

# Cultural Network Analysis: Mapping Cultural Theories of Mind

**Winston R. Sieck (wsieck@ara.com)**

Culture & Cognition Group, Applied Research Associates  
1750 Commerce Center Blvd, Fairborn, OH 45324 USA

**Louise J. Rasmussen (lrasmussen@ara.com)**

Culture & Cognition Group, Applied Research Associates  
1750 Commerce Center Blvd, Fairborn, OH 45324 USA

## Abstract

People's ability to interact with members of other cultures is determined, in part, by their understanding of the folk psychological theories that explain behavior in those cultures. A comprehensive methodology is offered here for investigating such folk theories. It attempts to characterize the distribution of mental models within a cultural group. A network representation is used to depict the consensus elements (and level of consensus) in a cultural group's knowledge within a domain. The method is general with respect to knowledge domain, though the emphasis here is on folk theories of mind. The methodology is illustrated with two studies directed at Afghan explanations of an Afghan Mullah's decision making in a well-defined context.

**Keywords:** Cultural epidemiology, cultural modeling, folk psychology, mental models, decision making, mixture modeling.

## Background

The epidemiological conception of culture has been gaining fairly wide acceptance among culture and cognition theorists. "Epidemiology" is used in the general sense of describing and explaining the distributions of any property within a population, and "cultural epidemiology" emphasizes explanations of the distribution of ideas within specific populations. According to Sperber (1996), culture is made up of contagious ideas, that is, the ideas that propagate effectively and durably in a population. One line of cultural research within this program seeks to directly explain how some ideas become widely distributed and long-lasting within a population (Berger & Heath, 2005). Other research has focused more on understanding the origins and distributions of complex concepts ("folk theories" or "mental models") that include systematic causal, explanatory beliefs (Atran, Medin, & Ross, 2005; D'Andrade, 1995; Hirschfeld & Gelman, 1994).

With respect to this latter area, cognitive psychology has long characterized the organization of knowledge in terms of networks of interconnected ideas, or mental models (Gentner & Stevens, 1983). Scientific investigations of mental models have spanned physical, biological, and psychological systems. Our research program focuses on understanding decision making within intercultural encounters. In particular, we have been investigating the relationship between how people represent the minds of culturally-different others and the decisions they make as regards those others (cf. D'Andrade, 1987). From this

standpoint, mental models that pertain to psychological and social domains are especially useful.

Research in the psychological domain has sought to establish that people have theories about the workings of other people's minds and behavior, as well as to elucidate the abstract and general properties of theories of mind (Gopnik, & Wellman 1994). There is a general consensus among theory of mind researchers that basic awareness of mental constructs and their relationship with behavior is universal (Wellman, 1998). This, however, does not entail that higher level folk psychology interpretations of these basic theory of mind constructs are culturally universal. In fact, evidence suggests that they are not (Lillard, 1998). For example, in some cultures, "because one wants to" will be considered an important reason for any action. In contrast, within another culture, the most important reason for doing anything might be "because it is prescribed". In such a culture, actions follow a set of rules—often referred to as traditions or rituals. For instance, if upon encountering a Mursi woman from Ethiopia, it would be mistaken to think that she wears a lip plate because 'she wants to.' Now, that does not necessarily mean that she wears it unwillingly—"will" simply has little to do with it.

Recent research in cognitive science on the neural foundations of social learning also provides evidence to support the existence of differences in theory of mind constructs across cultures. For example, Leslie, Friedman, and German (2004) differentiate between the mechanism underlying theory of mind reasoning and the content of the reasoning process. Their research suggests that, along with very basic 'theory of mind' concepts, modular processes that promote attention to mental states and facilitate learning about them appear very early and develop rapidly. On the other hand, the heuristic processes that select appropriate contents for mental states develop over a longer timeframe and undergo several major changes. This timeframe in which the contents of mental states are selected suggests an important window of opportunity for the introduction of cultural variations in mental models of psychology. As children grow up in different cultures with different practices, different languages, and different external circumstances, they would correspondingly also generate different ideas about the mind to fit those experiences.

