ATTITUDE AND VALENCE DYNAMICS IN RESPONSE TO CHANGES IN PERCEIVED SIMILARITY VS. DIFFERENCE: IMPLICATIONS FOR HUMAN CONFLICT

by

Jay L. Michaels

A Dissertation Submitted to the Faculty of

The Charles E. Schmidt College of Science

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

Florida Atlantic University

Boca Raton, Florida

May 2012

ATTITUDE AND VALENCE DYNAMICS IN RESPONSE TO CHANGES IN PERCEIVED SIMILARITY VS. DIFFERENCE: IMPLICATIONS FOR HUMAN CONFLICT

by

Jay L. Michaels

This dissertation was prepared under the direction of the candidate's dissertation advisor, Dr. Robin Vallacher, Department of Psychology, and has been approved by the members of his supervisory committee. It was submitted to the faculty of the Charles E. Schmidt College of Science and was accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

SUPERVISORY COMMITTEE:

Robin R. Vallacher, Ph.D.
Dissertation Advisor

David Bjorklund, Ph.D.

Marissa Greif, Ph.D.

Larry Liebovitch, Ph.D.

Vincent Naudot, Ph.D.

David L. Wolgin, Ph.D.
Chair, Department of Psychology

Gary W. Perry, Ph.D.
Dean, The Charles E. Schmidt College of Science

Barry T. Rosson, Ph.D.
Dean, Graduate College

April 5, 2012
Date

ACKNOWLEDGMENTS

Invariably, this space is insufficient to fully extend my thanks to everyone who's had some role in this work. First, I thank my advisor and mentor, Robin Vallacher for his untiring support, guidance, and encouragement of my research. I wish to further extend my gratitude to my long time committee members, Larry Liebovitch and Vincent Naudot. And, I greatly thank my more recent committee member, David Bjorklund and Melissa Greif, for agreeing to supervise and evaluate my work. Together, all of your efforts have paved the way to my growth from a graduate student to a researcher. My thanks are also given to the many colleagues who've offered insight and enthusiasm about my work: Susan Wiese, Urszula Strawinska, Stephen Parkin, and Bradley Trager. I am indebted to the dozens of undergraduate research assistants who have committed countless hours to data collection and input – I wish all of you the joys of graduate school. Finally, I thank the James S. McDonnell Foundation for funding part of this research.

ABSTRACT

Author: Jay L. Michaels

Title: Attitude and Valence Dynamics in Response to Changes in Perceived Similarity vs. Difference: Implications for Human Conflict

Institution: Florida Atlantic University

Dissertation Advisor: Dr. Robin Vallacher

Degree: Doctor of Philosophy

Year: 2012

Despite extensive research in conflict, relatively little is known about how psychological processes evolve over time in response to a dispute. The present research examines how cognitive and affective processes react to cooperative, competitive, or mixed cooperative-competitive interactions. Experimental predictions were derived from a model of two-actor interaction (Liebovitch, Naudot, Vallacher, Nowak, Bui-Wrzosinksa & Coleman, 2008). Specifically, it was expected that attitudes and emotional valence would exhibit stable dynamics when people encountered a neutral, continually cooperative, or continually competitive interaction. However, attitudes and emotional

valence were expected to exhibit perturbation in response to transitions from cooperation to competition and vice-versa.

These predictions were tested in four experiments. The first study verified most predictions, finding that people have little attitude or valence reaction to interactions that are neutral, continually cooperative or continually competitive. This study also established that people's attitudes are significantly unstable when faced with an interaction shifting from cooperation to competition, and this is experienced with negative emotions. However, interactions shifting from competition to cooperation resulted in stable attitudes and emotional valence.

The remaining three experiments sought to explain the lack of psychological reaction to the development of cooperation in a previously competitive interaction. In Study 2, interaction expectancy was ruled-out as a factor. Study 3 demonstrated that the reactivity to sudden competition and lack of reactivity to sudden cooperation developed regardless of interaction history. Finally, Study 4 offers evidence indicating that the lack of reaction to sudden cooperation results from factors other than the duration of cooperative feedback.

The research has several important implications. First, the results provide evidence that competition alone is not necessarily a key factor in promoting heightened psychological reaction in conflict. Rather, transitions between peace and conflict likely hold greater influence on psychological processes in disputes. Furthermore, the experimental evidence provides the first empirical test of the model predictions and offers insight into how the model may be improved. By combining experimental results with the model, the research provides much needed information about how mental dynamics unfold and differ in response to cooperation versus competition.

ATTITUDE AND VALENCE DYNAMICS IN RESPONSE TO CHANGES IN PERCEIVED SIMILARITY VS. DIFFERENCE: IMPLICATIONS FOR HUMAN CONFLICT

TABLES

FIGURES

INTRODUCTION

This first decade of the 21st century has hardly been the technological utopia envisioned by 1950's authors, television program producers, and film-makers. Instead of flying cars, space travel, and peace, we face energy crises, resource depletion, and climate change. In the midst of these, and other, challenges lurks one of the most persistent and destructive problems to affect human civilization: intractable conflict. Intractable conflicts are those disputes that persist for a long duration, involve complex situations, have dire consequences, and seem hopeless to resolve (Coleman, 2000; Pruitt & Olczak, 1995). Each year, intractable conflicts that persist within and between nations inflict suffering upon millions of people and cost governments trillions of dollars (Coleman, 2003; Deutsch, 1994). The destruction wreaked by malignant, protracted conflicts has not gone unnoticed in social research; conflict resolution is the most widely studied topic in the quickly expanding field of peace psychology (Blumberg, 2006a). Despite the urgency and considerable effort to resolve to human conflict, progress in finding a universal solution to wars, civil unrest, and violence has proven elusive.

A critical difficulty in conflict resolution research is that conflict emerges and evolves as a complex interactive system of various elements. Each conflict bears its own unique history, evolution, time-course, and circumstances that all contribute to the situation and may factor into whether the dispute ceases or remains irresolvable. Parsing the factors contributing to dissolution of peace between siblings, neighbors, or nations is not easy, and no single theoretical method can succeed in such an endeavor. For instance, qualitative case studies and experimental findings, their contributions notwithstanding, may lack generalization, especially across cultures (e.g., Hare, 2006; Kozan, 1997). The shortage of generalized approaches for understanding and resolving conflicts has been a primary challenge in this field of research (Weldon & Jehn, 1995), and a "broad-gauge theory of dynamics of conflicts" is needed (Pruitt's and Olczak, 1995, p. 61). In recent years, conflict has become increasingly framed as a system process rather than as a unique phenomenon isolated within a particular context.

Pruitt and Olczak (1995) proposed an eclectic approach to conflict resolution derived from a model of psychological disorder. Their proposed MACBE model addresses conflict as a system of five elements: motivation, affect, cognition, behavior, and social environment. Importantly, Pruitt and Olczak emphasize that severe conflicts "entail hostile elements in all five components of the MACBE model, in contrast to mildly escalated" conflicts, which feature more isolated hostilities (pp. 62-63). This distinction between intractable and benign conflicts is important. According to the MACBE model, intractable conflicts arise and persist when multiple factors become interlinked and the conflict becomes continually reinforced within each of the elements. This interlinking leads to a conflict that is inflexible, self-sustaining, and highly resistant of resolution. Continuing the evolution of conflict research, dynamical systems theory provides powerful concepts that have been used to explain how interlinking and inflexibility emerge in a social system and contribute to malignant conflict.

A Dynamical Approach to Conflict

Long successful with immensely complicated phenomena like weather and fluid turbulence, dynamical systems theory offers hope for unraveling conflict's intricacies by relating seemingly disparate observations to a single framework that is focused on conflict as a general process rather than a specific occurrence. The dynamical approach to psychology relies on two foundations. First, individuals, groups, and societies are considered *systems* of interacting and interconnected elements. At all levels of analysis, events in behavior, cognition, and social exchange involve multiple units that interact. On a micro scale, the system's units may be individual protein sequences in a gene or cell. On a macro scale, the system's units may be entire populations, interacting across cultures or national borders. Second, interacting systems exhibit *dynamics* – change and evolution in time (c.f., Strogatz, 1994). From cell phenotype arising from gene feedback loops (e.g., Michaels, Naudot, & Liebovitch, 2011) to cultural changes as a result of a group's history (e.g. Kitayama, Ishii, Imada, Takemura, & Ramaswamay, 2006), dynamical influences promote diversity and drive natural change. Combining these two core concepts, a *dynamical system* may be defined as a set of interconnected elements that interact and evolve in time. Although random events may play a role in a system's growth and change in time, most systems evolve according to specific patterns (see Cambel, 1993; Losick & Desplan , 2008). These patterns are not inherent in a system, but instead emerge over time from self-organization. *Self-organization* is the formation of specific, orderly patterns in a system with many interacting elements. Self-organization emerges from *feedback* between the various components that make-up a given system, and the feedback influences how each individual element reacts to and interacts with other elements. With persistent feedback, the constituent components of a dynamical system may form certain synchronies that give rise to coherent patterns. These highly coherent structures are the system's *attractors*. Dynamic influence, feedback, self-organization, and attractor formation are ideas from complex dynamical system theory that have been applied to research on human conflict.

Dynamic Influence and Feedback

A dynamical system is comprised of multiple interacting parts. The influence between any two interacting components may be linear or non-linear. *Linear* relationships are formed from relatively simple, weak interactions and tend to yield predictable outcomes. *Non-linear* relationships, on the other hand, arise from more complex, strong interactions and are capable of a rich array of outcomes (Hunt, 2007; Liebovitch, 1998; Newtson, 1994). Non-linear relationships may better represent phenomena in biology, psychology, and natural systems. For one, systems with components that interact in cooperative, competitive, or other interfering ways exhibit nonlinearity (Strogatz, 1994). Furthermore, linear relationships can exhibit unhindered growth or decay that is highly unrealistic for most systems (Gottman et al., 2005). This is certainly the case in psychology, where many phenomena exhibit floor or ceiling effects. Constant linear growth, or decay, in conflict research makes little sense, as linear growth allows for no limit on conflict escalation, or de-escalation. In reality, conflict can only become so severe, perhaps culminating with the complete destruction of one's adversary. Likewise, conflict cessation can only become so peaceful; a former opponent can only surrender so much of the kingdom, for example. The limiting nature of conflict and peace can be captured using certain non-linear relationships (discussed in detail later). Therefore, conflict seems best understood as a product of non-linear relationships between critical factors that influence and drive the circumstance. The relationship between components of a dynamical system is important for an additional reason. The relationships describe the type of feedback that one element exerts upon another, and is a crucial concept for dynamical approaches to conflict.

