Adjusting Social Inferences in Familiar and Unfamiliar Domains: The Generality of Response to Situational Pragmatics

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Two experiments investigated the influence of situational pragmatics on the selective use of specific instances and generalized knowledge structures to make social inferences. In Experiment 1, social inferences were made in an unfamiliar domain similar in structure to a typical situation of social greetings and address, but devoid of useful cues to social schemas. Participants were told that either one or another of the features of the situation was more pragmatically important for deriving inferences about appropriate social behaviour; consistent with predictions from a computational model of analogical mapping (ACME), they made reliable inferences based on analogies to specific instances, with the situational importance of relations guiding the selection of the optimal analogue. In Experiment 2, social inferences were examined in the more familiar domain of predicting social behavior between low and high status persons and between members of an ingroup and an outgroup in Japan. The availability of specific examples was varied, as was the perceived importance of status and group membership. The situation was isomorphic to that in the first experiment, except for the availability of generalized knowledge structures to guide inferences. Participants made relatively veridical inferences that were sensitive to variations in the pragmatic importance of dimensions. Provision of specific analogues had little impact on inferences, suggesting that participants were relying instead on more general and cross-culturally applicable knowledge about adjusting social relations according to situational pragmatics.

Dans les deux expériences conduites, on examine l'influence de la pragmatique situationnelle sur l'utilisation sélective d'exemples spécifiques et de structures de connaissance généralisées dans le processus des inférences sociales. Dans l'expérience 1, les inférences sociales ont été faites dans un contexte non familier où la structure est similaire à celle de la situation typique de salutation et de conversation mais dépourvue de tout signal indicatif de schèmes sociaux. Les participants ont été informés que l'une ou l'autre des caractéristiques de la situation était particulièrement important sur le plan pragmatique pour faire des inférences sur le comportement social approprié. Conformément aux prévisions élaborées à partir d'un modèle computationnel de correspondance analogique, les participants sont parvenus à des inférences fiables en faisant l'analogie à des exemples spécifiques où l'importance situationnelle des relations guidait le choix de l'analogue optimal. Dans l'expérience 2, les inférences sociales ont été examinées dans un contexte japonais plus familier dans lequel on peut prévoir le comportement social des participants selon leur statut social et selon qu'ils font partie d'un

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endogroupe ou exogroupe. La disponibilité des exemples spécifiques, ainsi que l'importance perçue du statut social et de l'appartenance à un genre de groupe précis, étaient variables. La situation était isomorphe à celle de la première expérience à l'exception faite de la disponibilité des structures de connaissance généralisées qui guident les inférences. Les participants sont parvenus à des inférences relativement véridiques sensibles aux variations de l'importance pragmatique des dimensions. Le fait de fournir des analogues spécifiques a eu peu d'impact sur les inférences faites, ce qui suggère que les participants, pour adapter leurs relations sociales en fonction de la pragmatique situationnelle, ont plutôt eu recours à des connaissances pratiques plus générales et interculturelles.

The ability to change one's inferences and action according to the demands of the situation is an important social skill. One of the hallmarks of the motivated tactician (S. Fiske, 1992, 1993; see also Kunda, 1990; Showers & Cantor, 1985) is goal-directed flexibility in information processing, whether in dealing with novel domains, where little conceptual knowledge is available, or in familiar domains, where generalized knowledge structures predominate. Far from being slaves to any fixed representation of a person, category, or schema, the ability to modulate social inferences by emphasizing or de-emphasizing different attributes according to situational pressures is basic (Holyoak & Thagard, 1989; Liu, 1992a; see also Kunda, 1990; Showers & Cantor, 1985). To serve the goal of avoiding social blunders in both a cross-cultural and a completely novel situation, people can substantially change what inferences they make, either from specific instances or from generalized knowledge structures, by directing attention to attributes relevant to the situation at hand, thus effecting a temporary change to their person representations; the greater their prior knowledge about a domain, the less influence specific instances will have and the smaller the amount of these changes.

Specifically, we suggest that the pragmatics of appearing graceful in typical social situations demand sensitivity to variations in the relative importance of status relations and group membership. Knowledge of how to respond to changes in the relative importance of observing social norms that denote status versus those that denote group membership may be built in to our information processing strategies and structures, and may follow similar rules across cultures.

Status and groups are among the most fundamental relational schemas that govern human interaction, according to A.P. Fiske (1992). The advantage of being able to modulate inferences according to situational variations in their relative importance is easy to illustrate: Imagine a regular board meeting where the relative status (and corresponding power differences) of the various board members is crucial to determining appropriate social behaviour, like who sits where or who is respectful to whom; however, that same board meeting could become the site of a battle between two factions for control of the company, and then it becomes more important to know whether the other board member is on your side than to know his or her rank. Adaptability in processing status and group membership information is important because these attributes structure human interaction and inference across cultures and situations, but with great variability (see, for example, Brown & Levinson, 1978, 1987; A. Fiske, 1992; A. Fiske, Haslam, & Fiske, 1991; Polhemus, 1978).

For instance, a popular stereotype in Western cultures is that social norms governing polite behaviour in Eastern cultures are difficult or impossible for outsiders to master. This may or may not be true, but we suggest that even in the absence of detailed knowledge about another culture, there is enough cross-cultural consistency in rules for polite behaviour that individuals can make a reasonable guess as to how to behave properly in new situations that embody different goals for social interaction. If this is the case, then teaching these principles may prove useful for cross-cultural adaptation.

The ability to modulate inferences according to situational changes in the importance of different person attributes should not be restricted to familiar dimensions of human interaction. Holyoak and Thagard's (1989) Analogical Constraint Mapping Engine (ACME) is a precise computational model that claims that pragmatic centrality, or prior knowledge about the importance of attributes and relations, is one of three basic constraints that governs analogical transfer from any specific instance to any target situation for which inferences are required.

Since generalized prior knowledge is usually unavailable or difficult to apply to unfamiliar domains, people often rely on information about

a single instance to generate inferences and guide future action (e.g. Gentner & Toupin, 1986; Gick & Holyoak, 1980; Read, 1983, 1984). In a standard adventure story, for example, the hero or heroine is deposited on some strange land where he or she must make quick decisions about who to trust and how not to offend. The decisions they make are often based on reasoning from a single instance, with danger imminent.

ACME models the process of analogical mapping as a compromise between structural isomorphism (which implies that mappings should be one-to-one and consistent), semantic similiarity (which yields a preference for mappings between items that are similar in meaning), and pragmatic centrality (subjective prior importance) using a connectionist algorithm (e.g. McClelland & Rumelhart, 1981). Of these three factors, the effects of similarity are most thoroughly documented (e.g. Holyoak & Koh, 1987; Issing, 1990; Kielian-Gilbert, 1990; Markman & Gentner, 1993; McAndrews & Moskovitch, 1985; Okagi & Koslowski, 1987; Read, 1987), whereas the effects of pragmatic centrality are least well understood; there is also some theoretical dispute as to its necessity (see Falkenhainer, Forbus, & Gentner, 1989 vs. Holyoak & Thagard, 1989).

