectively) and sexual faithfulness (74 and 91%). Second, the results revealed the emergence of lay terminology to complement the expert message. Both readers and listeners correctly mentioned the presence of montane vole (97 and 89%, respectively) in the text. However, 71% of listeners also inferred that field rats were mentioned in the initial text, whereas only 9% of readers made this error, Cramer's $V = .64$, $p < .001$. Third, all readers recalled vasopressin, but only 49% of listeners evoked it (Cramer's $V = .59$, $p < .001$), indicating that readers retrieve scientific terms that they did not use when communicating the information in their presentations. Listeners also erroneously cited testosterone more often than readers (29% vs. 6%; Cramer's $V = .303$, $p < .05$). Finally, a questionable result was cited incorrectly by 17% of readers and 60% of listeners, Cramer's $V = .44$, $p < .001$. No other significant differences between readers and listeners were evidenced. In the word selection task, pro-genetics ($M = 8.15$) did not give more correct responses than anti-genetics ($M = 7.44$), $F(1, 66) = 1.59$, *ns*.

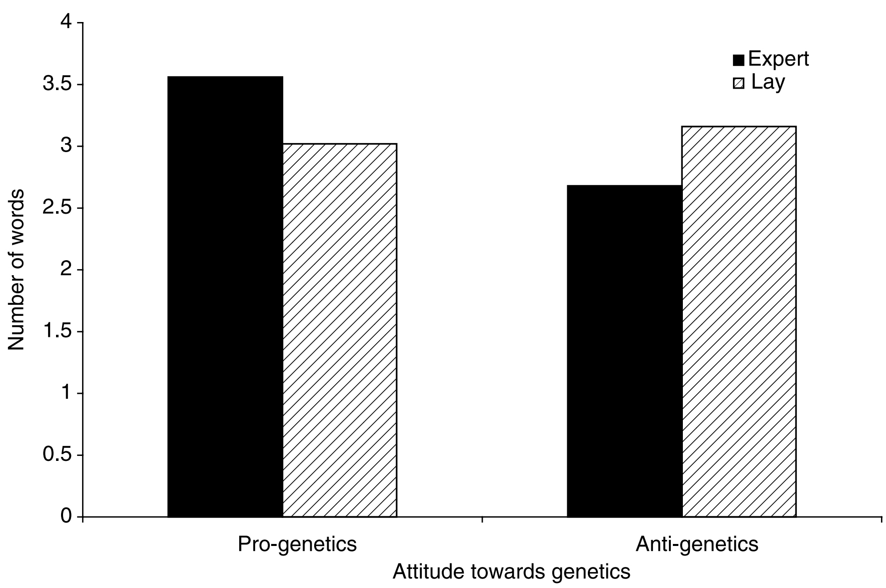

Figure 3. Mean frequency of expert and lay terms attitudes towards genetic explanations (Study 2).

Validation of reader–listener effect in content transformation
The impact of position in the chain on the presence of coded themes was examined. In support of the findings on the use of expert and lay terminology indicating that a message is simplified when it moves along the transmission chain, the results demonstrated that readers employed more scientific terminology ($M = 1.63$, $SD = 0.73$), evoked more often that the experiment transformed polygamous mice to be monogamous ($M = 2.66$, $SD = 0.54$), and referred more to human applications ($M = 1.83$, $SD = 0.75$) than listeners did ($M = 1.17$, $SD = 0.45$; $M = 2.14$, $SD = 0.65$; $M = 1.49$, $SD = 0.61$, respectively), $F(1, 69) = 8.72$, $p < .01$, $\eta^2 = .12$; $F(1, 69) = 10.76$, $p < .01$, $\eta^2 = .14$; $F(1, 69) = 4.94$, $p < .05$, $\eta^2 = .07$, respectively. Moreover, the presence of the three themes was positively related to the number of employed scientific terms (all rs $> .30$, $p < .001$). Position in the communication chain was not related to evoking limits in the experiment and a faithfulness gene in the text. However, a third of the participants evoked a faithfulness gene confirming an overarching emergence of the idea. Pre-existing attitudes did not affect the presence of these themes in the accounts.