In summary, there are several reasons to believe that theory of mind functionality is supported by mental models of psychology that vary across cultures, in much the same

way that folk theories of biology differ between cultural groups. The direct investigation of such cultural theories of mind is useful for theoretical development, as it provides a comprehensive base of kinds of explanations, as well as correlations among explanatory elements. It also has considerable practical potential, primarily for the purposes of enhancing understanding of a crucial component of thought between culturally distinct groups. In order to support such investigations, we provide a method for directly eliciting, analyzing, and representing cultural models in any domain, and illustrate its use for mapping cultural theories of mind.

## Cultural Network Analysis

We describe a comprehensive method for modeling culture as networks of ideas that are distributed among members of a population (Sieck, Rasmussen, & Smart, 2010). The method, Cultural Network Analysis (CNA), represents an interdisciplinary synthesis of techniques drawn from the fields of cognitive anthropology, cultural and cognitive psychology, and decision analysis. CNA is used to develop *cultural models* for groups and populations. The development of cultural models reflects a well-established practice in cognitive anthropology (D'Andrade, 2005; Quinn, 2005). Furthermore, CNA follows a similar overall pattern of research to other approaches for building cultural models, beginning with qualitative studies, followed by quantitative study and analysis. One refinement to the customary anthropological practice includes a common format for representing cultural models. Specifically, CNA cultural models are typically depicted as a network representation of the culturally-shared concepts, causal beliefs, and values that influence key decisions (Sieck, Rasmussen, & Smart, 2010). This and other refinements of the process are discussed more extensively by Sieck (2010). Here, we focus on providing a general overview of the process.

As mentioned, Cultural Network Analysis encompasses both qualitative, exploratory analysis, and quantitative, confirmatory analysis. The specific techniques used to achieve each step in the analysis depend on whether the cultural researcher is employing exploratory CNA or confirmatory CNA.

A primary goal of exploratory CNA is to develop an initial understanding of the concepts and characteristics that are culturally relevant within the domain. In exploratory CNA, concepts, causal beliefs, and values are extracted from interviews and other qualitative sources. Semi-structured interviews employ questions intended to elicit antecedents and consequences of concept states, as in the “explanatory models framework” sometimes used in cognitive anthropology (Garro, 2000). Questioning along these lines draws out a more comprehensive set of ideas than would typically be verbalized in standard think aloud procedures, and places particular emphasis on drawing out perceived causal relations. We have also combined this interview approach with “value focused thinking” from

decision analysis to elicit values and objectives directly, along with the causal beliefs that link more fundamental values with the means intended to achieve them (Keeney, 1994; Rasmussen, Sieck, & Smart, 2009). Qualitative analysis and representation at this stage yield insights that can be captured in initial cultural models.

Influence diagrams have proven to be quite useful for representing mental models relevant to key judgments and decisions (Bostrom, Fischhoff, & Morgan, 1992). We further believe they are an important representation format for depicting cultural models, especially for showing both qualitative structure and numeric prevalence information. In an influence diagram, nodes are linked by arrows that represent local causal influences. That is, the value of the concept at the beginning of an arrow affects the value of the concept at the arrow's point. Fully-specified influence diagrams can also represent numerical quantities, but the basic structure is useful as well. Specifically, an influence diagram provides a relatively simple and useful representation of a cultural model of another's mind that includes key judgments and decisions of interest to the researcher, as well as the culture-specific concepts, values, and causal beliefs typically used to explain those decisions within a population.

Confirmatory CNA serves to test the structure of previously developed qualitative cultural models, as well as to elaborate the models with quantitative data on the prevalence of ideas in the population(s) of interest. In confirmatory CNA, specially-designed structured questionnaires are used to obtain systematic data that can be subjected to statistical analysis. Most questionnaires treat ideas as independent entities, and so do not provide any means for revealing their interrelated, network form. A few studies have attempted to capture first-order causal beliefs. We have begun developing questionnaires that permit the analysis of longer causal belief chains by starting with influence diagram representations of qualitative cultural models from exploratory CNA to provide a suitable reference.

Statistical models, such as cultural consensus theory and mixture models are employed in confirmatory CNA to assess the patterns of agreement from the “causal-belief” surveys, and derive statistics describing the distribution of concepts, causal beliefs, and values. Cultural consensus theory is a collection of formal statistical models that has been long used within cognitive anthropology to assess agreement in knowledge and beliefs among a set of respondents (Romney, Weller, & Batchelder, 1986). When a cultural consensus is found, it provides the consensual responses that indicate culturally shared knowledge and estimates of the strength of consensus for those responses.