We might expect pragmatic centrality to be an especially important and dynamic variable in social situations, however. For instance, if the hero in our adventure story is nearly stung to death by the tail of an unfamiliar animal, he might accord the shape and colour of a second beast's tail more importance in generating inferences for action next time. Pragmatic centrality (or the subjective importance of constituent elements in a situation) can thus function to make inferences by analogy highly flexible. Certain elements of an individual or situation could dominate the analogy in one situation and be uninfluential in others (e.g. the venomous tail becomes less important if the hero acquires immunity to poison, and other attributes of the creature, like its beauty or ability to communicate, may become salient). We suspect that social situations may often embody motivational pressures to change the pragmatic centrality of constituent elements.

It is easy to imagine representations of persons and situations being fluid under the influence of goal-directed pragmatic centrality in unfamiliar domains. But both Brewer (1988) and S. Fiske and Neuberg (1990) have proposed person perception models where strong prior expectancies (e.g. those from theories, categories, or schemata) short-circuit extensive individuated processing. This suggests that providing people with a single instance in a familiar domain will do little to shift their social inferences, but does not specify whether information processing with highly practised knowledge structures will be rigid or flexible with respect to situational pragmatics (i.e. variations in the pragmatic centrality of different elements of a situation). Although some of the literature on stereotyping shows that we might have difficulty in avoiding automatic inferences (e.g. Devine, 1989; Uleman & Bargh, 1989), it and other work also suggests that we can make the proper adjustments given time (e.g. Gilbert, 1991). For familiar domains, does our information processing concerning status and group membership contain routines that allow us to modulate our inferences according to their relative importance? Will the presence of a specific instance change these inferences? For unfamiliar domains, will the impact of situational pragmatics be greater or less than in the familiar domain?

The generality of our ability to modulate social inferences according to situational pragmatics is tested in two boundary conditions. In the first experiment, we present participants with a completely unfamiliar social situation devoid of useful cues to prior knowledge. Only a single specific example and situational pragmatics can be used to guide inferences; here, any ability to adjust inferences must be made solely on the basis of analogical transfer. This augments existing knowledge about the impact of similarity on social analogical transfer (e.g. Gilovich, 1981; Read, 1983, 1984; Read & Cesa, 1991) with pressure from pragmatic centrality. In our second experiment, we shift to the more familiar situation of appropriate greetings and address between people varying in status and group membership. Here, we attempt to establish participants' ability to change inferences when status and group membership become alternatively more important, testing also the effects of an analogy in these situations. Together, these studies explore the assertion that people can change their inferences according to situational pragmatics whether their dominant form of knowledge about the domain is generalized or based on a single specific instance, and they provide guidance about how people can adapt to new situations embodying alternative goals for social interaction.

EXPERIMENT 1

In Experiment 1, we wanted to ascertain whether people are capable of adjusting their inferences on the sole basis of analogies, without any recourse to generalized prior knowledge. This can be very difficult with realistic materials, so we constructed a scenario that is isomorphic to a typical situation of greetings between individuals, but removed any clues to prior knowledge by making the target persons oddly configured aliens.

Method

Participants

Participants were 30 UCLA undergraduates (19 males, 11 females, with a median age of 19 years) who volunteered for the experiment in partial fulfilment of course requirements for an introductory psychology class. The study was administered in groups of one to four. All participants worked individually.

Materials, Design, and Procedure

Participants were told that their goal was to try to master appropriate social behaviour on the "Planet Futon" in order to qualify for a special mission to explore this new planet. They were informed that two particular dimensions of Futonian appearance were most important in dictating social norms for correct behaviour. As a test of their ability to adjust their inferences, the relative importance of the two dimensions was manipulated between subjects: some were told that the shape of a Futonian's head (triangular v. cylindrical) was most important in determining appropriate behaviour, and the other half were told that the colour of their blood (orange v. green) was crucial. The main dependent measures were the types of social inferences made after learning about specific instances of Futonian behaviour.

Participants were instructed to role-play top students in cultural anthropology (circa AD 3001) about to take a test that would qualify them for a mission to study intelligent life on a newly discovered planet. Previous failures to communicate with the "Futonians" were ascribed to a lack of understanding of their complex modes of social interaction. All participants were informed that there were two important dimensions of Futonian appearance, head shape and blood colour. Correspondingly, there are four kinds of Futonians (see Table 1), and the goal was to figure out appropriate Futonian social behaviour between these four kinds.

A written description of social interaction between four Futonians was then presented, where Futonian speech was described as either whistling or humming, and the Futonian mode of greeting was described as bopping the head in and out of its socket either 5, 10, or 20 inches (low, medium, high). In the proper social context, these behaviours could be considered analogues to formal and informal modes of speech and depth of bowing.

Two kinds of Futonians were observed interacting in the scenario (see design summary in Table 1). Only information about behaviour in situations corresponding to Cells 1 and 4 in Table 1 was provided in the example. The interactions among Futonians were presented serially, in the form of simple "scientific observations"; two instances of appropriate social behaviour between a pair of actors was provided for each cell.

TABLE 1
Description of "Futonian" Social Behaviour

	Blood Colour	
Headedness	*Same (both green- or orange-blooded)*	*Different (one green- and one orange-blooded)*
Same (both triangular or both cylindrical)	CELL 1 both bop heads high both make humming speech	CELL 2 no description given
Different (one cylindrical with one triangular)	CELL 3 no description given	CELL 4 CylGreen + TriOrange = CylG bop medium height TriO bop low both make whistling speech

From the information given on how Futonians with the same colour of blood and the same shape of head behave (Table 1, Cell 1), and information on how Futonians with different blood colour and different head shape behave (Cell 4), participants had to infer how two Futonians with different blood colour but the same head shapes (Cell 2), and ones with the same blood colour but different head shapes (Cell 3), ought to interact.

The manipulation of situational pragmatics was straightforward: half the participants were told that head shape was "the most important dimension dictating appropriate social behaviour on Planet Futon," and the other half were told that blood colour was most important. Violations of rules for the more important dimension were described as having a horrible consequence, as the offended party spat a noxious yellow fluid in the social blunderer's face, branding him or her with a foul odour for days. No consequences were described for violations of social rules based on the less important dimension.

Immediately after they read the scenario, participants were given a memory test to ensure that they had memorized the behaviours from the source adequately. They were asked to fill out a sheet listing all the speech and head movement behaviours for the four interactants using the source scenario as a reference, writing down any consistent patterns they saw. Next, they took a "closed book" memory test for the behaviours. Finally, they read the importance manipulation, and then were given a "prediction test" where they were asked to make inferences about what mode of speech and head movement were appropriate for four new interactions between Futonians, involving two situations falling into each of Cells 2 and 3 in Table 1. Question order was counterbalanced, with half of the participants getting questions on head bopping first and the other half questions on whistling or humming first. Pretesting revealed no systematic prior expectancies for the materials.

Derivation of Predicted Analogical Inferences

Because there is a complex relationship between the test cases drawn from Cells 2 and 3 and the source analogues drawn from Cells 1 and 4, the predictions based on a model of analogical transfer are not trivial. For example, the test case for Cell 2 involved an interaction between a triangular-headed Futonian with green blood and a triangular-headed Futonian with orange blood. If sameness of head shape is more important, the test case should be mapped to one of the Cell 1 source examples, whereas if sameness of blood colour is more important then it should be mapped to one of the Cell 4 examples. The expected inferences would then follow if the behaviours in the preferred source example are "carried over" to the novel test case.