There are two general forms of feedback that appear in many different biological and social systems: inhibitory feedback (negative feedback) and excitatory feedback (positive feedback). *Inhibitory feedback* limits and terminates action or response (Nowak et al., 2007). Comparatively, e*xcitatory feedback* intensifies, amplifies, and sustains action or response (Nowak et al., 2007). In human behavior and interactions, and in many systems, regulation is maintained through a combination of inhibitory and excitatory feedback. For example, if a husband and wife engage in an argument, excitatory feedback in the interaction may escalate the dispute to an increasingly hostile level. In a healthy couple, however, eventually the husband and wife recognize the destructive nature of the argument and engage in behavior to reduce the tension (Gottman, Swanson, & Murray, 1999). Without inhibitory feedback, excitatory feedback can yield dire consequences and is of special interest in conflict research.

In the absence of sufficiently strong inhibitory feedback, excitatory driven processes tend to stabilize, becoming resistant of change (Cinquin, 2002). Without inhibition, excitation can cause runaway excitation, leading to rapid and often disastrous escalations. The idea of runaway excitatory feedback has been prominent in dynamical treatments of conflict. According to Coleman, Vallacher, Nowak, and Bui-Wrzosinska

(2007), “a balance between positive and negative feedback loops is critical for effective self-regulation” and for preventing a minor dispute’s escalation into a destructive conflict (p. 1463). Such regulation seems essential for cooperation to exist in society, as without inhibitory feedback, the onset of a conflict would result in ceaseless tit-for-tat response and retaliation (Nowak, 2006). Recognizing the danger posed by runaway excitation, dynamical systems theory of conflict proposes that benign conflicts are those that preserve balance between inhibitory and excitatory feedback. In contrast, intractable conflicts are those that are uncontrolled and lack sufficient inhibitory feedback mechanisms to prevent destructive escalation (Coleman et al., 2007; Nowak et al., 2007; Vallacher, Coleman, Nowak, & Bui-Wrzosinska, 2010a). Persistent excitatory feedback can stabilize a system, locking it in a particular pattern of action and interaction (Cinquin, 2002). If two adversaries engage in escalating retaliatory responses, shaped by uncontrolled excitatory feedback, the dispute can transition from one that is benign and resolvable to one that is destructive and intractable. This transition may be dynamically understood by using the concept of an attractor.

Self-Organization and Attractors

An *attractor* is a state that a system converges upon over time. Through this convergence, attractors stabilize a system and makes it resistant to change (Nowak and Vallacher, 1998; Vallacher, Coleman, Nowak, & Bui-Wrzosinska, 2010a,b). Excitatory feedback loops are one important mechanism for promoting attractor formation. Whereas, inhibitory feedback weakens links between individual units within the system, excitatory feedback strengthens links (e.g. Cinquin, 2002). Over time, persistent strengthening of connections between system elements can lead to the emergence of coherent macro-scale structures, like attractors (Johnson, 2001).

Attractors have been used to explain and examine the differences between benign and intractable conflicts. A conflict that is *intractable* is one that persists over long periods of time without resolution in-spite of the heavy toll exacted against those groups involved (Coleman, 2000). Coleman et al. (2007) and Vallacher et al. (2010a, b) propose that intractable conflicts emerge when a benign conflict spreads into domains outside of the precise focus of the conflict via excitatory feedback. For example, a minor dispute over a natural resource can escalate into an intractable conflict if the parties involved become increasingly polarized, stop communicating, denounce the opposition as immoral or evil, and then begin massing military materiel near their borders as a show of force. Without an inhibitory feedback to cool the tensions, such a scenario can rapidly escalate into an intractable conflict.

Once a conflict transitions to intractability, the conflict assumes a controlling influence over subsequent interactions between rival groups or individuals. Attempts at dislodging the intergroup interaction from the conflict fail because the exchanges between the warring parties become less complex as the conflict attractor seizes control. As the attractor comes to dominate the system, it reduces the potential for alternative stable interaction states to exist between the groups. Over time, the conflict attractor metaphorically deepens (Nowak et al., 2007). Thus, as the uncooperative relations persist between the groups or individuals over time, conflict becomes the dominant force over the social interaction through its own self-organization (Coleman et al., 2007). Although using the dynamical systems framework metaphorically to the study of conflict allows useful conceptualization of underlying processes, there is a need to quantify proposed dynamical concepts and test dynamical predictions (Coleman et al., 2007; Vallacher & Nowak, 1997). One strategy for quantifying and testing dynamical perspectives on conflict is to follow Gottman's et al. (2005) approach to marriage research by using a combination of non-linear modeling and experimental tests of the model predictions.

Mathematical Models in Social Psychology

Before examining Gottman's et al. (2005) work on modeling dyadic interactions between a husband and a wife, it is worthwhile to briefly examine the history of computational modeling in social psychology. There is a rich diversity of models in social psychology. Early in the field's development, Lewin (1936) developed his now famous "Lewin equation." A heuristic rather than a model, Lewin's equation elegantly relates human behavior to interactions between the self and with the environment. While Lewin's heuristic illustrates the use of mathematical notation in social psychology, rigorous mathematics generally appear later in the field's evolution. By the 1940s, game theory researchers developed sophisticated mathematics of human interaction (e.g von Neumann & Morgenstern, 1944). In more recent years, game theory researchers have developed new mathematical approaches to better explain why cooperation is so prevalent in social systems (e.g. Axelrod & Hamilton, 1981; Nowak, 2006). Other computational models of social interaction appeared during the 1960's when computer simulations were becoming more commonplace (e.g. Gullahorn & Gullahorn, 1963). With continuing advances in computer technology and its affordability, simulations have emerged as an important tool for exploring and explaining human behavior. Simulations have been powerful tools to examine phenomena such as social influence (e.g. Nowak, Szamrej, & Latane, 1990; Centola, Willer & Macy, 2005); group performance (e.g. Losada, 1999), and mate selection (e.g. Kalick & Hamilton, 1986). Mathematical models and computer simulations are useful for identifying key parameters of complex social systems (Nowak & Lewenstein, 1994) and for generating new theories (Sun, 2008). However, models are only as good as their outputs accurately reflect behavior, decisions, or social patterns in the real world. Empirical validation of mathematical models remains one important area for continued work in the behavioral sciences (Sun, 2008). Pairing experimental studies with mathematical simulations afford one promising approach to studying complex social phenomena, as illustrated by Gottman's extensive work on marital relationships.

The Power of Models and Experiments: Gottman's Research

Gottman's research on marriage exemplifies the power of coordinating laboratory research with mathematical modeling in order to better understand complicated human interactions. Originally, Gottman conducted research using usual social science methods, such as a longitudinal study of conflict in married couples (Gottman, 1993). Later, by using nonlinear difference equations, Gottman, Swanson, and Swanson (2002) captured the relationship between several marriage parameters and were then able to successfully predict couple's marital stability and divorce. Their model's predictions were also found to be valid in laboratory settings (Gottman et al., 1999). Beyond the success of their work on marriage, Gottman, Murray, Swanson, Tyson, and Swanson (2005) summarize that the principle strength of modeling in research is that the mathematics force rigorous definition of parameters and theories which reduces ambiguity and allows specific predictions to be proven or disproven through experimental work. Additionally, when investigating a set of parameters using a mathematical model, unanticipated outcomes may surface, which in-turn lead to new findings (Gottman et al., 2005). Mathematical models have already proven useful for considering parameters previously neglected in conflict research.

Mathematical Models in Conflict Research

Lim, Metzler, and Bar-Yam (2007) developed a mathematical model to investigate how the spatial distribution of different groups can result in conflict. Their model resulted in the novel discovery that the boundary structures in place between opposed groups can explain the resultant global conflict pattern between the groups. When applying their model to study conflict development between the different groups found in each former Yugoslavia and India, the model outputs closely matched the qualitative pattern of conflict observed in both of those regions, thus confirming the accuracy of Lim's et al. model. While Lim et al. (2007) modeled group spatial distribution and boundary factors that contribute to conflict, Liebovitch et al. (2008) focused on modeling the temporal pattern of cooperation and conflict between two actors. More recently, Bhavnani and Miodownik (2009) used an agent-based model to find that polarization between groups according to ethnicity contributes to the formation of intergroup conflict. Through their model's results, Bhavnani and Miodownik (2009) were able to conclude that the salience of ethnic identity within groups is a principle factor in the development of conflict between groups. By examining the intricacies of human conflict using mathematical modeling, Lim et al. (2007) and Bhavnani and Miodownik (2009) were able to isolate specific variables fundamentally tied to conflict origination. By providing novel findings that correspond to observed real world patterns, these research efforts demonstrate the value modeling affords to studying conflict. One limitation of both studies is that they establish a preexisting condition that the interacting groups are competing rivals. What happens when two interacting groups transition between cooperation and competition?

Classic game theory research examined how cooperative versus competitive interaction strategies would lead to various outcomes in the Prisoner's Dilemma scenario. Axelrod's (1984) work initially concluded that reciprocating actions would lead to the best possible outcome for each individual engaged in the Prisoner's Dilemma. That is, if one person acts cooperatively, then the other should respond in the same manner to obtain maximal gain. Likewise, when an individual engages in a competitive action, then the other person should do the same. This "tit-for-tat" strategy, however, only succeeds if the individuals or groups are rivals prone to defection through a predominantly competitive interaction style (Nowak, 2006). Otherwise, between groups or individuals where cooperation exists, Nowak and Sigmund (1993) finds that a strategy less immediately reactive than tit-for-tat leads to better outcomes for involved individuals. The reason for this is that continually reciprocated actions on the part of two interacting individuals or groups can lead to the establishment of long-duration retaliatory periods following a single competitive action (Nowak, 2006). These game-theory studies demonstrate that even in a simple game like Prisoner's Dilemma, where a limited number of outcomes are present, the precise interaction strategy leading to maximal gains for either individual varies depending on the propensity of the actors to establish cooperation or competition between one-another. Closer examination of what effects interaction styles have on the transition between cooperation and conflict between individuals and groups is necessary to determine how stable peace can emerge from episodes of conflict.

Nonlinear Model of Two-Actor Cooperation-Competition

To model cases of cooperation and competition between two individuals or groups (called actors), Liebovitch, Naudot, Vallacher, Nowak, Bui-Wrzosinska, & Coleman (2008) devised a system of autonomous differential equations that incorporate three specific parameters: 1) each actor's inertia to change (m_1 and m_2 terms), 2) each actor's uninfluenced state (b_1 and b_2), and 3) each actor's influence on the other (c_1 and c_2). This third parameter is paired with the hyperbolic tangent function to form the influence function, thus providing the model:

$$\begin{cases} \dot{x} = m_1 x + b_1 + c_1 \tanh(y) \\ \dot{y} = m_2 y + b_2 + c_2 \tanh(x) \end{cases} \tag{1}$$

Liebovitch et al. (2008) choose to use the hyperbolic tangent function because they desired a model that would allow the actors to influence one another "approximately proportionately at small influence levels" while maintaining saturation (bounds) for each actor's state. Finally, Liebovitch et al. (2008) used an influence function to allow each actor to affect the other through positive or negative feedback. It should be noted that saturating functions, such as the hyperbolic tangent function, are often used in dynamical systems modeling. In particular, the hyperbolic tangent function is useful as its curve is similar to the one generated by the frequently used Michaelis-Menten equation while having an unrestricted domain (Haefner, 2005). This unrestricted domain allows each actor's state (x, y) to be represented as any positive or negative real number, which is useful for mathematically conceptualizing positive, cooperative, and negative, antagonistic, states. Simulated interactions between two actors may be interpreted geometrically using two types of plots: phase space and trajectory behavior over time.