Discussion
The results replicate the evolution of information throughout the communication chain found in Study 1. Again, the initial information was transformed by a decrease of scientific terms on the one hand and a stability of lay terminology on the other. The results of the word selection task supported this finding. This occurred especially among listeners, located at the end of the communication chain. Nevertheless, independent of one's position in the communication chain, participants mentioned a faithfulness gene. Though genetic determination of faithfulness was evoked, the existence of a specific faithfulness gene was never mentioned in the text. Readers recalled expert terms (e.g. vasopressin) more often than listeners, though they did not use the term in the written accounts. This result indicates that the diffusion process, conceptualized here as a communication chain, differs from individual encoding in memory. Readers abandon expert terms, though they can retrieve them from memory, presumably to enhance understanding of a scientific experiment and thus to improve transmission to others (Smith & Semin, 2004; Wagner, 2007). Listeners at the end of the chain, in turn, are forced to introduce new lay terms to interpret and give meaning to the readers' scientific narrative. Results on content coded themes provided further validation by showing that the scientific terminology and the core message are altered when the message moves from a reader to a listener.

In line with our predictions, endorsement of genetic explanations had an impact on the terminology employed in the participants' accounts of the discovery. Pro-genetics employed more information from the original article than anti-genetics. This difference was not due to differences in knowledge concerning genetics or to neglect of other explanations of behaviour. In summary, greater expertise in genetics did not explain that individuals supporting genetic explanations employed elements of the scientific experiment. We suggest that the performance of pro-genetics was induced by their beliefs that converged with the initial message allowing them to focus on the textual argumentation. Persons rejecting a genetic explanation, in turn, were confronted with information contradicting their beliefs. They may be inclined to search for elements disqualifying the discovery of a genetic explanation for faithfulness. Individuals holding anti-genetic stances may thus replace expert terms with lay terms they master and that match their belief system. By changing the narrative area, participants described a version of the story that supports their beliefs. As Potter (1996, p. 187) asserts, 'the choice of boundaries and the huge range of descriptive terms available mean that highly contrasting versions of the 'same thing' can be produced while resisting criticisms of inaccuracy, falsehood or active confabulation.' This explanation also finds support in rumour research (Rouquette, 1975).

STUDY 3

The last study further investigated the transmission process as a function of converging or diverging stances towards genetic explanations. The main objective of this study was to gather more evidence that individuals supporting, more than those opposing, a genetic explanation of behaviour remain closer to the content of the message when interpreting information related to the scientific discovery. Instead of asking participants to write a description of the scientific discovery, participants were invited to associate keywords to the message. These keywords were then coded as descriptive or evaluative. On the basis of the anchoring conjecture positing that information is incorporated into pre-existing attitudes, we expect that endorsement of genetic explanations is related to descriptive associations, since the message is consistent with one's attitudes, whereas rejection of genetic explanation should be related to evaluative accounts of the information. Individuals opposing genetic explanations should take a more critical stance, because the information is incongruent with their beliefs. This prediction is supported by the fact that the coding of participants' opinions in Study 2 revealed that anti-genetics mentioned that faithfulness is socially acquired.[1] This stance converges with the idea that faithfulness is not genetically determined. Moreover, anti-genetics feared the implications of the finding with respect to romantic relationships more frequently than pro-genetics did.

Method

Participants

Eighty-seven people aged 16–76 from a French speaking Swiss town participated in a study. Five participants failed to complete the entire experiment and seven misunderstood the task. They were eliminated from the analyses. The final sample consisted of 75 participants (51 women).

Procedure and material

The participants first answered a questionnaire assessing their position towards genetic explanations of behaviour identical to the one used in Study 2. This time, everyone read the *Le Monde* reference text in the second phase and then, to simulate a presentation, listened to a taped account of the text. Finally, participants were asked to associate three keywords to the description they heard. The generated keywords constituted the dependent measures of this study.[2]

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[1] *In addition to writing an account on the reference article, participants were invited to write their opinion about the study on a separate sheet. These data were not presented in the current paper.*
[2] *Participants were randomly assigned to listen to one of two versions of a taped description of the text. However, because the descriptions were evaluated similarly by the participants they were pooled and analysed together.*

As in the previous study, participants were separated, by means of a hierarchical cluster analysis, into pro-genetics ($N = 43$) and anti-genetics ($N = 32$) as a function of their positioning towards three questions on genetic explanations of behaviour.