Transfer predictions for the goal-directed use of analogy were derived using ACME (Analogical Mapping by Constraint Satisfaction), a computational model of analogical transfer that finds the optimal mapping between two situations based on trade-offs between various types of constraints (Holyoak & Thagard, 1989). Details of this connectionist model have been described elsewhere (see Holyoak, Novick, & Melz, 1993; Spellman & Holyoak, 1992, 1993, in press). For the purposes of this study, it is essential to note only that a selective attention mechanism constrains the analogical mapping process so that pragmatically central facts dominate the mapping (e.g. if head shape is more important than blood colour, then a triangular-headed, green-blooded Futonian should tend to map to an actor with a triangular head but orange blood rather than one with green blood but a cylindrical head).

The dominant inference patterns predicted by ACME are summarized in Table 2 and explained in detail in the Appendix. If head shape is emphasized, then participants should transfer behaviours from Cell 2 to Cell 1 and from Cell 3 to Cell 4. If blood colour is emphasized, then they should map behaviours from Cell 2 to Cell 4 and from Cell 3 to Cell 1.

Results

The data were analyzed by using interacting pairs of characters as a unit, and aggregating across the two within-subjects replications. Question order effects were not significant in any analysis and therefore are not reported.

Speech inferences were coded into three categories: Hum (both actors hum), Mixed (one hums and the other whistles), and Whistle (both actors whistle). Hum was the pattern associated with the Cell 1 source examples and Whistle was the pattern associated with the Cell 4 source examples. Inferences for head movement were coded into four categories: High Equal (both actors make

TABLE 2
Analogical Mapping Predictions from a Pragmatic Model for a Fictional Scenario

	Social Dimension Emphasized	
Interactants	*Headedness*	*Bloodedness*
(Cell 2)		
TriG + TriOr	both bop heads high	TriG bops head medium
Same Heads		TriOr bops head low
Diff Blood	both hum	both whistle
CylG + CylOr	same as above	CylG bops head medium CylOr bops head low
(Cell 3)		
TriG + CylG	CylG bops head medium	both bop head high
Diff Heads	TriG bops head low	
Same Blood	both whistle	both hum
TriOr + CylOr	CylOr bops head medium TriOr bops head low both whistle	same as above

high head bops), Low Equal (both make medium or low bops), High Unequal (one makes a high bop and the other a medium or low bop), or Low Unequal (one makes a low bop and the other a medium bop). The High Equal pattern corresponded to the behaviour illustrated by the Cell 1 source examples whereas the Low Unequal pattern corresponded to the behaviour illustrated by the Cell 4 source examples.

Analyses of frequency data were conducted using a multinomial analysis of variance model with Wald test statistic (approximating a Chi-square, see Woodward, Bonnet, & Brecht, 1990); either pattern of speech or head bopping served as the dependent variable, and the attribute emphasized as more important was the independent variable.

Speech: Inferences about Appropriate Sounds

Table 3A presents the data for speech patterns as a function of the emphasized relation, head shape or blood colour. For Cell 2 test cases (actors with same head shape and different blood colour), the vast majority of participants (97%) inferred that the two Futonians ought to hum to each other when head shape was emphasized, whereas 67% inferred that the actors should whistle to each other when blood colour was emphasized, $\chi^2(1,30) = 47.29$, $P < .001$ (the empty category of mixed inferences was dropped for this analysis). These patterns are precisely those that the ACME model predicted should be dominant (see Table 2).

Table 3B presents the comparable results for the Cell 3 test cases (actors with different head shapes and same blood colour). The situational pragmatics manipulation again resulted in the predicted pattern, which was the exact reverse of that obtained for the Cell 2 test cases. For Cell 3 cases, 87% of participants in the head-shape condition inferred that the two Futonians ought to whistle to each other, whereas 97% of participants in the blood-colour condition inferred that the actors should each hum, $\chi^2(1,30) = 140.98$, $P < .001$.

Head Movement: Inferences about Appropriate Head Bopping Behaviour

The data for the Futonian mode of head movements, presented in Table 4, were no less consistent with predictions. For Cell 2 test cases (Table 4A), 57% of participants in the head-shape condition inferred that the two Futonians ought to each bop their heads to a high level (High Equal), whereas 60% of participants in the blood-colour condition predicted that the green-blooded Futonian should bop to a moderate level and the orange-blooded Futonian to a low level (Low Unequal), $\chi^2(3,30) = 16.97$, $P < .001$.

Inferences for the Cell 3 test cases (Table 4B) were similarly consistent with our predictions, which were again opposite to those for the Cell

TABLE 3
Speech Inferences as a Function of Perceiver Goal

Table 3A: Cell 2 Inferences: Same Heads, Different Blood

Speech Inference (N = 30)	*Perceiver Goal to Emphasize*	
	HEADEDNESS	*BLOODEDNESS*
Whistle	33%	97%
Mixed	0%	0%
Hum	66%	3%

Table 3B: Cell 3 Inferences: Different Heads, Same Blood

Speech Inference (N = 30)	*Perceiver Goal to Emphasize*	
	HEADEDNESS	*BLOODEDNESS*
Whistle	87%	3%
Mixed	0%	0%
Hum	13%	97%

Dependent variable expressed as percentage of inferences falling into a given pattern; *N* refers to total number of inferences made by participants in that experimental condition; each participant provided two inferences.

TABLE 4
Futonian Greetings by Individuals with Different Blood as a Function of Perceiver Goal

Table 4A: Cell 2 Inferences: Same Heads, Different Blood

Bop Height (N = 30)	*Perceiver Goal to Emphasize*	
	HEADEDNESS	*BLOODEDNESS*
High Equal	57%	13%
Low Equal	17%	23%
High Unequal	0%	3%
Low Unequal	27%	60%

Table 4B: Cell 3 Inferences: Different Heads, Same Blood

Bop Height (N = 30)	*Perceiver Goal to Emphasize*	
	HEADEDNESS	*BLOODEDNESS*
High Equal	20%	74%
Low Equal	0%	3%
High Unequal	10%	7%
Low Unequal	70%	17%

Dependent variable expressed as percentage of inferences falling into a given pattern; *N* refers to total number of inferences made by participants in that experimental condition; each participant provided two inferences.

2 cases. In the head-shape important condition, 78% of participants inferred that a green-blooded Futonian should bop to a moderate level and an orange-blooded Futonian to a low level when they greet each other (Low Unequal), whereas in the blood-colour important condition 73% of participants inferred that the Futonians ought to each bop their heads to a high level (High Equal), $\chi^2(3,30) = 46.92$, $P < .001$. The great majority of participants transferred information directly from one of the two cells illustrated in the source scenario (Cells 1 and 4), and very few generated the Low Equal or High Unequal patterns (novel patterns not seen in the source scenario).

Memory for the Source Scenario

Data from the memory tests conducted prior to the importance manipulation indicated that memory for the source scenario was virtually flawless. The 30 participants, who had to remember 12 speech behaviours and 12 head movement behaviours each (720 total items), produced only 6 errors on the memory test. There were no differences in memory accuracy across either the importance manipulation or the two types of Futonian behaviours.