Model Results: Mutually Constant Feedback Cases

Informally, phase space is a map of all possible paths that an equation or system of equations yield from a given set of initial conditions. A single path is called a trajectory. Results from numerical analysis demonstrate two general phase space configurations possible from Liebovitch's et al. (2008) model. One configuration presents a single stability (Figure 1a). This particular state emerges when the influence parameters in the model (Equation 1) are set to small values. When the influence parameters involve greater constants, the single stability undergoes a saddle-node bifurcation which results in two stable nodes separated by a single saddle (Figure 1b). These two different configurations of the phase space will be preserved regardless of which precise values are chosen for the model's parameters. Since all of the fixed points are hyperbolic (given that none of the eigenvalues are zero), it can be concluded from index theory that there will always be an odd number of fixed points where there must be more attractors or repellors than there are saddles (i.e., for n saddles, there must be n+1 attractors or repellors) (Wiggins, 2000).

According to Liebovitch et al. (2008), interpretation of the two actors' interaction is dependent on where the stable nodes appear in the phase space. A neutral interaction is mathematically represented by the case where the influence parameters are set to small constant values, where the resultant phase space features a single stable node. The alternate case where two stable nodes are present can capture either cooperation or competition between the two actors. When the stabilities appear in the first and third quadrants of the standard Cartesian plane, the interaction is cooperative (Figure 2a). Comparatively, when the stabilities occur in the second and fourth quadrants, the interaction is competitive (Figure 2b). Finally, in cases where the influence parameters have values with different signs, the phase space exhibits a single stable spiral (Figure 3). This scenario represents the eventual neutral stalemate that emerges from situations where one actor exhibits constant cooperative behavior, and the other acts using constant competitive behavior.

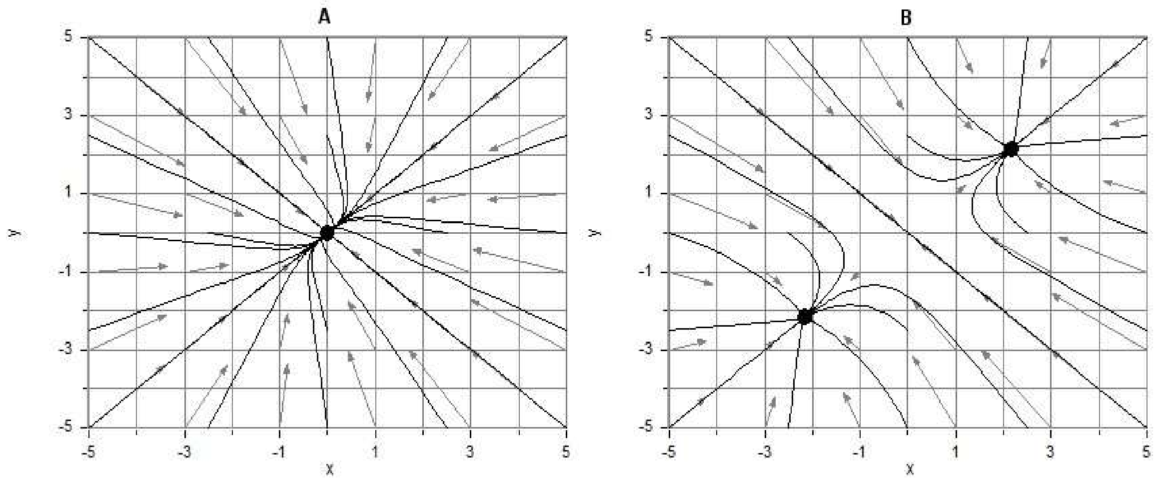

Figure 1: Two general phase space configurations given by Liebovitch's et al. (2008) model. Stabilities are noted with points in the graph. A: The single stability case. B: The bistability case, the two attractors are separated by a saddle. The stable manifold of the saddle is shown with the straight line running diagonally from the top left to bottom right of the phase space.

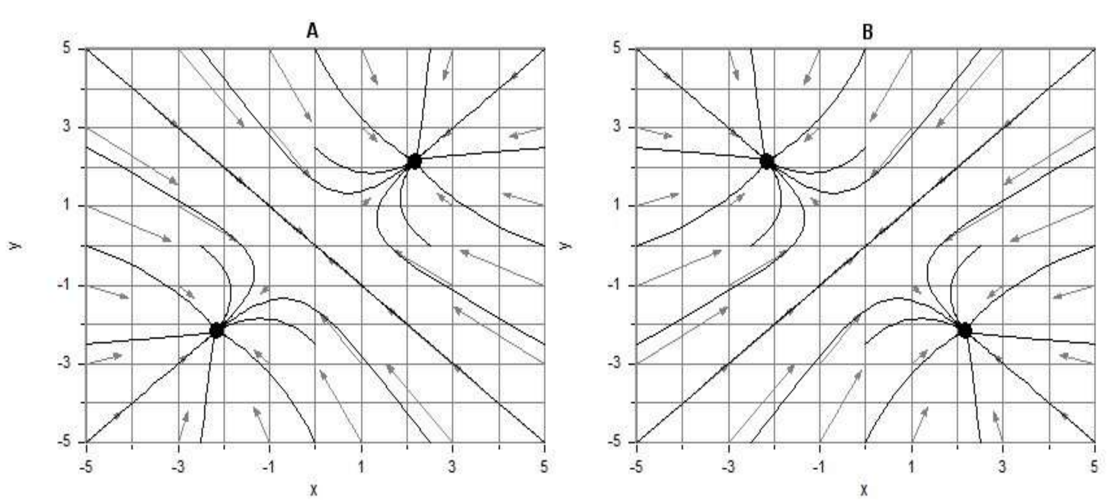

Figure 2: Phase spaces generated from cooperative and from competitive feedback scenarios. A: Positive, cooperative, feedback. B: Negative, competitive, feedback.

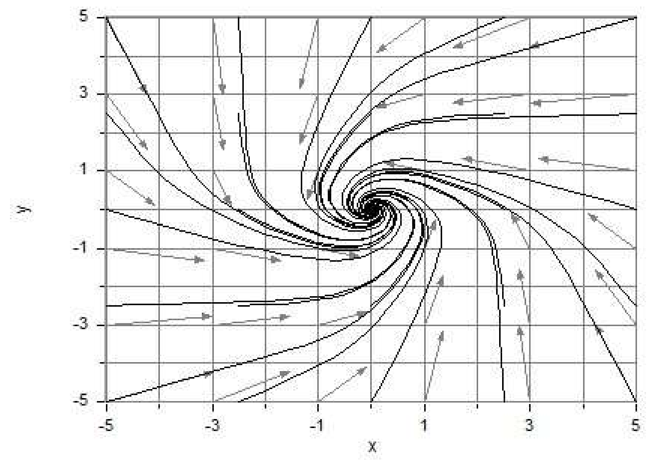

Figure 3: Phase space for a scenario where one actor responds with positive, cooperative, feedback and the other actor responds with negative, competitive, feedback.

Examining the behavior of the trajectories over time reveals qualitatively useful patterns for interpreting the model in terms of social behavior. For any case where the two actors' interaction evolves to neutrality, the trajectories converge to zero over time (Figure 4a). This contrasts with cooperative situations, which are represented in the model as events where the two interacting actors' trajectories both progress into a positive state ($x > 0$) or a negative state ($x < 0$) over time (Figure 4b and 4c). As Liebovitch et al. (2008) summarize from Deutsch (2006), in cases of cooperative interaction, positive feedback exists between the two individuals or groups; over time, the two cooperating actors come to sink together or swim together.

Competitive interactions present trajectory patterns where one actor's outcome falls into a positive state while the other actor's outcome ends up in a negative state so long that the parameter values associated with each actor are not identical. This means that for a competitive scenario, one actor wins while the other loses (Figure 5a). If actors in a competitive situation are modeled as having identical parameter values and initial conditions, then there interaction will evolve to a neutral stalemate – neither of the two actors is strong enough to win the interaction, nor is any of the two actors weak enough to lose (Figure 5b). It should be noted that this neutral outcome from two competing actors modeled with identical parameter values is unusual in that it is not especially realistic. Few, if any, real world conditions allow two interacting groups or individuals to possess precisely the same psychological factors and states at any given instant.

Mathematically, too, the neutral state that evolves from identically matched actors is highly unstable and is easily perturbed. The reason for the neutral condition's sensitivity in a constant competitive condition is that the evolved trajectories are precisely situated along the stable manifold of the saddle. This manifold separates the two basins of attraction that qualitatively capture distinct winning and losing states (Figure 6). The minutest change in parameter values will perturb the two actors off of this stable manifold, thus causing each to fall into an attractor's basin.

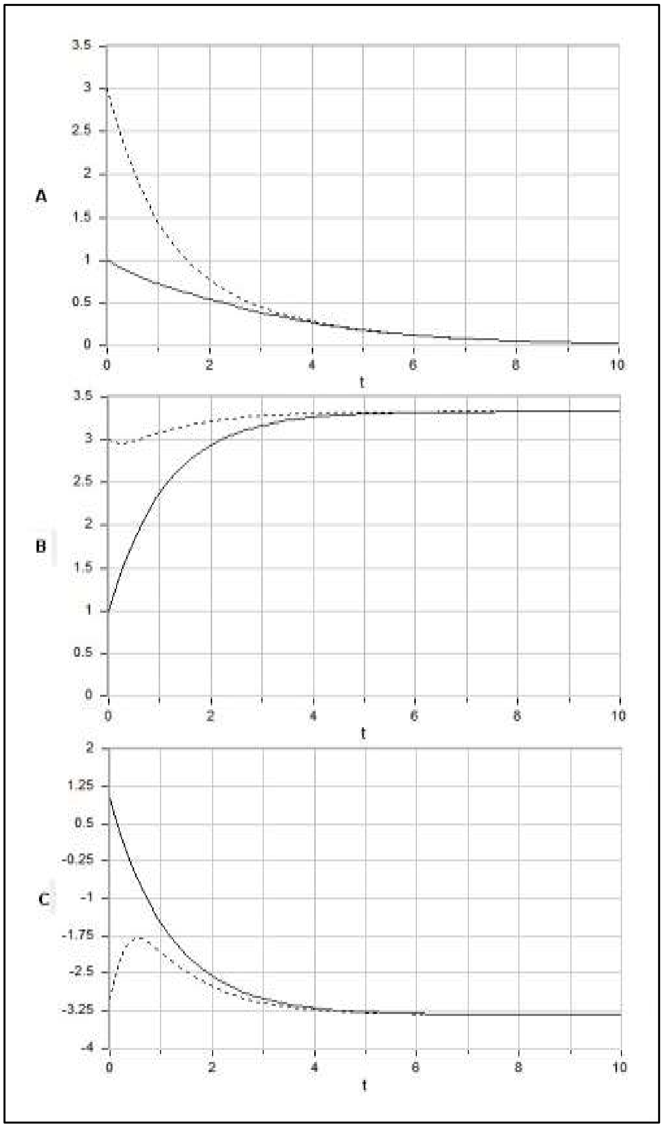

Figure 4: Numerical integration results from Liebovitch's et al. (2008) model showing the trajectories of specific two actor interaction cases. The solid line and dashed line each represent one actor's state over time. A: Weak feedback between the two groups or individuals results in both converging to a neutral state ($y = 0$). B: A cooperative interaction where both actors proceed to a positive, winning, outcome. C: A cooperative interaction where both actors end in a negative, losing, outcome.