Results and discussion

Keywords associated to the taped description were first coded as either descriptive or evaluative. A dichotomous measure was employed because 66 participants (88%) provided either only descriptive or only evaluative terms. Thus, associations were coded as descriptive when all three keywords were present in the text or taped description (e.g. vasopressin, faithfulness gene, behaviour, genetic modification, etc.), whereas associations were considered evaluative when one or more of the keywords expressed a critical judgment (e.g. confusion, subjective, credulity, imprecise, dangerous etc). Thirty-four (45%) respondents associated evaluative terms to the keywords to the description they heard.

The anchoring hypothesis was tested by observing the impact of endorsement of genetic explanations (pro-genetics vs. anti-genetics) on the style of keywords associated to the description (descriptive vs. evaluative keywords). Corroborating our hypothesis, an association between the connotation of keywords associated to the taped description and the endorsement of genetic explanation of behaviour was demonstrated, $\chi^2(1) = 6.64$, $p < .01$. Seventy-one per cent (29 out of 41) of respondents using a descriptive style were pro-genetics, whereas there were only 41% (14 out of 34) of pro-genetics among respondents using the evaluative style. That is, pro-genetics made more descriptive accounts and anti-genetics made more evaluative accounts. The results showed that the convergence between ones beliefs and the content of the message was associated to a more descriptive processing of information compared with the situation when beliefs and the message were incongruent. This indicates that the interpretation of a scientific message depends on the pre-existing attitudes of individuals participating in its diffusion.

GENERAL DISCUSSION

Three studies investigated the diffusion of scientific news concerning a genetic discovery. We focused on the objectification of news about the influence of vasopressin on the sociability of voles and the anchoring processes driven by endorsement or rejection of genetic explanation of behaviour. Taken together, Studies 1 and 2 demonstrated that expert and scientific traces decreased with a shift towards everyday language as the message moved along the communication chain from the article published in *Le Monde* to accounts made by individuals who only hear about the discovery. Illustrating the objectification process of scientific information, a simplified figurative meaning of the message was progressively formed. The original scientific message about the discovery of the impact of vasopressin on the sociability of voles was crystallized into a faithfulness gene.

The rumour paradigm analysed through the lens of social representations theory improves the understanding of a particular communication and sense-making process in which information circulates through chains of individuals and groups (see also Bangerter, 2000). The link between differential lexicon use and social sense making in this process deserves some discussion. A move along the communication chain was characterized with an evolution of vocabulary from a scientific semantic universe towards a mundane semantic universe. This was evidenced notably with a variation in category use (e.g. Lakoff, 1987). In the scientific realm and early in the chain precise examples of a biological category, like voles, were evoked. Further in the chain, categories became more approximate. More familiar and typical examples from the lay realm which resemble the original example such as rat and mouse from the rodent category were associated to the discovery. Superordinate categories such as animals in general were also maintained in the message as it progressed. The semantic shift, as exemplified by a switch in categories is driven by a pragmatic goal of meaning making (Potter, 1996). Much like analogies or metaphors in scientific communication (Gentner, 1982; Maasen & Weingart, 1995; see also Lakoff & Johnson, 1980), words were drawn from a mundane vocabulary instead of a scientific vocabulary in order to interpret and understand the meaning of the genetic discovery.

To our knowledge, this research is one of the first to study experimentally the transmission of scientific narratives as a function of pre-existing attitudes. Studies 2 and 3 demonstrated that the development of the scientific message depended on personal endorsement of genetic explanations. For individuals accepting genetic explanations of behaviour, the information was transformed to a lesser extent and remained closer to the initial content, including scientific terminology, than for those rejecting genetic explanations. Moreover, pro-genetics were more descriptive in their accounts, whereas anti-genetics gave more evaluative accounts of the discovery. That is, supporters of genetic explanations anchored the information in their existing belief system that is consistent with the findings. For those rejecting genetic explanations, the findings were inconsistent with their belief system and they were thus more critical. The classification distinguishing pro- and anti-genetics converged in the two studies, revealing its robustness and allowing the exclusion of the possibility that our results were driven by the level of expertise of the respondents.