Discussion

The results of Experiment 1 provide strong evidence that people can make social inferences about unfamiliar situations on the basis of analogical transfer, and that this transfer process is modulated by the pragmatic importance of relevant social dimensions. The patterns of inference participants generated were predictable from a model of analogical mapping based on the principle of maximizing satisfaction of multiple constraints, with selective attention reducing the influence of less important dimensions.

It appeared to be easy for participants to focus their attention on the "person" attribute described as more important for generating social inferences in the test scenarios, and ignore the less important attribute almost completely. Without prior knowledge about "Futonians," representations of these aliens were completely fluid for the purposes of making inferences; the less important dimension was not represented in most participants' inference patterns.

EXPERIMENT 2

Our second investigation examined situational pragmatics in the types of inferences made by Americans about appropriate forms of address and bowing for Japanese actors at a business lunch. The presence or absence of a specific example of appropriate Japanese social behaviour was manipulated, along with the relative status and group membership of the actors. We hypothesized that participants should be able to adjust their inferences in response to situational pressures to treat either status or group membership as more important regardless of whether these inferences were drawn from a specific example plus prior knowledge or prior knowledge alone. The social behaviours used were form of address (formal or informal) and style of bowing (nodding, bowing modestly, or bowing deeply). Although there is some cross-cultural consistency regarding both these kinds of action, Japanese social behaviours are still widely regarded by Westerners as complex or "inscrutable." They furnish an excellent domain for observing how American students translate their generalized prior knowledge about customs involving respectful greetings to the specific situation of a Japanese business lunch, and whether they can modulate these inferences to take account of the situational pragmatics. In designing materials for this experiment, we tried to mimic actual Japanese social norms regarding status and group membership, but for obvious reasons, the scenario we used is only a gross approximation.

Assessment of Prior Knowledge

Prior to conducting the experiment proper, we measured American students' prior expectancies regarding appropriate Japanese social behaviour. We were concerned that given the more individualistic orientation of Americans compared to Japanese (Markus & Kitayama, 1991; Triandis, 1989), our participants would tend to believe that personal status should be more important than group membership in determining social behaviour. Additionally, given their lack of familiarity with rules governing bowing compared to rather commonplace rules for formal versus informal address, our participants might also be more certain about their inferences regarding address.

A different group of 30 UCLA undergraduates was approached by an undergraduate research assistant and asked to fill out a brief two-page survey regarding their understanding of Japanese business relationships. Participants were asked to indicate how important they thought relative status and group membership were in determining appropriate Japanese social behaviour for both address and bowing (on 7-point Likert scales), and how certain they were about these beliefs. They also made a forced choice between status and group as the more important factor.

Analyses of variance regarding the relative importance of status vs. group membership revealed that participants thought that status should be more important in determining appropriate social behaviour [$M = 5.6$ compared to $M = 4.6$, $t(29) = 2.1$, $P < .05$], and they were more certain about the effect of status [$M = 5.3$ vs. $M = 4.2$, $t(29) = 2.2$, $P < .05$] than groups. On the forced-choice measure, participants again chose status as being more important than group membership for both address (87%) and bowing (85%). Participants also expressed more certainty about their inferences regarding form of address ($M = 4.6$) than style of bowing [$M = 4.1$, $t(29) = 1.7$, $P < .05$].

Method

Participants

Participants were 74 non-Asian undergraduate students (20 males, 54 females) from the university of California, Los Angeles (UCLA), who participated in exchange for course credit. The median age was 20, and the ethnic composition was 37 Whites, 11 Blacks, 14 Latinos, and 12 who labelled themselves as "Other." Asian students were excluded from participation because pilot tests revealed that they believed themselves to have considerable prior knowledge about Japanese social roles, and therefore would be less susceptible to the influence of the independent variables.

Design

A 2 × 2 between-subjects design (status vs. group membership described as more important, and analogues either provided or not provided) was employed. A control group, which received neither an importance manipulation nor source analogues, was added to provide a baseline measure of inferences based on prior knowledge alone. Participants were therefore randomly assigned to one of five possible experimental con-

ditions (15 participants were assigned to each of the 4 manipulated conditions and 14 to the control condition).

The materials used in the analogy were written descriptions of a business lunch in which four male Japanese actors, varying in status and group membership, greeted and addressed one another. Actual Japanese norms for appropriate social behaviours in these situations are approximated in Table 5. Status was modelled as age plus occupational title, and groups by what company the actors were from. Cells 1 and 4 are isomorphic to those in Table 1 for Futonians, except the contributions of prior knowledge.

The participants' aim was again to make accurate inferences about how individuals differing in attributes (in this case, status and group membership) should greet one another. Situational pragmatics were manipulated using instructions that stressed the importance of either observing status rules or group membership rules in Japan. A greetings scenario was provided in the analogy condition that provided information corresponding to Cells 1 and 4 of Table 5, just as in Experiment 1. Two pairs of actors who were in the same company and of equal status (Cell 1) or else in different companies and of unequal status (Cell 4) interacted in a way that was consistent with actual Japanese greeting customs, thus reinforcing any correct prior assumptions participants may have had.

The source scenario provided information on degree of bowing (deep, moderate, or just a nod) and form of address (formal vs. informal) used among equal status ingroup members (the behaviour of two men of equal status from the same company, corresponding to Cell 1 in Table 5) and among outgroup members of different status (the behaviour of two men of unequal status and from different companies, corresponding to Cell 4 in Table 5).

The crucial dependent variables involved inferences about proper behaviour (degree of bowing and form of address) for characters with relationships fitting into the two cells for which analogies were not provided for participants in any condition (Cells 2 and 3 in Table 5). What inferences would participants make regarding appropriate social behaviour for two men of equal status from different companies (Cell 2), and for two men of unequal status from the same company (Cell 3)?

The predictions are clear for conditions in which a source analogue is provided, and correspond to the logic used in Experiment 1. When status is emphasized, analogy participants should map each new case to the source case that matches in terms of status relations (i.e. Cell 2 to Cell 1 because in both cases the actors are of equal status, and Cell 3 to Cell 4 because in both cases the actors are of unequal status). In contrast, when group membership is emphasized, analogy participants should map each new case to the source case that matches in terms of group-membership relations (i.e. Cell 2 to Cell 4 because in both cases the actors are from different social groups, and Cell 3 to Cell 1 because in both cases the actors are from the same social group).

TABLE 5
An Approximation of Japanese Rules for Appropriate Social Behaviour as a Function of Status and Group Membership

	Group Membership	
Status	*Same Group*	*Different Group*
Equal	both nod both informal address	both modest bow both formal address
	CELL 1	CELL 2
Unequal	hi status nods low status modest bow hi status informal add. low status formal add.	hi status modest bow low status deep bow both formal address
	CELL 3	CELL 4

It is less clear what inferences to expect for participants in the prior knowledge alone and control conditions. To the extent that participants had pre-experimental knowledge of how changes to the importance of status and group-membership influence greetings, they would be expected to make similar inferences to participants in the analogy condition. If, however, they lack such prior knowledge, they would have no clear basis for responding.

Materials and Procedure

The experimental materials for the analogy condition consisted of six parts: an introductory page, a reference page highlighting the four actors in the source scenario, a source scenario, a manipulation of pragmatic importance page, a test scenario, and a questionnaire with the dependent variables. Participants in the prior knowledge alone condition received identical materials without a source scenario or reference page, and participants in the control condition did not receive

the source scenario, the reference page, or any manipulation of situational pragmatics.