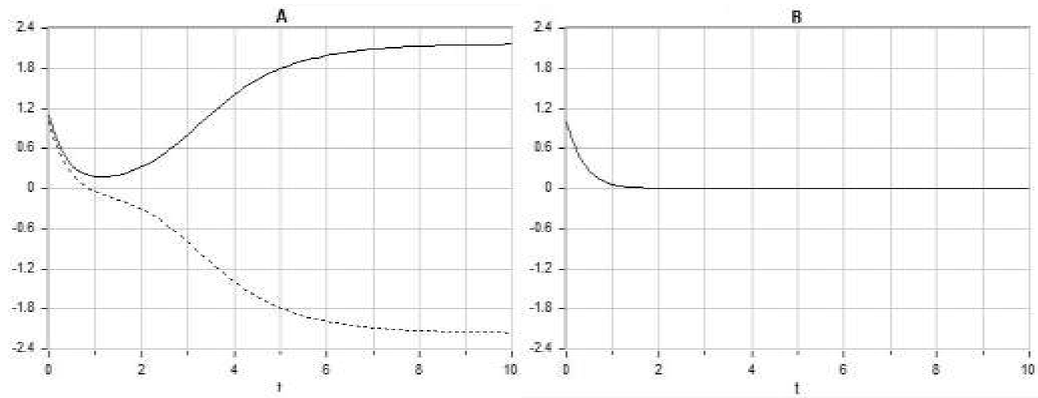

Figure 5: Numerical integration results showing the trajectories for competitive interactions. A: When two competing actors do not share identical parameter values and initial conditions, then one actor wins (solid line in this case) while the other loses (dashed line in this case). B: If both actors are modeled as having the same parameter values and the same initial conditions, then the actors evolve to a neutral stalemate if in a constant competition (note that in this case, the two actor’s trajectories perfectly overlap, thus only a single line is plotted).

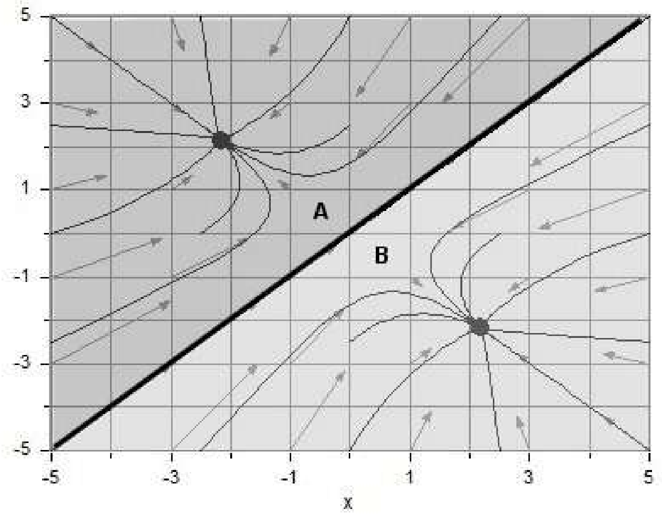

Figure 6: Phase space for a competitive interaction scenario. The stable manifold is represented by the bold solid diagonal line from the lower left to the upper right of the phase space. The basins of attraction for the two separate stabilities fall on either side of this manifold and are indicated by the dark grey (A) and light grey (B) shaded regions.

The different trajectory patterns presented by the model for cooperative and competitive scenarios between two groups or individuals are similar to the outcomes in the well-known Prisoner's dilemma. In the Prisoner's dilemma, a cooperative scenario occurs when both prisoners confess or do not confess. When both prisoners fulfill the same decision, it is analogous to the model scenario where positive feedback is assumed; both prisoners exhibit mutually congruent decisions. Negative feedback situations, however, occur in the Prisoner's dilemma when one prisoner confesses while the other does not. In such a case, one prisoner wins by not-confessing while the confessor loses. Figure 7 summarizes the comparison between trajectory-time plots from Liebovitch's et al. (2008) model and the four scenarios from the Prisoner's dilemma game.

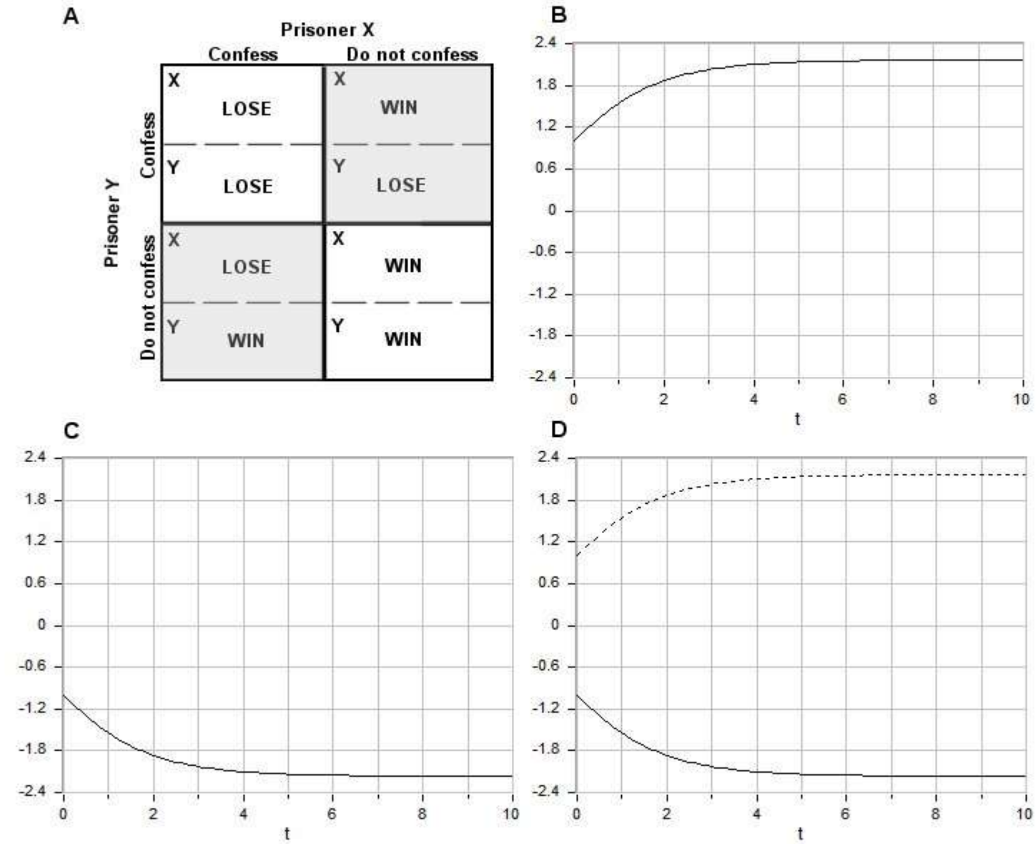

Figure 7: Framing the Prisoner’s Dilemma Game in terms of the non-linear model outputs. A: Prisoner’s Dilemma pay-off matrix in qualitative terms. B: Trajectory over time output from the model that corresponds to Prisoner X and Prisoner Y both exhibiting positive feedback where neither confesses resulting in both having a “win” payoff. This corresponds to the lower right quadrant of the matrix. C: When Prisoner X and Prisoner Y exhibit positive feedback where they both confess, both receive a “lose” payoff, as in the upper left quadrant of the matrix. D: If one prisoner does not confess while the other does, then the confessor loses (solid line) and the non-confessor wins (dashed line). This corresponds to negative feedback and relates to the two shaded parts of the matrix.

From the previously discussed numerical simulations, Liebovitch’s et al. (2008) model qualitatively captures the payoff matrix from the Prisoner’s Dilemma game. The model's success at generating outcomes parallel to those generated by the Prisoner's Dilemma payoff matrix supports that Liebovitch's et al. (2008) formalization can validly model social cooperation and competition phenomena. This is especially true since the Prisoner's Dilemma is well-researched and known as a valuable tool for framing the complexities involved in human decision-making and the evolution of cooperative or competitive interactions (see Zwick, Erev, and Budescu, 1999, for a discussion of game theory's value in psychology research). The similarities in the previously described outcomes notwithstanding, the non-linear model differs from the Prisoner's Dilemma game in that the model's results are driven by the feedback between two individuals or groups whereas the game's outcomes are generated by decisions. The difference is subtle. The non-linear model assumes continuous feedback between the actors; through feedback continuity, results are dynamically driven. The iterated Prisoner's Dilemma, in comparison, assumes discrete action and response scenarios. According to the game's design, an actor chooses a course of action, which is followed by the other actor deciding whether to reciprocate. Furthermore, the Prisoner's Dilemma is framed in such a way that each actor seeks to maximize his or her payoff. The model allows this maximization, but also allows each actor to seek to minimize the other's payoff.

Beyond the specific parallels with the Prisoner's Dilemma paradigm, Liebovitch's et al. (2008) model also gains support from several studies that demonstrate initial conditions are fundamental precursors to eventual outcomes in human interactions. This is a key concept within the dynamical systems metatheory – that the conditions existing early in some interaction affect the time dependent evolution of that interaction. Such an idea derives directly from chaos theory, which posits complex systems as having tremendous sensitivity to initial conditions (Liebovitch, 1998). Simpler systems, such as those defined by a fixed point attractor, exhibit less sensitivity to initial conditions,and the final system state converges on the stability (Nowak & Vallacher, 1998, pp. 58-61).