Our group has increasingly been relying on mixture modeling as an alternative approach to cultural consensus theory, primarily as it permits direct segmentation of cultural groups based on clusters of consensus (Mueller & Veinott, 2008; Sieck & Mueller, 2009). Mixture models have been applied in many scientific fields, including

marketing, biology, medicine, and astronomy. A mixture model, or “finite mixture model,” is given as a combination of different groups, each described by a distinct probability distribution. Mixture models sort through the data and group them into sets of relatively homogeneous cases or observations. In cultural modeling applications, the distinct segments resulting from the analysis represent *cultural groups*, i.e., groups defined by the similarity of their ideas.

Finally, influence diagram representations of the cultural models are constructed in confirmatory CNA that illustrate the statistical properties, as well as the qualitative structure elucidated in exploratory CNA. In the confirmatory CNA application, the influence diagram represents the “culturally correct” concepts, values, and causal linkages as determined by mixture modeling for each cultural group that was found. Furthermore, the numerical probability values in the diagram are populated with the prevalence of each idea, as measured by selection percentage, within a group. The result in this case is a summary of the full distribution of ideas, with probabilities indicating the consensus on any particular causal link (or node).

As discussed above, CNA provides an integrated collection of techniques and procedures that can be usefully employed to build cultural models in virtually any knowledge domain. Here, we illustrate their use for building cultural models that pertain to folk psychology. Specifically, the substance of our research primarily considers the general concept of corruption and its relationship to explanations of individual decisions in the context of Afghanistan.

## Exploratory CNA: Afghan Expatriates

### Method

**Participants** 14 Afghans living in the U.S. participated in the study. Most (80%) were men, aged between 20 and 34 (mean 26.7) years, and had resided in the U.S. for a time between 3 months and 9 years (mean 2.7 years). All spoke English in addition to Dari or Pashto.

**Materials** The interviews were structured around short scenarios based on real events. All involved Afghan actors who engaged in some behavior that puzzled Americans. Here, we focus on a scenario involving a Mullah who was helping a group of Afghans and Americans to distribute humanitarian assistance supplies in several villages. The scenario included that the Mullah was extremely helpful, especially in facilitating positive interactions with village elders. Everything was going very well. After finishing with the distribution, as everyone was packing up to leave, the American leader learns that the Mullah has kept a truckload of the supplies. The American who originally relayed this incident indicated a belief that the Mullah was operating out of a desire to increase his own wealth. As will be seen, the Afghan interpretations are somewhat different.

**Procedure** Each participant was interviewed individually using the same CNA interview guide. A primary and

secondary interviewer were present for all interviews. The primary interviewer was responsible for covering the questions in the interview guide. The secondary interviewer took notes and asked additional questions of clarification. The interview guide consisted of open-ended questions to elicit participants’ overall explanations of the situation, as well as their beliefs regarding the Mullah’s intentions, objectives, fundamental values, and causal links between them. Questions also covered participants’ beliefs about the Mullah’s decision process, value conflicts, and anticipated reactions to possible mitigating actions.

### Results and Discussion

**Coding** Two independent coders read through all of the transcripts and identified segments that contained concept - causal belief - value chains. Next, the two analysts coded each segment by identifying the antecedent, the consequence, and the direction of the relationship between the antecedent and consequence (increasing or decreasing) for each causal belief. Percent agreement for the coding was 95.2%.

**Representation** The concept - causal belief – value chain fragments were then integrated into a network diagram that synthesized participants’ models of the Afghan Mullah’s mind, as bounded by the scenario (See Figure 1). In the diagram, circles depict concepts, arrows represent causal beliefs, and values are indicated by color of the circles. One analyst constructed an initial draft of the overall diagram by first focusing on fragments related to key decision points and fundamental values within the scenario, and subsequently adding further detail. Three other analysts independently reviewed the resulting diagram against the original set of codes, and a final version determined by consensus.