The first page contained a general introduction and instructions. The reference page introduced four characters (two older Vice-Presidents from one Japanese company and two younger Section Coordinators from a second company) and disclosed information about the age, the position, and company of each character.

The source scenario provided information on the appropriate degree of bowing (deep, moderate, or nod) and form of address (formal vs. informal) for the four characters introduced in the reference page. A business lunch was described, in which two Vice-Presidents from "Nagoya Motors" had lunch with two Section Coordinators from "Quality Control Company," and behaved very properly. The source scenario thus provided information on appropriate address and bowing for Cells 1 and 4 in Table 5. To maximize realism, interactions between the four characters were embedded in a prose narrative.

For the manipulation of situational pragmatics, participants were informed that either status rules or group-membership rules were more important to Japanese, and more severely punished if violated. For example, participants in the "group-membership important" condition read the following:

> In Japan, violations of group-membership are treated most harshly. It seems, however, that violations of status rules are not quite as bad because the Japanese are mainly concerned with getting along within and between groups. If a person behaves with a person who is also a member of the same ingroup (i.e. you both belong to the same company) as though he belonged to an outgroup, that person might get very angry, even if he does not show it in public. Similarly, if a person behaves with a person who is a member of a different group (i.e. you belong to different companies) as though he belonged to an ingroup, that person might get very embarrassed and confused. In either case, you probably would be thought of as rude or strange if you treated a member of your own group the way you should have treated an outgroup member (or vice versa).

In the test scenario, a second set of four characters were introduced that filled out Cells 2 and 3 in Table 5 (i.e. two unequal status members of the same company and two equal status members of a different company). Information about the age, the position, and the company of each character was provided. Participants were then asked to judge the appropriate form of address and degree of bowing for the characters in this new scenario. As in Experiment 1, the source analogue did not include any cases that were identical to the test cases with respect to the two critical attribute dimensions; there was always one attribute (either status or group) for which the people described in the source scenario differed from the people in the test.

Participants were randomly assigned to one of the five experimental groups, and told that the experiment was about learning Japanese social roles. They were asked to read the materials, and those participants who were given the importance manipulation were instructed to verbally summarize its content. Participants were then told to read the test scenario and complete the questionnaire.

Results

The dependent variables were participants' inferences of appropriate social behaviour for form of address (informal or formal) and style of bowing (nod, moderate, deep) for each of the two test cases, outgroup equal status behaviour (Cell 2 in Table 5) and ingroup unequal status behaviour (Cell 3). Analyses of frequency data were again conducted using a multinomial analysis of variance model; a 2×2 design is reported for most analyses, with the additional control condition invoked where it provides illumination for the 2×2. There were a few instances of data missing from participants who failed to complete all dependent measures.

For each dependent variable, we analyzed the data for each interacting pair of characters as a unit, aggregating across the two pairs of interacting actors with the same relationships between them. No interacting pair or question order effects were found.

Speech: Inferences about Appropriate Form of Address

Table 6 reports the percentage of participants' responses in each condition who predicted that (1) the two actors would address each other informally (Informal, as in Cell 1 of Table 5), (2) one actor would use informal address and the other actor would use formal address (Mixed), or (3) the two actors would address each other

TABLE 6A
Inferences for Outgroup Equal Speech as a Function of Perceiver Goal and Prior Knowledge (Experiment 2)

	Pragmatic Goal		
	Status Important	*Group Important*	
	Inferences Made:	*Inferences Made:*	*Row Totals*
Prior Knowledge	*Informal/Mixed/Formal*	*Informal/Mixed/Formal*	*Informal/Mixed/Formal*
Analogy plus Expectancy	20% / 0% / 80% $N = 30$	0% / 0% / 100% $N = 30$	10% / 0% / 90% $N = 60$
Expectancy only (No analogy)	32% / 7% / 61% $N = 28$	3% / 0% / 97% $N = 30$	17% / 3% / 80% $N = 58$
Column Totals	26% / 3% / 71% $N = 58$	2% / 0% / 98% $N = 60$	No goal control ($N = 28$) 7% / 0% / 93%

TABLE 6B
Inferences for Ingroup Unequal Speech as a Function of Perceiver Goal and Prior Knowledge (Experiment 2)

	Pragmatic Goal		
	Status Important	*Group Important*	
	Inferences Made:	*Inferences Made:*	*Row Totals*
Prior Knowledge	*Informal/Mixed/Formal*	*Informal/Mixed/Formal*	*Informal/Mixed/Formal*
Analogy plus Expectancy	20% / 47% / 33% $N = 30$	60% / 30% / 10% $N = 30$	40% / 38% / 22% $N = 60$
Expectancy only (No analogy)	7% / 57% / 36% $N = 28$	43% / 27% / 30% $N = 30$	26% / 41% / 33% $N = 58$
Column Totals	14% / 52% / 34% $N = 58$	52% / 28% / 20% $N = 60$	No goal control ($N = 28$) 21% / 36% / 43%

Dependent variable expressed as percentage of inferences falling into a given pattern; N refers to total number of inferences made by participants in that experimental condition; each participant provided two inferences.

formally (Formal, as in Cell 4 in Table 5). Table 6A presents the data for Cell 2, the situation in which the two actors are of equal status but from different groups.

As the control group shows (bottom right), there was a great deal of consensus (in the absence of the manipulation of situational pragmatics or source scenario) that the two actors ought to address one another formally (93%). This is completely in accord with actual Japanese social norms (Cell 2, Table 5), and suggests that our participants possessed reasonably good prior knowledge about appropriate forms of address for this situation.

The manipulation of situational pragmatics—whether status or group membership was described as the most important determinant of behaviour—had a significant impact on inferences made, $\chi^2(2,60) = 21.06$, $P < .001$. As can be seen in Table 6A, participants responded more informally in the status important condition than in the group condition, as predicted. That is, equal status persons should use informal address if their group membership is not important, whereas equal status persons from different groups should use formal address if it is important.

The observed inference pattern was not significantly influenced by the provision of an analogy, either as a main effect, $\chi^2(2,60) = 4.46$, $P > .10$, or in interaction with the manipulation of situational pragmatics, $\chi^2(2,60) = 3.07$, $P < .22$. The inference pattern in the control condition differed significantly from that observed in the status-important conditions, $\chi^2(2,34) = 8.92$, $P < .01$, but not the group-membership important conditions, $\chi^2(1,34) = 1.14$, $P > .29$).

Table 6B presents the comparable results for Cell 3, in which the actors were of unequal status but from the same group. For Cell 3, all Mixed responses involved informal speech by the high-status actor to the low-status actor and formal speech from the latter to the former. This time, control participants were less veridical and consensual in their inferences: only 36% inferred that the higher-status person should use informal address, and the lower-status person use formal address; 42% predicted that both persons should use formal address, and 21% inferred that informal address would be correct.

The effect of the manipulation of situational pragmatics was again significant, $\chi^2(2,60) = 24.31$, $P < .001$. As predicted, participants inferred that speech ought to be more formal in the status important condition; this suggests that for the analogy conditions, Cell 3 was mapped onto Cell 4 when status was emphasized and onto Cell 1 when group membership was emphasized. In other words, if status is more important, then unequal status persons should behave more formally, and if groups are more important then unequal status persons of the same group should behave informally.