One example of initial conditions fostering significant relation to later events comes from Filsinger's and Thoma's (1988) longitudinal study of couple's interaction, which demonstrated that conditions developing early in the relationship significantly influenced later relationship outcomes. Likewise, Liebovitch's et al. (2008) model results for positive influence state interactions demonstrate that the initial conditions determine the attractor (positive, beneficial outcome or negative, losing outcome) at which the interacting actors eventually stabilize. Rusbult, Verette, Whitney, Slovik, and Lipkus (1999) completed a series of experiments with couples to discern whether or not the couples engaged in accommodating behavior when faced with a challenge. From their results, Rusbult et al. (1999) reported that preexisting level of commitment was the principle predictor of accommodating behavior. Therefore, from Rusbult's et al. (1999) study, the preexisting state rather than the interaction state has particular relevance to the exact outcome of a couple's interaction. Lucas, Clark, Georgillis, and Diener (2003) examined marital status and happiness of German citizens in a longitudinal study between 1984 and 1999. From this work, Lucas et al. (2003) observed that participant's initial reaction to events, recorded by a life satisfaction instrument, accounted for 80-percent of the variability in later scores. Lucas' et al. (2003) work demonstrates the significance of preexisting and initial conditions to the eventual outcome of a given event. Work by Rogge, Bradbury, Hahlweg, Engel, and Thurmaier (2006) also demonstrates the importance of initial and prexisting conditions on the eventual outcome of a relationship. In their longitudinal study, Rogge et al. (2006) observed that specific scores from an initial survey could predict the outcomes of divorce or marital satisfaction five years later. All of these studies on relationship interaction demonstrate the substantial importance of conditions at the onset of the relationship to the longevity, success, and happiness of the relationship. These findings thus lend support to simulations from the Liebovitch et al. (2008) model, where the final outcomes experienced by the hypothetical individuals or groups in those simulations highly dependend on initial conditions. Beyond studies of relationship interaction, Rouhanna (2004) examined conflict reconciliation and analyzed several major conflicts (e.g., World War II, South Africa's emergence from apartheid) and identified that slightly different initial conditions in the opposing groups' power structures could offer insights in the later evolution of the respective conflicts. These studies, taken together, provide support for the results for interaction outcomes that emerge from Liebovitch's et al. (2007) model of cooperation and competition.

Model Results: Mixed Feedback Cases

In addition to mutual cooperation or competition, the non-linear model allows for a third type of feedback between two groups or individuals: mixed cooperative and competitive feedback. In this condition, one actor in a given interaction responds to the other with cooperative feedback while the other responds with competitive feedback. In a social context, this scenario would equate to a weaker group seeking to appease a dominant competitor, a powerful opponent seeking to make reparations for a misdeed to a weaker adversary, or one party involved in an intractable conflict seeking mediation.

Mixed feedback is not well-captured by the iterated Prisoner's Dilemma game, as the game assumes that each player responds to the other; at no instant do both players make a decision at the same time (except, perhaps, at the very onset of the game). Therefore, a truly mixed feedback strategy cannot be represented in the iterated Prisoner's Dilemma. At each discrete moment of a decision, a player is either performing the same action as the other (positive feedback) or is performing an opposite action (negative feedback). Simulation results from Liebovitch's et al. (2008) model exhibit interesting patterns for the mixed feedback case.

Considered over a long duration, the mixed feedback case always evolves to a state where both interacting actors reach a neutral end state. Considering the phase space portrait generated by the mixed feedback case indicates why this outcome arises. In this feedback scenario, the resultant phase space is defined by one spiral stability (Figure 8a). Over time, both involved actors rotate towards the attractor. A consequence of the spiral is that each actor's trajectory exhibits oscillations over time. Qualitatively translating this mathematical picture to the social experience, this means that each individual or group engaged in a mixed feedback interaction cycles between periods of winning and periods of losing. If the mixed feedback persists uninterrupted, the end result is that the payoff from each subsequent win and the cost from each subsequent loss will decrease (Figure 8b). This dampening is akin to two sides engaged in an intractable conflict where one party decides to seek peace while the other side continues to fight. The initial cessation of violence by the peace-seeking party results in that group experiencing significant loss, but over time, the loss is diminished. Meanwhile, the opposing group finds initially high reward for continuing the violence, but the subsequent wins lead to ever diminishing payoff. Such a scenario evokes real world events such as where one group is so devastated by a conflict that it has little left to lose; conceding to the other side results in some initially heavy losses, but at the benefit that the opposed group benefits less and less from continuing aggression.

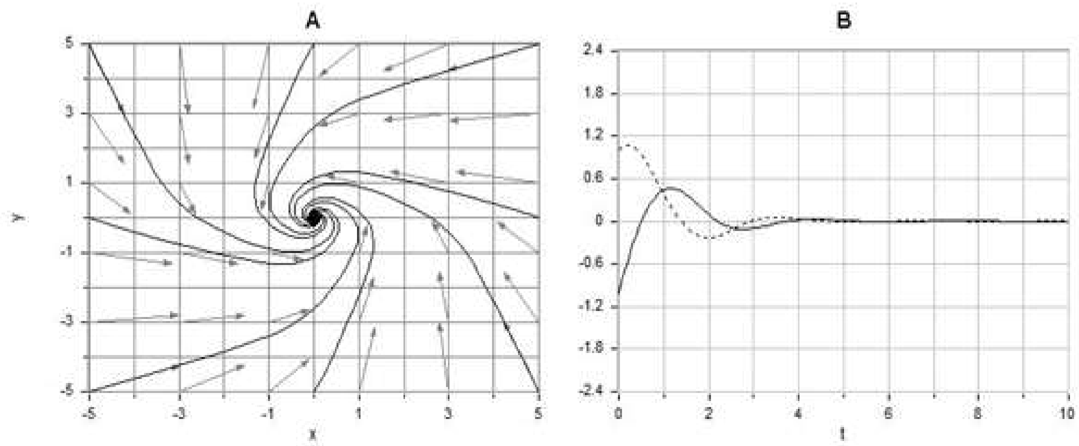

Figure 8: Phase space and numerical integration for a mixed feedback case. A: Phase space showing a spiral stability centered at the origin. B: Numerical integration showing that the two individuals or groups oscillate over a short period before eventually reaching a neutral state.

In the mixed feedback case, the oscillatory nature of the trajectories through time is of greater interest than the evolution of a neutral end state. This is because the oscillations indicate that the winner and loser roles in a conflict can be reversed if one of the two interacting groups or individuals were to switch feedback style. Competition is represented in the model by negative feedback between the two actors. If the losing actor in a competitive situation were to change from a negative feedback style to a positive feedback style, then the subsequent interaction would no longer be purely dictated by negative feedback. Instead, a mixed feedback case would emerge. The win-loss state of the two actors will, according to the model's predictions, oscillate. After a period of time, the previously losing actor would become a winner. Once that occurs, the now winning actor could return to a competitive feedback style and retain the winning state (Figure 9).

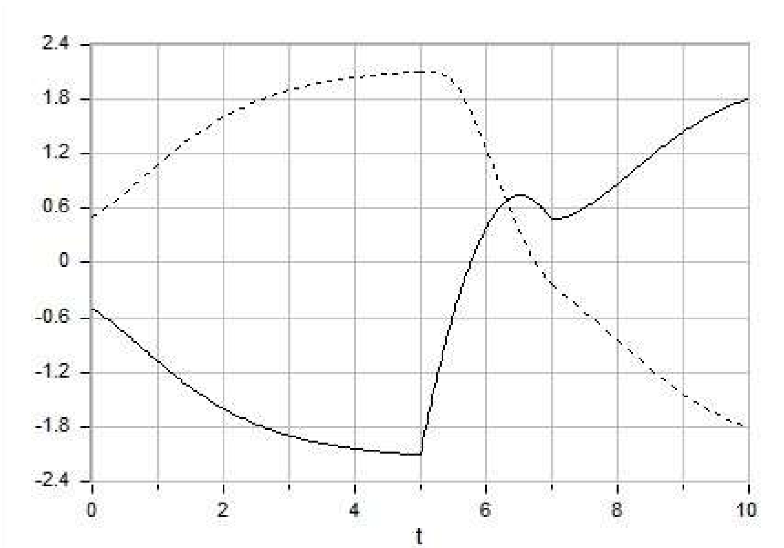

Figure 9: Numerical integration for two actors who are initially engaged in mutual competitive feedback (t_0 to t_5), which results in one actor winning, dashed line, and one actor losing, solid line. After the solid-line actor changes to a cooperative interaction strategy, the resulting mixed feedback causes oscillations in the trajectories (t_5 to t_7). Eventually, the oscillation allows the previously losing actor, solid line, to emerge a winner. Once in a winning state, this actor changes back to a competitive interaction strategy, thus remaining in the winning state (t_7 to t_{10}).

In a similar fashion, if the winning actor in a constantly competitive interaction were to switch strategies, then that actor risks emerging as a loser. Once the winner of a conflict disengages from the competition, then that person or group opens the possibility for the losing side to persist in the conflict. Over time, the disengaging winner may emerge as a loser should the formerly losing side continue to compete. This model prediction may afford insight into intractable conflicts' longevity and resistance to change. Per the model, once a winner emerges in a protracted conflict, then the winner's gains are at considerable risk if that person or group ceases competition with the losing opponent.

Evidence from studies on antecedents to the cessation of various conflicts offers support for these model predictions. The model's prediction that changes in feedback between two individuals or groups involved in a conflict situation accrue risk for the winner seems supported by Rouhana's (2004) examination of conflict reconciliation in terms of power structures. Rouhana (2004) identified that reconciliation was most likely to occur when a dominant (winning) group was overthrown, collapsed, or on the verge of collapse or when the non-dominant (losing) group was so reduced that it offered little real threat to the stronger opponent. Historical examples of these various scenarios include reconciliation following World War II, when the once powerful and winning Nazi regime collapsed following strategic Allied victories and South Africa's emergence from the apartheid. Another example is the ultimate Arab loss in the First Arab-Israeli war, where following initial Arab victories, an influx of new weapons and disorganization among the various Arab units allowed the previously losing Israeli forces to emerge as victors (Cleveland, 2004; Dupuy, 1978). In these cases, the reconciliation emerges as a result of change in power structures. The non-dominant group gains advantages allowing it to become the more powerful opponent. Per Rouhana's (2004) assessment, dominant groups do not typically seek reconciliation. The winner of an intractable conflict has little to gain from making peace with the losing side unless other forces are involved. This is more evident from Rouhana's (2004) observation that a second path to reconciliation involved the losing group becoming so diminished that it no longer offered a threat to the winning adversary. The long conflict between Native Americans and the United States Government during the 18th and, especially, 19th century exemplifies such a scenario. Eventually, the weakened losing side has little choice but to fully concede to the dominating winner. Once again, the key observation from Rouhana's (2004) work is that winners in a conflict situation are unlikely to seek reconciliation. Mason (2004) also concedes the persistence of conflict by summarizing Stam's (1996) book on conflict by emphasizing that should one group involved in a conflict cease fighting, then that group risks "defeat through capitulation" (p. 177). The non-linear model suggests that this may be a result of the increased risk a winning individual or group experiences if ceasing conflict with a losing opponent.