As suggested by social representations approaches, the transmission and transformation processes demonstrated in the three studies were presumably shaped by simultaneously operating communicational requirements as well as personal relevance and attitudinal factors (Wagner, 2007). The same initial message therefore led to different stories at the end of the communication chain. Objectification of the scientific message was driven by pragmatic communicational concerns. A communicator must provide some evidence of a meaning (e.g. existence of a genetic basis for affiliation) such that the addressee can infer this meaning on the basis of the evidence (see Sperber & Wilson, in press). In order to understand the discovery and to communicate an understandable version of it, individuals focused on intriguing aspects of the message and associated them to lay vocabulary. Attitudinal concerns, in turn, influenced anchoring processes in which people tend to assimilate information with pre-existing knowledge and beliefs. Insofar as beliefs are shared within groups, anchoring is not merely an intra-personal process of assimilation (see Joffe, 2003). Besides raising diverging stances concerning genetic explanations of behaviour, we assumed that the discovery about the role of vasopressin on sociability of voles would interest individuals because it provided information related to faithfulness in romantic relationships. Indeed, in addition to *Le Monde*, the discovery was reported in a number of newspapers often referring to human applications. The experimental paradigm simulating a communication chain allowed us to illustrate the directions an intriguing scientific discovery takes in the course of its diffusion in society.

The construction of meaning in social representations research has already been examined by means of word associations that convey the content, structure, and polarization of representations (e.g. Abric, 2003). The methodological originality of our studies lies in the dynamic approach that analyses, with changes in vocabulary, the transformation of a scientific message throughout the communication chain. In line with Lakoff (1987) and Potter (1996), we argued that lexical descriptions involve semantic categories and areas which allow expressing viewpoints. Concretely, participants adopted a vocabulary to translate and adapt new and abstract information to their semantic and pragmatic repertories. By deriving dependent variables from narratives, our approach allowed the experimental investigation of the development of narratives in Studies 1 and 2.

One caveat of this approach is nevertheless the great variation in terminology in the accounts produced by participants, which limited the number of usable indicators. Thus the dependent measure could not be as accurately assessed as a Likert scale measure. In support of this approach, a qualitative analysis of the narratives (Green & Clémence, 2002) yielded similar tendencies to the results reported in this paper. Moreover, the word selection task employed in Study 2 and the keyword associations in Study 3 were more controlled measures that supported the results revealed by the narrative measures. Also the content coding of central themes presented in Study 2 provided external validation of the results. The absence of measures on retrieval processes limits the conclusions that can be drawn from the results, since we were not able to disentangle the role of individual memorization processes in our results. Focusing on distinct words in a semantic analysis has yet another drawback, since words are separated from their immediate context. Analysing the discourses employed by respondents would certainly provide a richer understanding of the transformation and the transmission of the genetic discovery. Indeed, the transcription of discussions between readers and listeners in the communication chain and an in-depth analysis of the rhetoric employed in the written accounts are ways to extend the current research. Notwithstanding these limits, our research showed the impact of interpersonal communication and pre-existing beliefs on transmission and transformation of the content of a scientific discovery. The study provides researchers insights on factors influencing the comprehension and popularization of their findings in society. The proposed model can be employed in other fields of communication from the study of basic cultural transmission processes (e.g. Mesoudi, Whiten, & Dunbar, 2006) to applied domains such as political or health communication.

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Received 20 December 2006; revised version received 5 September 2007

Appendix

Frequencies of 18 expert and lay terms in three databases

Word	French Web[a]	Frantext[b]	Le Temps[c]
Expert			
Vasopressin	24	1	1
Receptor	208	9	8
Arginine	79	14	1
Vole	281	5	5
Prairie	0	–	0
Montane	0	–	0
Mammal	22,000	78	85
Monogam -ous, -y	76	10	6
Polygam -ous, -y	706	23	15
Lay			
Hormone	1,500	269	73
Gene	79,300	444	581
Rat	88,600	754	177
Field	127	–	14
Mouse	165,000	1653	320
Animal	1,350,000	4,392	>1000
Faithful, -ness	41,200	2,648	356
Unfaithful, -ness	5,310	314	53
Mean ratio (lay/expert)	74	75	21

[a] Number of French web pages with the word in the title found with Yahoo search engine (http://fr.yahoo.com/, October 12, 2005).
[b] Occurrences in a French database Frantext, a collection of 1,250 French texts including novels, essays, and popular scientific writings published between 1900 and 2000 (http://www.frantext.fr/, University of Nancy, 2005, October 14, 2005).
[c] Occurrences in all articles of a major Swiss French newspaper *Le Temps* between 1990 and 2000 (http://www.letemps.ch/, October 14, 2005).