As with the Cell 2 test case, there was no significant main effect for providing an analogy, $\chi^2(2,60) = 4.17$, $P > .10$, nor did provision of an analogy interact with the importance manipulation, $\chi^2(2,60) = 1.25$, $P > .50$. The inference pattern in the control condition differed significantly from that observed in the group-membership conditions, $\chi^2(2,34) = 9.70$, $P < .01$, but not from that observed in the status conditions, $\chi^2(2,34) = 2.15$, $P < .34$.

Bowing: Inferences about Appropriate Head Inclination and Bowing

Table 7 presents the percentages of participants' responses in the experimental conditions who made various patterns of inferences about style of bowing (nod, moderate bow, or deep bow). We divided participants' inferences into four categories: both actors nod to each other (Informal Equal, as in Cell 1 of Table 5), both actors either make moderate or else deep bows to each other (Formal Equal), one actor nods and the other makes either a moderate or a deep degree bow (Informal Unequal), and one actor makes a moderate bow and the other a deep bow (Formal Unequal, as in Cell 4 of Table 5). In every case but one where there were unequal bowing inferences, the lower-status person was judged to bow deeper than the higher-status person.

Control participants' inferences for outgroup equal bowing were surprisingly veridical: 70% inferred that the two actors ought to both bow modestly (see Table 5, Cell 2).

The pattern of inferences about bowing for the Cell 2 test case approached but did not yield significant main effects for the manipulation of situational pragmatics, $\chi^2(3,60) = 5.45$, $P < .15$ (see Table 7A). However, the interaction between the importance manipulation and provision of analogies was significant, $\chi^2(3,60) = 12.02$, $P < .007$. In general, few participants generated the Formal Unequal pattern consistent with an emphasis on the importance of group membership; however, when group membership was emphasized, this pattern was produced by 28% of participants who received an analogy versus 0% of those who did not. This effect was partially responsible for a main effect of providing an analogy, $\chi^2(3,60) = 18.2$, $P < .001$; participants who received an analogy generated more Formal Unequal patterns than those who did not.

Table 7B presents the comparable data for the Cell 3 test case, in which the two actors were of unequal status but were members of the same group.

Control participants' inference patterns were again close to the veridical: 71% inferred that the higher-status person should nod and the lower-status person bow modestly.

The situational pragmatics manipulation had a significant impact on the inference pattern, $\chi^2(3,60) = 14.39$, $P < .002$. As predicted, when status was emphasized participants were more likely to generate the Formal Unequal pattern than when group membership was emphasized (i.e. if status is important and actors are unequal, then the lower-status person should bow formally and the higher-status person less formally).

There was no significant interaction between situational pragmatics and analogy, $\chi^2(3,60) = 2.2$, $P > .50$. There was, however, a main effect of providing an analogy versus not providing one, $\chi^2(3,60) = 10.91$, $P < .01$. Participants in the analogy condition were less likely to make equal bowing inferences, whereas in the prior knowledge alone condition they preferred to make Informal Unequal inferences. The rather post hoc nature of these patterns does not inspire confidence that analogy, rather than uncertainty, was the driving force behind the inferences given.

TABLE 7A
Inferences for Outgroup Equal Bowing as a Function of Perceiver Goal and Prior Knowledge (Experiment 2)

	Pragmatic Goal											
	Status Important				*Group Important*				*Row Totals*			
	Inferences Made:				*Inferences Made:*							
Prior Knowledge	*Informal Equal*	*Formal Equal*	*Informal Unequal*	*Formal Unequal*	*Informal Equal*	*Formal Equal*	*Informal Unequal*	*Formal Unequal*	*Informal Equal*	*Formal Equal*	*Informal Unequal*	*Formal Unequal*
Analogy plus Expectancy	20%	63%	0%	17%	7%	66%	0%	28%	14%	64%	0%	22%
	$N = 30$				$N = 29$				$N = 59$			
Expectancy (No analogy)	11%	71%	14%	4%	33%	67%	0%	0%	22%	69%	7%	2%
	$N = 28$				$N = 30$				$N = 58$			
Column Totals	16%	67%	7%	10%	20%	66%	0%	14%	No goal control ($N = 27$)			
	$N = 58$				$N = 59$				15%	70%	11%	3%

TABLE 7B
Inferences for Ingroup Unequal Bowing as a Function of Perceiver Goal and Prior Knowledge (Experiment 2)

	Pragmatic Goal											
	Status Important				*Group Important*				*Row Totals*			
	Inferences Made:				*Inferences Made:*							
Prior Knowledge	*Informal Equal*	*Formal Equal*	*Informal Unequal*	*Formal Unequal*	*Informal Equal*	*Formal Equal*	*Informal Unequal*	*Formal Unequal*	*Informal Equal*	*Formal Equal*	*Informal Unequal*	*Formal Unequal*
Analogy plus Expectancy	7%	7%	53%	33%	23%	20%	40%	17%	15%	13%	47%	25%
	$N = 30$				$N = 30$				$N = 60$			
Expectancy (No analogy)	0%	0%	82%	18%	7%	13%	60%	20%	3%	7%	71%	19%
	$N = 28$				$N = 30$				$N = 58$			
Column Totals	3%	3%	67%	26%	15%	17%	50%	18%	No goal control ($N = 28$)			
	$N = 58$				$N = 60$				11%	7%	71%	11%

Dependent variable expressed as percentage of inferences falling into a given pattern; *N* refers to total number of inferences made by participants in that experimental condition; each participant provided two inferences.

Taken as a whole, the greater influence of analogies for bowing as opposed to form of address is consistent with pretest results indicating that participants were more confident about their inferences regarding the latter.

Discussion

Situational pragmatics exerted significant main effects on social inference making in three of the four analyses conducted in this study of familiar domains, and interacted with the presence of an analogy in the fourth case. Presenting an imperfect analogue modified inferences drawn from generalized prior knowledge only when participants were relatively uncertain about these inferences, in the case of rules about bowing.

When given information that status rules were important, participants adjusted their inferences about the appropriate form of address in the direction of greater formality in the case of ingroup unequal speech, and lesser formality in the case of outgroup equal speech. They appeared to have some knowledge or strategy that allowed them to infer that when status is important, equal status persons should use the informal address whereas unequal status persons should use formal address, regardless of group membership. Similarly, when groups were emphasized, they inferred that ingroup address should be relatively informal, and outgroup address more formal, regardless of status equality or inequality.

The importance manipulation had the same effect on inferences made from a specific example plus prior knowledge as from prior knowledge alone in three of four analyses. The much smaller effect of pragmatic influences in Experiment 2 compared to Experiment 1 suggests that

modulation of social inferences in familiar domains is more conservative than in unfamiliar domains; generalized prior knowledge structures appear to be responsive to situational pressures, but less so compared to inferences based on a single instance. These results suggest that basic dimensions of social relations such as rank and group membership are likely to be represented as person features across most situations, even when they are explicitly designated as less important (see A.P. Fiske, 1992, for a theory that incorporates both elements as fundamental relational schemas).