Although case-study evidence indicates that winning competitors are unlikely to seek reconciliation, this generalization may fail in scenarios where there does not exist a significant power differential between the groups or individuals. Without a clear power advantage, a winning adversary runs the risk of losing for each moment that the conflict persists. Accordingly, with more closely matched opponents, there is greater incentive for ending a conflict. The arms race between the United States and the former Soviet Union exemplifies this incentive, as the Cold War deterrence strategy brought clear risk that a misconception could lead to tremendous consequence (Blumberg, 2006b). In response to the Cold War, Osgood developed the Graduated Reciprocated Initiatives for Tension reduction (GRIT) strategy, which operates by one competitor engaging in various conflict-reducing initiatives while communicating those initiatives to the adversary (Blumberg, 2006b). Per the GRIT strategy, the precise winner or loser in a conflict situation is less important than the fact that one-side begins the conflict de-escalation. Betz's (1991) experimental study of the GRIT strategy found it to be more successful at eliciting peace between adversaries than the tit-for-tat strategy, especially when GRIT was combined with open communication between competitors. The GRIT strategy success in reducing conflicts lends support to Liebovitch's et al. (2008) model results for mixed feedback scenarios. In these scenarios, the intensity of the conflict – as measured by the disparity between the two actor's states – is reduced over time and eventually settles into neutrality.

The predictions pertaining to switches in feedback offered by Liebovitch's et al. (2008) model also correspond well to expectations derived from Heider's (1958) balance theory. Given two interacting partners, Heider's (1958) theory asserts that the goal of both individuals is to have a balanced, predictable interaction. To achieve such balanced interaction, each of the individuals will respond to one another in a mutually congruent manner, such that cooperative and competitive behavior will be met in-kind. Accordingly, Heider's (1958) theory would ascribe stability to the constantly cooperative and constantly competitive interaction situations described earlier as these situations evoke balanced attitudes between the interacting individuals. In situations where one actor changes from cooperation to competition, or vice-versa, the balance is disrupted.

The previously anticipated exchange pattern ceases to exist. This change forces the individual who did not initiate the change in the interaction to adjust his or her attitudes. Until such adjustment takes place, the individual experiences a dissonant state.

Summary of Non-linear Model Predictions

The non-linear model Liebovitch et al. (2008) developed provides several predictions for what will occur in a two-actor interaction involving cooperation, competition, or some combination of the two. 1) If two individuals or groups are only weakly interacting, then their joint outcome will be neutral. 2) In cases where two individuals or groups cooperate at a comparably strong interaction level, then they will share either a mutual positive or a mutual negative outcome. 3) When two individuals or groups compete at a sufficiently strong but disproportionate interaction level, one of the actors will realize a positive outcome while the other experiences a negative outcome. 4) If one actor interacts with cooperation while the other interacts with competition, then each actor will oscillate between positive and negative outcomes before eventually converging on a single shared neutral state. 5) Because of the oscillations described previously, if only one actor changes from a competitive interaction to a cooperative interaction in a conflict, then that one change can cause the conflict to deescalate to neutrality. 6) Finally, if one actor changes from competition to cooperation in a conflict situation and follows this change with a return to a competitive interaction style, then the role of the winner and loser in a conflict can be reversed.

Empirically Testing the Non-linear Model's Predictions

According to Liebovitch et al. (2008), the model of two-actor cooperation-competition reveals the state of each individual involved in an interaction. In the model, the state is thought to represent the individual's emotions or attitudes and is dependent on the type of feedback present in the interaction (Liebovitch et al., 2008; 2010). Therefore, two variables were isolated for experimental testing of the model predictions, including attitude similarity and valence (positivity or negativity of emotional state). Attitude similarity was used to generate a sense of cooperative interaction, whereas attitude dissimilarity was used to form a sense of competitive interaction.

Attitude similarity and dissimilarity have important links that influence whether an interaction is perceived to be cooperative or competitive. At a basic level, conflict may be defined as an incompatibility of beliefs (Marcus, 2006). Belief incompatibility generates a sense of negative, competitive relations and may trigger a conflict (Bodtker & Jameson, 2001). In contrast, belief similarity generates perceived positive, cooperative relations (Heider, 1946; 1958). According to Deutsch (1973; 1994), attitude similarity promotes a sense of compatibility that leads to cooperation in conflict resolution. McNeel and Reid (1975) summarized several classic studies, concluding that perceived similarity between people enhances tendency towards cooperation. Conversely, competition increases perceived attitude dissimilarities, at least if the competition exists with out-group members (Holtz & Miller, 2001). Attitude dissimilarity can contribute to a sense of incompatibility, which is strongly implicated as a core factor in conflict (e.g. Boulding, 1962; Kolb & Putnam, 1992; Schmidt & Kochan, 1973). Finally, Maio and Haddock (2007) explain that attitudes have potent effects on social situations and are often considered a primary factor in social problems. Clearly attitudes are important factors in cooperation or competition. Therefore, examining changes in an individual's emotional state and attitude state by using perceived attitude similarity or difference seems an elegant way to initially examine the predictions offered by Liebovitch's et al. (2008) model. By evoking a sense of cooperation through similarity or competition through difference the different model scenarios may be tested (Figure 10).

From a qualitative examination of the different model phase space patterns (Figure 10), it is evident that all five cases where at least one actor responses with limited, neutral feedback are analogous. These five cases result in a rapid stabilization on a single fixed point at the origin, representative of the evolution to a neutral state. To maintain as elegant an experimental procedure as possible, the five cases involving at least one actor in a neutral feedback state can be collapsed into a single "control" condition. This leaves four non-control conditions for experimental investigation.

After establishing an interaction that evokes a sense of cooperation in the participant (*x*-axis), the confederate's feedback can either maintain a cooperative state (top right panel) or can switch to a competitive state (bottom right panel). These two scenarios are very different from one another. In a scenario where a participant experiences continual cooperative feedback, the model predicts participants' emotions and attitudes will exhibit fast stabilization. Comparatively, the spiral trajectories evident in the feedback switching case (bottom right panel) are indicative of attitude and emotion perturbation over time. Although these trajectories are mathematically stable – they do converge upon an attractor – they take a much longer duration to settle into the attractor state due to the spiraling. Qualitatively, this pattern may be thought of as cognitive and affective destabilization, where the participant experiences fluctuation in his or her attitudes and emotions over time.

Similarly, the two other non-control scenarios suggested by the model include a case where the interaction begins with competition then remains competitive (bottom left panel). In this case, the model predicts that the continual competition leads to fast stabilization of attitudes and emotions; the participant, in the face of conflict, becomes locked into a particular mental state. Comparatively, when the interaction begins with competition and is followed by the confederate becoming cooperative (top left panel), the phase space dynamic becomes governed by a spiral. While stable in the long run, the attitude and emotional pattern suggested by the spiral is one that is fluctuating in time and therefore may be psychologically experienced as a period of instability.

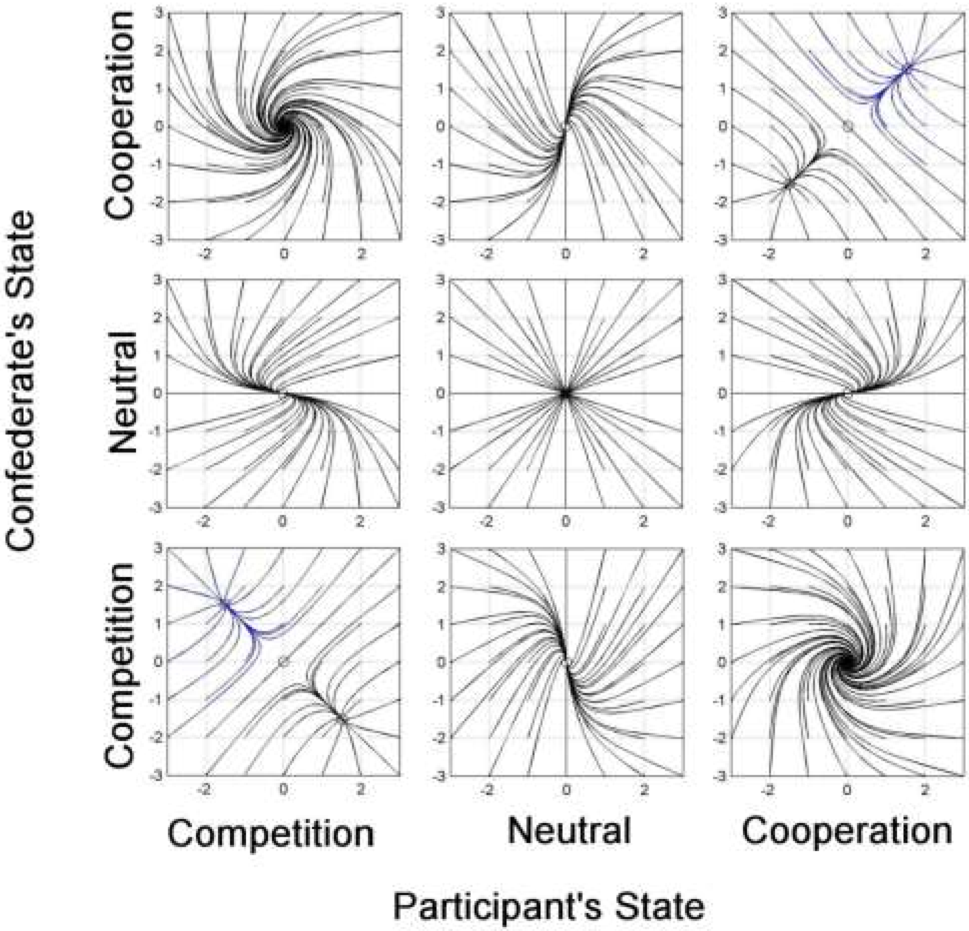

Figure 10: The possible interaction configurations according to the model.

Experimentally, five of the nine scenarios were tested as the cases involving at least one actor engaging in neutral feedback lead to qualitatively identical outcomes where both actors quickly evolve to a stable attitude and emotional state. The scenarios involving both actors engaged in cooperation (top right panel) or competition (bottom left panel) feedback lead to rapid attitude and emotion stabilization. In contrast, scenarios involving a mixed feedback (bottom right panel and top left panel) show presence of a spiral attractor. The spiraling trajectories indicate the evolution of attitude and emotional stability over time, but qualitatively suggest a short term lack of stability.