**Findings** A rich structure emerged from the process, as illustrated in Figure 1. As can be seen in Figure 1, three main sections of peoples’ beliefs about the Mullah’s mental states are represented: 1) Mullah successfully acquiring supplies, 2) Mullah being caught taking supplies, and 3) Mullah’s concept of theft. As shown, respondents believed that the Mullah’s intentions for the supplies included using them within his own household, selling them, or distributing them among people within his village (this latter category can be further decomposed into distinct groups of people, as described in Study 2). Interestingly, the fundamental values projected onto the Mullah rarely reflected considerations of material gain for the sake of wealth alone. Instead, the Mullah’s fundamental values guiding his decisions in this situation were believed to comprise considerations of status, respect, power, and honor. These considerations are examined further in Study 2. Being caught with the supplies was generally felt to negatively impact these four values, and so come at a significant personal cost to the Mullah. However, respondents believed the degree of impact would be minimized or exacerbated depending on how discreetly

the situation was resolved. With respect to the concept of theft, participants did not believe the Mullah would consider himself as stealing and also felt that he would likely view theft quite negatively. In order for the act of reserving supplies to be considered theft, the goods would need to come from local rather than foreign sources.

## Confirmatory CNA: Afghans in Afghanistan

### Method

**Participants** Participants were 405 men from 4 provinces (Balkh, Kandahar, Kabul, Herat) representing north, south, east, and west regions of Afghanistan. Approximately half were from rural villages (54%), and the remainder lived in urban areas. Ages ranged from 18 to 78 years old (mean = 32.6). The vast majority (96.8%) spoke either Pashto or Dari as their primary language.

**Materials** The Mullah section of the survey consisted of a series of brief vignettes describing possible intended actions, followed by closed-form questions about the

Again, the survey options presented were not created by the researchers, but instead derived from interviews with Afghans in the exploratory CNA study. The sequences ultimately led to six fundamental values that were also derived in the exploratory phase of the study: *status, honor/respect, wealth, power, safety, and family approval*. The CNA survey was translated into Dari and Pashto languages, and back-translated to ensure preservation of meaning (Brislin, 1970).

**Procedure** The survey was administered to participants through structured face-to-face interviews. The interviews were conducted by trained Afghan interviewers who live in the same province where they collected data. Before the data collection began, supervisors from each provincial data collection center met with the principal investigator at the opinion research center headquarters in Kabul to discuss the study purpose, survey content, and data collection procedures. The supervisors then returned to their provincial centers and held similar sessions for the local Afghan interviewers. Local interviewers then collected data

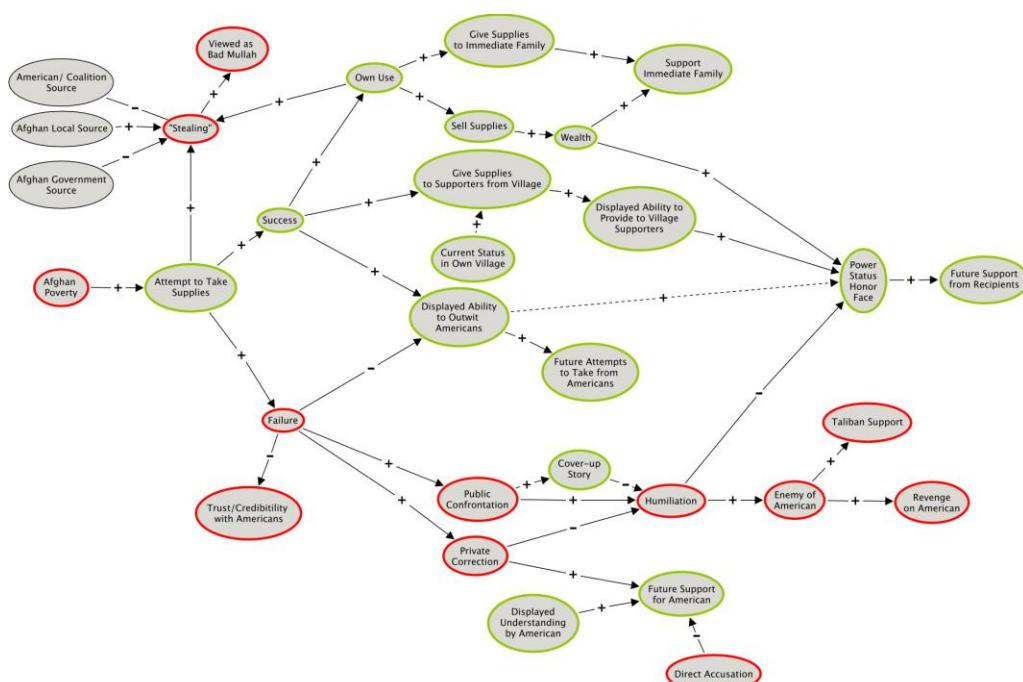


Figure 1. Qualitative cultural model of a Mullah's mind.

objectives and consequences for those actions. An example vignette/question is, assuming the Mullah successfully acquires the supplies, “what will he most likely do with the supplies?”