GENERAL DISCUSSION

The power of situational pragmatics was demonstrated both for a novel domain, where inferences were based solely on analogical transfer, and for a more familiar domain, where inferences were largely based on generalized knowledge structures about politeness behaviour. Participants' goals to avoid social blunders changed the pragmatic centrality of elements of the situation in a coherent and predictable manner.

Work by Read, Jones, and Miller (1990) has shown that goals can be an integral part of our organized knowledge structures about *others* (see also Daehler & Chen, 1993; Marchant & Robinson, 1993); our work complements theirs by showing that the goals of the *perceiver* affect social inference processes as well. The effect of perceiver goals on information processing appears to be quite pervasive in categorization (see S. Fiske & von Hendy, 1992; Liu, 1992b) as well as in social inference generation. The cumulative record suggests that the formation of generalized knowledge structures, like relational schemas and social categories, is shaped by goal-directed processes that become incorporated into knowledge processing structures or strategies if encountered frequently enough. Our data from Experiment 1 suggest that in the absence of such prior knowledge and regularly encountered motivations, person representations may have an unstable role in information processing. Goals may therefore provide cross-temporal and cross-situational stability to person representations precisely because they specify how and where inferences drawn from them should vary.

If situational pressures are as prevalent as some theorists (Goffman, 1959; Schlenker, 1980; Snyder, 1979) contend, it would make sense that information processing should be adaptive to the most important among them. People need to know how to behave when status differentials are the dominant factor determining social interaction, and they also need to know how to behave when the situation shifts to groups being important if they are to act optimally. Our results are consistent with the work of Brown and Levinson (1978, 1987), who claim that social distance (e.g. group membership) and power differentials (e.g. status) are universal control parameters for politeness behaviour; it shows that social inferences about politeness in a written scenario follow a logic similar to that used in actual social interaction, and that people know how to respond to manipulations of these factors.

These findings may be useful in teaching people how to behave properly in a cross-cultural situation. If persons adapting to a new culture are told that status is more important in this culture, our research suggests that they will have some intuitive understanding that their politeness behaviours with persons of equal status should mirror those of their hosts, and their interactions with people of unequal status should be more formal with respect to higher-status individuals. Similarly, if groups are more important, it is not difficult to infer that interactions within one's own group should become more informal, and interactions with an outgroup member should become more formal. Rather than emphasize differences between social norms for politeness across cultures, the process of teaching cultural sensitivity could begin with a description of their commonalities, especially with regard to goals.

Future Research

The current research has essentially mapped out goal-directed inference-making processes near the extremes of internal knowledge representations. In Experiment 1, information about specific instances completely determined inferences because cues to existing prior knowledge structures were eliminated, and in Experiment 2, very general but well-developed knowledge structures about status and groups appeared to dominate the inference-making process. Now that the effect of situational pragmatics has been documented in both these cases, the crucial terrain that must be charted is the region of interface between the extremes: Situations where there are partial cues to existing knowledge structures, but also salient information about specific instances. The interac-

tion between specific instances and generalized knowledge structures in making inferences could be demonstrated in a more compelling fashion than in the current studies to reveal whether analogy functions to activate social concepts that might not otherwise come to mind, or creates new relational concepts where old ones cannot successfully be applied.

Knowledge of how existing knowledge structures can be adapted for use in unfamiliar domains would be valuable in enabling us to understand better the nature of variances and invariances across culture and how they develop (e.g. from ad hoc categories, like "green-blooded Futonians" to more natural categories like "high-status persons"; see Barsalou, 1983, 1985). More wisdom about the source of situational pragmatics and perceiver goals in naturalistic settings would offer us a clearer picture of how this knowledge can be adapted to serve our needs, especially across cultural boundaries.

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APPENDIX

The ACME model is described in detail by Holyoak and Thagard (1989) and has been applied to complex mappings between social situations by Spellman and Holyoak (1992). Its application to the inference task in Experiment 2 is summarized here. In general terms, the model takes as its input propositional representations of the source scenario and of a test case, expressed in a predicate-calculus notation. For example, the proposition

(head-of (obj_Tri01 val_triangle) Tri01_is_triangle)

means that the head of a certain actor, Tri01, has the value triangle, where

"Tri01_is_triangle" is simply a mnemonic label for this fact. The Appendix, Part A, sketches the representations of the source scenario and two of the four test cases. Note that the source examples include specifications of the behaviours of actors to each other, such as

(bop-to (obj_Tri01 obj_Tri02 val_hi) Tri01_hi_Tri02),

indicating that actor Tri01 bops to Tri02 with a high value of head extension. The test cases do not specify any such behaviours, which must be inferred by analogy to the source.

After receiving the input representations, ACME forms a network of units representing possible mappings between elements (e.g. a unit would represent the possibility that TriGnew in the test case maps to CylG1 in the source). The units are interconnected by weighted links that reflect the three classes of constraints. The optimal mappings are then identified by using a connectionist algorithm to settle the network into a stable state in which the activation of each unit reflects the acceptability of the mapping it represents.

ACME Simulation of Goal-directed Inferences in Experiment 1

A. Predicate-calculus Representations of Source Scenario and Transfer Problems

Representation of Source Scenario

Descriptions of Four Pairs of Actors Based on Tri01, Tri02, CylG1 and CylG2

Cell 1, Example 1:
(head-of (obj_Tri01 val_triangle) Tri01_is_triangle)
(blood-colour-of (obj_Tri01 val_orange) Tri01_is_orange)
(head-of (obj_Tri02 val_triangle) Tri02_is_triangle)
(blood-colour-of (obj_Tri02 val_orange) Tri02_is_orange)
(same-value (Tri01_is_triangle Tri02_is_triangle) Tri01_same_head_Tri02)
(same-value (Tri02_is_triangle Tri01_is_triangle) Tri02_same_head_Tri01)
(same-value (Tri01_is_orange Tri02_is_orange) Tri01_same_colour_Tri02)
(same-value (Tri02_is_orange Tri01_is_orange) Tri02_same_colour_Tri01)

Cell 1, Example 2 adds:
(head-of (obj_CylG1 val_cylinder) CylG1_is_cylinder)
(blood-colour-of (obj_CylG1 val_green) CylG1_is_green)
(head-of (obj_CylG2 val_cylinder) CylG2_is_cylinder)
(blood-colour-of (obj_CylG2 val_green) CylG2_is_green)
(same-value (CylG1_is_cylinder CylG2_is_cylinder) CylG1_same_head_CylG2)
(same-value (CylG2_is_cylinder CylG1_is_cylinder) CylG2_same_head_CylG1)
(same-value (CylG1_is_green CylG2_is_green) CylG1_same_colour_CylG2)
(same-value (CylG2_is_green CylG1_is_green) CylG2_same_colour_CylG1)

Cell 4, Example 1 adds:
(diff-value (CylG1_is_cylinder Tri01_is_triangle) CylG1_diff_head_Tri01)
(diff-value (Tri01_is_triangle CylG1_is_cylinder) Tri01_diff_head_CylG1)
(diff-value (CylG1_is_green Tri01_is_orange) CylG1_diff_colour_Tri01)
(diff-value (Tri01_is_orange CylG1_is_green) Tri01_diff_colour_CylG1)