STUDY 1

The first study addressed whether the pattern of attitudinal similarity or difference with another individual would evoke changes in a person's attitudes and valence. To approximate the different cooperation-competition scenarios described in Liebovitch's et al. (2010) model, participants experienced one of five different attitude similarity or difference patterns during an interaction with another individual (who was a confederate). Two of these patterns maintained similarity or dissimilarity throughout the interaction. These are thought to be analogous to Liebovitch's et al. (2010) constant positive feedback (cooperation) and constant negative feedback (competition) states in the model. Two patterns of attitude similarity/dissimilarity transitioned midway through the interaction. One transition went from similarity to dissimilarity while the second pattern switched from dissimilarity to similarity. These interactions were considered analogous to the model's feedback switching cases, where an interaction shifts from negative feedback to positive feedback, or vice-versa, based on only one actor's feedback. The fifth condition was a control case.

Based on the model predictions, we expected that the greatest attitude and valence changes would be observed in participants who experienced a transition in the interaction, with feedback switching from similarity to dissimilarity or vice-versa. It was expected that little difference in attitude change or valence change would manifest in participants who encountered an exchange involving continual attitude similarity/dissimilarity. In these continual attitude similarity/dissimilarity cases, participants were not expected to differ from the control condition in terms of attitude or valence change.

Method

Participants

Ninety-four Florida Atlantic University undergraduate psychology students completed this study including 39 males and 57 females. Data from an additional 3 participants were not used because of experimenter error (2 participants) or because the participant did not follow instructions (1 participant). All participants received research participation credit in their introductory psychology class for completing this study.

Procedure

Each participant visited the laboratory on two separate days, with each visit approximately one week apart. During the first session, it was alleged that the participant was taking part in a study on group formation based on people's responses to survey items. The participant then completed a 40-item attitude survey (Appendix 1), which measured level of agreement or disagreement, importance, and certainty on 6-point Likert scales. The 6-point scale was chosen to avoid ambiguity in discerning whether a participant was more "for" or more "against" each of the 40 items (for reasons that will be apparent in the independent variable section). After completing this survey, the participant was instructed to return to the lab on a later date to finish the study. Typically there was at least a one week delay between the initial and final lab session.

For the second session, the participant was told that he or she would be completing another attitude survey, but this time with another participant (who was, in fact, a confederate) who had not yet arrived for the study. The experimenter brought the participant to one of the two lab rooms, which was the same that the participant was in for completing the first survey, and provided instructions. The participant was told that he or she would be communicating with another participant using Skype, an online voice-over-Internet protocol. The participant was provided a computer headset with an attached microphone. For the session, participants were told to take turns reading and listening to items on a printed survey containing 40 items identical to those included on the first survey (the items were in reverse order to avoid potential memory effects). The participant was instructed to read the first survey statement after hearing the ready signal over the headset. After reading the item, the participant was told to say "I agree" or "I disagree" to indicate his or her attitude about the statement. Then, the other participant (confederate) would respond in the same way to indicate his or her attitude. After hearing the other person's response, the participant was told to pause and fill-out the survey's 6-point Likert scales that measured agreement/disagreement, importance, and certainty. After this, the other participant (confederate) read the subsequent survey item and then would indicate his or her agreement or disagreement with the statement. After hearing how the other person replied to the statement, the participant was to say "I agree" or "I disagree" to indicate his or her attitude before filling out the Likert-scales corresponding to the item. Therefore, the participant would read aloud and be the initial responder to the 20 even-numbered (highlighted) survey items while the confederate would read aloud and be the first responder to the 20 odd-numbered survey items.

Once the participant indicated that he or she understood the instructions, the experimenter activated the Skype program, discretely turned on the video camera, left the room, and told the participant to wait to hear the ready signal before reading the first survey statement. There was a short pause (approximately 2-minutes) from the time that the experimenter left the participant to the start of the session. During this time, the experimenter went to a different room to let the confederate know to return to the lab for the study. Confederates hid at a location separate from the lab to avoid raising participant's suspicions. As a further control, the participant only heard the confederate's voice over the computer; no video signal was provided. This controlled for appearance and facial expression.

When the interaction session was complete, the experimenter returned to the room to instruct the participant on how to complete the final part of the study. For this last task, participants viewed a video recording of the session and completed a dynamical valence measure, as described in the dependent variables section. When done with the valence measure, the participant was debriefed, asked to not reveal the true purpose of the study to others, and was released.

Independent Variable

Prior to the second experimental session, experimenters used each participant's survey responses to prepare a script for a confederate. The script indicated how the confederate should respond to each survey item. Responses congruent to the participant's would yield an interaction involving attitude similarity, eliciting a sense of cooperation. Oppositional script responses involving attitude dissimilarity would create a sense of competition. Depending on the confederate's script, each participant experienced one of the five randomly assigned experimental conditions during the second lab session in this study: constantly cooperative (attitudes are similar), constantly competitive (attitudes are dissimilar), cooperative switching to competitive (attitudes are similar, switching to dissimilar), competitive switching to cooperative (attitudes are dissimilar, switching to similar), or control (no attitude exchange – participants and confederates only took turns reading the statements, no indication of agreement/disagreement was shared).

In the constantly cooperative condition, the confederate vocally responded to each survey item in a way congruent to the participant's indicated attitude. In the constantly competitive condition, the confederate vocally indicated an attitude that was the opposite of the participants (i.e., agreeing when the participant disagreed and vice-versa based solely on participants' responses to the initial attitude survey). There were two mixed cases. In one of these, the interaction started with the confederate cooperating. Halfway through the interaction session, though, the confederate switched style and began to compete. The confederate then maintained competition through the end of the session. The other mixed case involved the confederate initially competing and then, halfway through the experimental session, switching to a cooperative style that was then maintained until the conclusion. Finally, the last condition was a control where neither the participant nor the confederate vocally expressed their attitudes. In the control condition, the participant and confederate merely took turns reading the survey items. There were no exchanges of agreement or disagreement with the survey items.

It is important to note that in non-control conditions confederates always responded based on the scripts generated from the participant's initial attitude survey.

That is, in a case of cooperation (attitudes are similar) if a participant indicated agreement with a statement such as “Pepsi is better than Coke” on the first survey, the confederate responded with agreement on the second survey – even if the participant indicated disagreement with that same statement. The strict scripts used allowed greater control over the experiment (since confederates had to offer the initial response to half of the survey items). Furthermore, effects resulting from random attitude changes could be identified by comparing the experimental conditions with the control condition, where significant differences in the number of changes would likely indicate cognitive changes based on the interaction experience.

Dependent Variables

There were two dependent variables measured in this study. Participants’ attitudes were measured using two surveys. Participants’ retrospective valence was dynamically measured using a specialized computer program in conjunction with video playback of the interaction session.

Participants were video recorded during the interaction using a Panasonic PV-DV950 recorder mounted on an Orion Paragon-HD tripod located approximately 3-feet to the left and front of the participant. Upon completing the interaction session, an experimenter returned to the lab room, rewound the video recording, and prepared a computer program that would track mouse cursor movements. This program tracked participants’ moment-to-moment valence by recording the mouse cursor movements at 10-msec intervals and was similar to the mouse tracking programs successfully used by Vallacher and Nowak (1994, 1997) to dynamically study social evaluations. The background on the computer monitor displayed black screen with seven white vertical lines (Figure 11). The middle line was solid while the remaining lines were dashed.

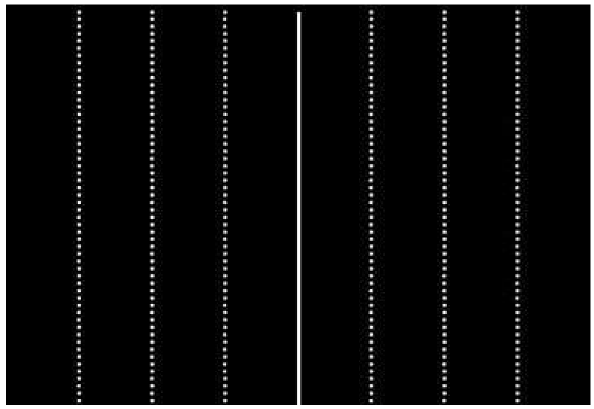

Figure 11: Computer screen used with the mouse cursor tracking program.

The experimenter explained that each participant would view a video recording of himself or herself during the interaction session. While viewing the video, the participant was told to keep his or her hand on the computer mouse cursor and to move it according to how he or she felt while viewing the video. Each participant was told to move the cursor towards the right side of the screen when feeling “most positive, most content, and most comfortable.” When feeling “negative, upset, or uncomfortable,” the participant was told to move the cursor towards the left side of the screen. It was explained that there was no right or wrong way to move the cursor, but that the participant should keep his or her hand on the mouse cursor during all times of the session. When done with the experiment, the mouse cursor data were saved in a raw text file format for later analysis.

Results

Attitude Survey

This experiment used a between subjects design with five factors (interaction condition). Raw data from participants' attitude surveys were initially used for creation of several summary measures. Since participants' attitudes about individual survey items were not the focus of this study, analysis addressed how participants' changed their attitudes between the first survey, which provided a baseline comparison for each individual, and the second survey, which was completed during experimental manipulation. Overall attitude change was assessed by computing the absolute difference between Likert-scale responses of comparable items from survey one to survey two for each participant. Absolute difference was used as summing the raw difference between items could cause real changes to be severely under recorded because items having comparable magnitudes of attitude change but different signs would cancel when summed (e.g. from "1" disagree to 6 "agree", the change here is +5; and "5" to "1" equates to a change of -1. Summing these +5 – 5 = 0). Finally, to collapse this data into a single measure of attitude change between the two halves of the survey, the attitude change for the last 20 items of survey two was subtracted from the first 20 items of survey two.

It is helpful to illustrate this computation. For instance, suppose a participant's responses to an 8 item attitude survey using a 1 to 6 Likert scale was: $x = \{3, 3, 4, 5, 1, 5, 5, 1\}$. Suppose then the participant's responses to a second attitude survey, with identical items, was: $y = \{3, 2, 4, 3, 1, 5, 2, 3\}$. First, the absolute change in response from the first to the second survey is computed. Whether participants agreed or disagreed is not of interest here – only the amount of attitude fluctuation or change is critical. The paired item changes are computed:

$$\{|x - y|\} = \{|3 - 3|, |3 - 2|, |4 - 4|, |5 - 3|, |1 - 1|, |5 - 5|, |5 - 2|, |1 - 3|\}$$

Which provides:

$$\{|x - y|\} = \{0, 1, 0, 2, 0, 0, 3, 2\}$$

Next the sum of the first half (first four change scores) and the second half (last four change scores) is computed:

$$\{0 + 1 + 0 + 2, 0 + 0 + 3 + 2\} = \{3, 5\}$$

Finally, the difference in the two sums is taken to provide a sense of whether the participant's attitudes exhibited greater change or lesser change during the latter portion of the experiment:

Sum Change of Time 1 = 3, Sum Change of Time 2 = 5, 5 – 3 = 2

In this computation, positive values indicate a greater amount of attitude change during the latter half of the interaction whereas negative values indicate less attitude change. This computation did not use absolute value, as the direction of the change (whether more change occurred for the first 20 items or the last 20 items) was important for the analysis. Data from 2 participants was omitted because of incomplete surveys. Descriptive statistics are provided in Table 1.