1. Use in his immediate household;
2. Sell or trade them;
3. Give them to his close friends or supporters;
4. Give them to his extended family; and
5. Give them to needy people in his own village.

at randomly assigned sampling points in their province. Participants were interviewed individually by one interviewer. The interviewer documented participant responses to the survey using paper-and-pencil. The survey took approximately 1 hour to administer.

### Results and Discussion

Model fitting was conducted using a statistical package called “FlexMix” (Leisch, 2004). FlexMix uses an iterative maximum likelihood procedure called the, “EM algorithm,”

for model estimation. A mixture of binomial distributions was fitted to the data set, after categorical variables were recoded in binary terms. The possible (“finite”) number of resulting groups was allowed to vary between 1 and 7. The best fitting model was selected using the Bayes Information Criterion (BIC) statistic. The BIC statistic indicated that the best fit was achieved with 3 cultural groups (BIC = 73096.7) of roughly equivalent size ( $n_1=121$ ,  $n_2=152$ ,  $n_3=132$ ).

Differences between the groups appeared to be fairly subtle. For brevity, a trimmed version of the cultural model is presented for Group 2, only (see Figure 2). As illustrated in Figure 2, participants in this group tended to believe the Mullah would use the supplies within his own household, though reasonable proportions felt he would either sell them, or distribute them among the needy in his village. Interestingly, the majority of possible motivations for Mullah actions center around fundamental values of status and respect. The possibility that the Mullah is simply seeking to increase his wealth appears to constitute a minority view among Afghans. This finding corroborates the initial results from the exploratory CNA study, and again differs from the original American interpretation that the Mullah was operating out of greed.

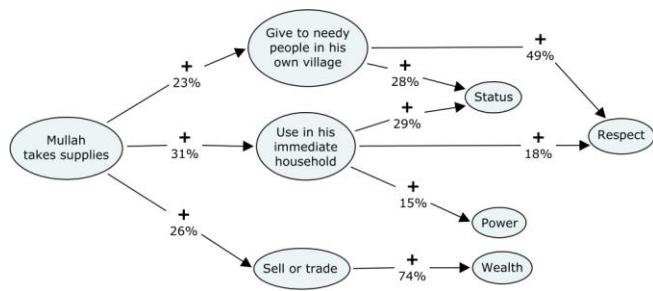


Figure 2. Quantitative cultural model of a Mullah’s mind.

## Discussion

We all have the ability to think and speculate about the behavior of objects, events, and other people. We do this naturally in a variety of domains. In the social domain, we are able to make guesses about other people’s thoughts and therefore speculate about their intentions and their motives and use those guesses to generate plausible explanations for their behavior. Human interaction and communication relies heavily on our ability to anticipate each other’s actions and questions. In fact, one could argue that the ability to predict and explain the behaviors of people around us in common terms is central to our ability to thrive in the local social environment. Methods to support the investigation of such explanations and predictions among localized populations are clearly warranted.

In this article, we described a method that can be used to study folk theories of psychology. The method, Cultural Network Analysis seeks to explicitly map the distribution of mental models within a cultural group. Specifically, the

distribution of a cultural group’s knowledge within a domain and situation is analyzed and displayed using a network representation of consensus elements. We also illustrated the use of the method to explicitly represent folk theories of mind in a cultural context. In particular, we used exploratory and confirmatory CNA, respectively, in two studies to tease out Afghan explanations of an Afghan Mullah’s decision making in an ethically-charged scenario.

A core assumption of our program is that peoples’ intuitive understandings of human psychology are fundamental to many more complex domains of interest in cultural research and applications (e.g., reading intentions, negotiating, and collaborating across cultures). Hence, cultural investigations of mental models of psychology using cultural network analysis, among other methods, will provide a useful starting point for addressing these more complex cultural domains.

## Acknowledgments

This research was supported in part by the Human Social Cultural Behavioral (HSCB) modeling program, under CTTSO cooperative agreement W91CRB-09-C-0028. The authors thank collaborators Mansour Javidan, Rafik Ullah Kakar, Joyce Osland, Ben Simpkins, and Jennifer Smith, for assistance and suggestions at various stages of the research.