Cell 4, Example 2 adds:
(diff-value (CylG2_is_cylinder Tri02__is_triangle) CylG2_diff_head_Tri02)
(diff-value (Tri02_is_triangle CylG2_is_cylinder) Tri02_diff_head_CylG2)
(diff-value (CylG2_is_green Tri02_is_orange) CylG2_diff_colour_Tri02)
(diff-value (Tri02_is_orange CylG2_is_green) Tri02_diff_colour_CylG2)

Descriptions of Four Interactions

Cell 1, Example 1:
(bop-to (obj_Tri01 obj_Tri02 val_hi) Tri01_hi_Tri02)
(bop-to (obj_Tri02 obj_Tri01 val_hi) Tri02_hi_Tri01)
(speech-to (obj-Tri01 obj_Tri02 val_hum) Tri01_hum_Tri02)
(speech-to (obj_Tri02 obj_Tri01 val_hum) Tri02_hum_Tri01)

Cell 1, Example 2:
(bop-to (obj_CylG1 obj_CylG2 val_hi) CylG1_hi_CylG2)
(bop-to (obj_CylG2 obj_CylG1 val_hi) CylG2_hi_CylG1)
(speech-to (obj_CylG1 obj_CylG2 val_hum) CylG1_hum_CylG2)
(speech-to (obj_CylG2 obj_CylG1 val_hum) CylG2_hum_CylG1)

Cell 4, Example 1:
(bop-to (obj_CylG1 obj_Tri01 val_med) CylG1_med_Tri01)
(bop-to (obj_Tri01 obj_CylG1 val_lo) Tri01_lo_CylG1)
(speech-to (obj_CylG1 obj_Tri01 val_whistle) CylG1_whistle_Tri01)
(speech-to (obj_Tri01 obj_CylG1 val_whistle) Tri01_whistle_CylG1)

Cell 4, Example 2:
(bop-to (obj_CylG2 obj_Tri02 val_med) CylG2_med_Tri02)
(bop-to (obj_Tri02 obj_CylG2 val_lo) Tri02_lo_CylG2)
(speech-to (obj_CylG2 obj_Tri02 val_whistle) CylG2_whistle_Tri02)
(speech-to (obj_Tri02 obj_CylG2 val_whistle) Tri02_whistle_CylG2)

Additional propositions (not shown) encode basic semantic knowledge, such as:

(cylinder (val_cylinder) cylinder_S),

indicating that val_cylinder belongs to the category "cylinder."

Examples of Representations for Test Cases

Descriptions of Pairs of Actors Based on Tri01, CylG1 (from Source), and TriGnew (Novel)

Cell 2:
(head-of (obj_TriGnew val_triangle) TriGnew_is_triangle)[h]
(blood-colour-of (obj_TriGnew val_green) TriGnew_is_green)[c]
(head-of (obj_Tri01 val_triangle) Tri01_is_triangle_T2)[h]
(blood-colour-of (obj_Tri01 val_orange) Tri01_is_orange_T2)[c]
(same-value (TriGnew_is_triangle Tri01_is_triangle_T2) TriGnew_same_head_TrO1)[h]
(same-value (Tri01_is_triangle_T2 TriGnew_is_triangle) Tri01_same_head_TriGnew)[h]
(diff-value (TriGnew_is_green Tri01_is_orange_T2) TriGnew_diff_colour_Tri01)[c]
(diff-value (Tri01_is_orange_T2 TriGnew_is_green) Tri01_diff_colour_TriGnew)[c]

Cell 3:
(head-of (obj_TriGnew val_triangle) TriGnew_is_triangle)[h]
(blood-colour-of (obj_TriGnew val_green) TriGnew_is_green)[c]
(head-of (obj_CylG1 val_cylinder) CylG1_is_cylinder_T3)[h]
(blood-colour-of (obj_CylG1 val_green) CylG1_is_green_T3)[c]
(diff-value (TriGnew_is_triangle CylG1_is_cylinder_T3) TriGnew_diff_head_CylG1)[h]
(diff-value (CylG1_is_cylinder_T3 TriGnew_is_triangle CylG1_diff_head_TriGnew)[h]
(same-value (TriGnew_is_green CylG1_is_green_T3) TriGnew_same_colour_CylG1)[c]
(same-value (CylG1_is_green_T3 TriGnew_is_green) CylG1_same_colour_TriGnew)[c]

Note: Additional propositions (not shown) encode the same basic semantic knowledge as in source scenario. Superscript [h] denotes test propositions marked as "important" to simulate headedness condition; superscript [c] denotes propositions marked as "important" to simulate colour condition. Two additional test examples (not shown) were also used (one each for Cells 2 and 3). The novel actor for the latter examples was a Futonian with a cylindrical head and orange blood, CylOnew, substituted for TriGnew.

B. Major Parameter Values

excitation:	.005
inhibition (structural):	−.160
similarity of identical predicates:	.005
decay	.005
starting activation, all units	.001
attentional inhibition	−.040

Constraint satisfaction was performed using the Grossberg updating rule with maximum activation of 1 and minimum activation of −.3. All simulations settled with all units at asymptotic activations after 317 cycles of updating.

C. Analogical Inferences Generated for Test Cases after Mapping

Cell 2, Head Condition (Derived by Mapping from Cell 1, Example 1)
(BOP-TO (OBJ_TRIO1 OBJ_TRIGNEW VAL_HI) CELL 2.1)
(BOP-TO (OBJ_TRIGNEW OBJ_TRIO1 VAL_HI) CELL 2.2)
(SPEECH-TO (OBJ_TRIO1 OBJ_TRIGNEW VAL_HUM) CELL 2.3)
(SPEECH-TO (OBJ_TRIGNEW OBJ_TRIO1 VAL_HUM) CELL 2.4)

Cell 2, Colour Condition (Derived by Mapping from Cell 4, Example 1)
(BOP-TO (OBJ_TRIO1 OBJ_TRIGNEW VAL_LO) CELL 2.5)
(BOP-TO (OBJ_TRIGNEW OBJ_TRIO1 VAL_MED) CELL 2.6)
(SPEECH-TO (OBJ_TRIO1 OBJ_TRIGNEW VAL_WHISTLE) CELL 2.7)
(SPEECH-TO (OBJ_TRIGNEW OBJ_TRIO1 VAL_WHISTLE) CELL 2.8)

Cell 3, Head Condition (Derived by Mapping from Cell 4, Example 1)
(BOP-TO (OBJ_CYLG1 OBJ_TRIGNEW VAL_MED) CELL 3.1)
(BOP-TO (OBJ_TRIGNEW OBJ_CYLG1 VAL_LO) CELL 3.2)
(SPEECH-TO (OBJ_CYLG1 OBJ_TRIGNEW VAL_WHISTLE) CELL 3.3)
(SPEECH-TO (OBJ_TRIGNEW OBJ_CYLG1 VAL_WHISTLE) CELL 3.4)

Cell 3, Colour Condition (Derived by Mapping from Cell 1, Example 2)
(BOP-TO (OBJ_CYLG1 OBJ_TRIGNEW VAL_HI) CELL 3.5)
(BOP-TO (OBJ_TRIGNEW OBJ_CYLG1 VAL_HI) CELL 3.6)
(SPEECH-TO (OBJ_CYLG1 OBJ_TRIGNEW VAL_HUM) CELL 3.7)
(SPEECH-TO (OBJ_TRIGNEW OBJ_CYLG1 VAL_HUM) CELL 3.8)