## References

- Atran, S., Medin, D. L., & Ross, N. O. (2005). The cultural mind: Environmental decision making and cultural modeling within and across populations. *Psychological Review*, 112(4), 744-776.
- Berger, J. A., & Heath, C. (2005). Idea habitats: How the prevalence of environmental cues influences the success of ideas. *Cognitive Science*, 29, 195-221.
- Bostrom, A., Fischhoff, B., & Morgan, M. G. (1992). Characterizing mental models of hazardous processes: A methodology and an application to radon. *Journal of Social Issues*, 48, 85-100.
- Brislin, R. W. (1970). Back-translation for cross-cultural research. *Journal of Cross-Cultural Psychology*, 1, 185-216.
- D’Andrade, R. (1987). A folk model of the mind. In D. Holland and N. Quinn (Eds.), *Cultural Models in Language and Thought* (pp. 112-148). Cambridge: Cambridge University Press.
- D’Andrade, R. (1995). *The Development of Cognitive Anthropology*. Cambridge: Cambridge University Press.
- D’Andrade, R. (2005). Some methods for studying cultural cognitive structures. In Naomi Quinn (Ed.), *Finding Culture in Talk* (pp. 84-104). New York: Palgrave Macmillan.
- Garro, L. C. (2000). Remembering what one knows and the construction of the past: A comparison of cultural consensus theory and cultural schema theory. *Ethos*, 28(3), 275-319.
- Gentner, D., & Stevens, A. L. (Eds.). (1983). *Mental models*. Mahwah, NJ: Lawrence Erlbaum & Associates.

- Gopnik, A., & Wellman, H. M. (1994). The theory theory. In L. Hirschfeld & S. Gelman (Eds.), *Mapping the Mind: Domain Specificity in Cognition and Culture* (pp. 257-293). New York: Cambridge University Press.
- Hirschfeld, L., & Gelman, S. (Eds.). (1994). *Mapping the mind: Domain specificity in cognition and culture*. New York: Cambridge University.
- Keeney, R. L. (1994). Creativity in decision making with value-focused thinking. *Sloan Management Review*, 35(4), 33-41.
- Leisch, F. (2004). FlexMix: A general framework for finite mixture models and latent class regression in R. *Journal of Statistical Software*, 11(8), 1-18.
- Leslie, A. M., Friedman, O., & German, T. P. (2004). Core mechanisms in 'theory of mind'. *Trends in Cognitive Sciences*, 8(12), 529-533.
- Lillard, A. (1998). Ethnopsychologies: Cultural variations in theories of Mind. *Psychological Bulletin*, 123, 3-32.
- Mueller, S. T., & Veinott, E. S. (2008). Cultural mixture modeling: Identifying cultural consensus (and disagreement) using finite mixture modeling. *Proceedings of the Cognitive Science Society*. Washington, DC.
- Quinn, N. (2005). Finding Culture in Talk: A Collection of Methods. New York: Palgrave Macmillan.
- Rasmussen, L. J., Sieck, W. R., & Smart, P. (2009). What is a good plan? Cultural variations in expert planners' concepts of plan quality. *Journal of Cognitive Engineering & Decision Making*, 3, 228-249.
- Romney, A. K., Weller, S. C., & Batchelder, W. H. (1986). Culture as consensus: a theory of culture and informant accuracy. *American Anthropologist*, 88, 313-338.
- Sieck, W. R., & Mueller, S. T. (2009). Cultural variations in collaborative decision making: Driven by beliefs or social norms? In *Proceedings of the International Workshop on Intercultural Collaboration* (pp. 111-118). Palo Alto, CA.
- Sieck, W. R. (2010). Cultural network analysis: Method and application. In D. Schmorow & D. Nicholson (Eds.), *Advances in Cross-Cultural Decision Making*, CRC Press / Taylor & Francis, Ltd.
- Sieck, W. R., Rasmussen, L. J., & Smart, P. (2010). Cultural network analysis: A cognitive approach to cultural modeling. In D. Verma (Ed.), *Network Science for Military Coalition Operations: Information Exchange and Interaction* (pp. 237-255). Hershey, PA: IGI Global.
- Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Malden, MA: Blackwell.