Male				Female				Total			
Group	Mean	SD	N	Group	Mean	SD	N	Group	Mean	SD	N
Control	-4.3750	9.81162	8	Control	-8.3000	15.3046	10	Control	-6.5556	12.9488	18
Coop	-4.3750	11.01865	8	Coop	-2.6667	7.66485	9	Coop	-3.4706	9.12495	17
Comp	-6.4286	6.87646	7	Comp	-3.2727	8.10051	11	Comp	-4.5000	7.60224	18
Coop → Comp	1.3333	5.35413	6	Coop → Comp	6.7812	11.3621	16	Coop → Comp	5.2955	10.2570	22
Comp → Coop	-7.4286	10.51756	7	Comp → Coop	-2.0000	13.2582	10	Comp → Coop	-4.2353	12.1631	17
Total	-4.4167	9.11004	36	Total	-.9732	12.3186	56	Total	-2.3207	11.2468	92

Table 1: Attitude change descriptive statistics for Study 1. The means given are the mean differences of participants' attitude change. Positive values indicate participants exhibited greater attitude change and fluctuation as the experiment progressed. Negative values indicate participants' attitudes became more stable with less change as the experiment progressed.

Total attitude change between the first and second survey was analyzed using an ANOVA with type of experimental interaction and gender being between subjects factors. The type of interaction participants had with the confederate during the experimental session was significant; $F(4,82) = 2.580$, $p = 0.043$, with an effect size of partial $\eta^2 = .112$ and retrospective power = .703. Multiple pairwise comparisons were performed using Tukey's HSD to discern which of the five interaction groups accounted for the significance. The cooperative to competitive interaction was significantly different from the control ($M = 11.851$, $p = .007$), the constant competitive interaction ($M = 9.7955$, $p = .039$), and was marginally significantly different from the competitive to cooperative interaction ($M = 9.5307$, $p = .054$). A plot of the means for the total attitude change for each experimental interaction factor and for men and women is shown in Figure 12; a plot with standard error of means is given in Figure 13.

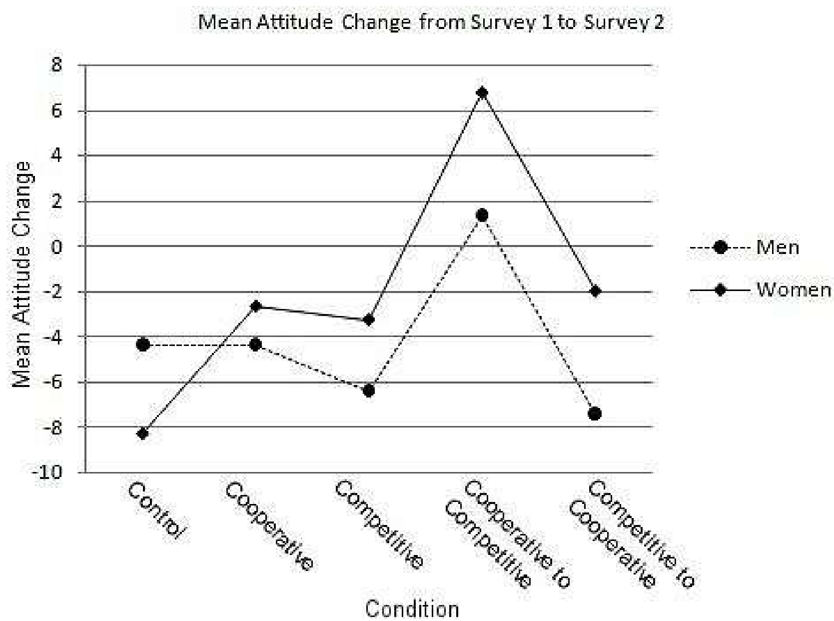

Figure 12: Mean total attitude change ("change of the changes") for each experimental condition compared between genders.

The total attitude change differences in the other experimental interaction conditions were not significant. The effect of gender was not significant; $F(4,82) = 1.407$, p = .309. The interaction between experimental interaction type and gender also was not significant; $F(4,82) = .570)$, $p = .685$. Homogeneity of variance of the total attitude change variable was tested using Levene's test (*n.s.*) and the assumption of equal variance was not rejected. The normality assumption was also not rejected when considering residual plots. To verify the robustness of these results, a second ANOVA was performed with consideration of when the experiment was completed as a factor. During the study, participants completed the experiment during one of two blocks, one running from September through mid-October and the second running from mid-October until late November. The between subjects effects showed that when the experiment occurred was not a significant factor; $F(4,92) = .006$, $p = .939$. Likewise, all of the experimental block interaction effects failed to reach significance. Therefore, the results from the September-October experiment sessions were replicated by the results from the October-November experiment sessions.

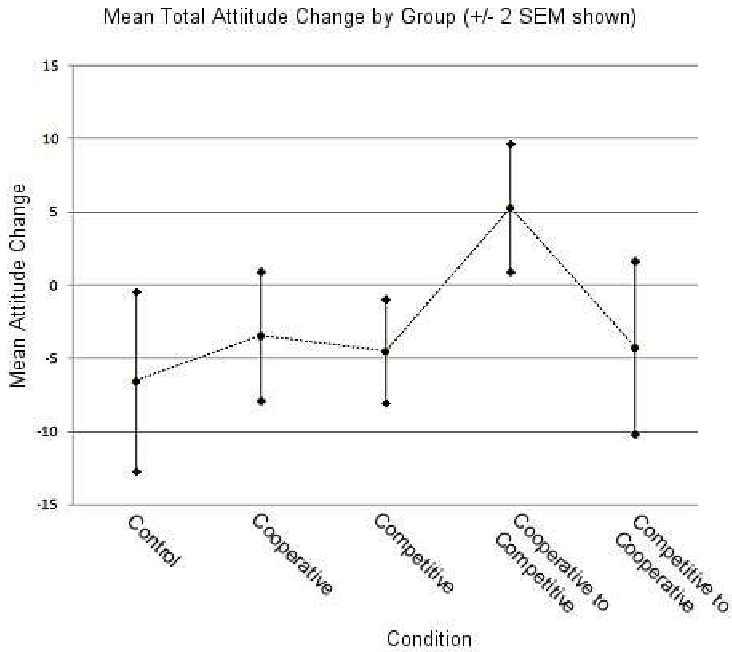

Figure 13: Mean total attitude change ("change of the changes") for each experimental interaction condition with +/- 2 SEM indicated.

From these results, participants who experienced the experimental condition where the confederate switched from a cooperative feedback style involving similar attitudes to a competitive style with dissimilar attitudes exhibited greater attitude change during the second half of the interaction than did participants in the control, continually competitive, or competitive to cooperative feedback switch cases. Although failing to reach statistical significance, the means plots reveal that participants in the cooperative, attitudes similar, to competitive, attitudes dissimilar, feedback condition also had greater attitude change than either the constantly cooperative condition. Decreasing amount of attitude change over the course of the experiment implies attitude stability over time.

From this interpretation, it is apparent that only the participants in the cooperative to competitive condition became less stable since the mean amount of attitude change in this group increased from the first half of the session to the second half of the session. This finding offers some support for the non-linear model's prediction that an interaction where one actor changes feedback style will destabilize the interaction outcome.

Valence Measure Analysis

A measure similar to the total attitude change was used for assessing participants' mouse cursor movements reflecting each individual's retrospective valence. Adapted from a computation proposed by Vallacher, Nowak, Froehlich, and Rockoff (2002), this measure is calculated by transforming participant's cursor positions, where positions to the right of the starting point (positive valence region) of the computer monitor are assigned a value of "1" and cursor positions within the left half (negative valence region) of the computer monitor are assigned a value of "-1". This data transformation is useful to eliminate problems in data structure, including non-stationary and heteroscedasticity, which make comparing participant's data using standard parametric procedures difficult. While the transform eliminates the magnitude of participant's cursor movements from analysis, it retains the valence expressed according to the cursor's position on the computer monitor (see Figure 14).

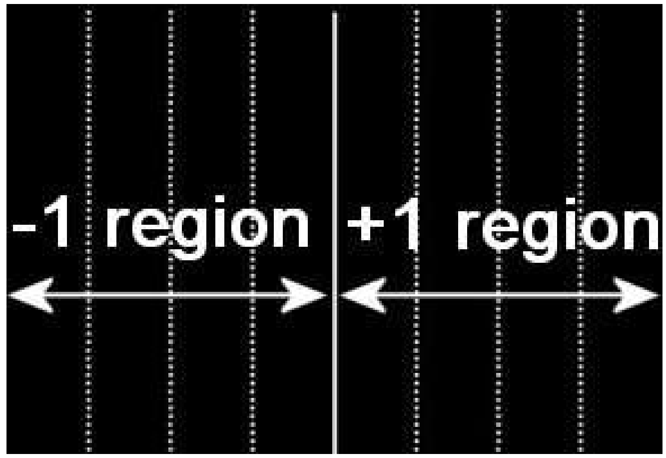

Figure 14: Illustration of the binary transform used to summarize the valence data. Whenever the cursor was located within the right half of the computer monitor, the position was coded “+1”. The cursor pixel location was not utilized. Whenever the cursor was situated within the left half of the computer monitor, the position was coded “-1”. Summing these recoded cursor positions would allow a summary of whether a participant tended to maintain the cursor more within the positive (right) domain or negative (left) domain during the experiment.

Valence is expressed in this transformation as it identifies individuals’ net cursor position. If participants tend to position the cursor predominantly in the negative valence region (left screen area), the cursor positions will sum to a negative number, whereas positions predominantly within the positive valence region (right screen area) will sum to a positive number. By taking the difference between the total (summed) binary transform cursor positions for the first half of the session and subtracting that sum from the second half of the session, the overall change in how a participant positioned the cursor during the second half of the session could be identified.

Mouse cursor position data were unavailable for 5 participants due to computer malfunction or file corruption. A single additional data file was unable to be analyzed due to experimenter coding error with the participant identification number. These omissions yielded a sample size of 88 (34 males, 54 females) for the valence measure analysis. Descriptive statistics for the mouse cursor position binary test data are given in Table 2.

The difference in cursor positions between the two halves of the session were analyzed using an ANOVA with two fixed factors (experimental group and gender). Results indicate that the interaction group was significant, $F(4,84) = 3.104$, $p = .020$ (effect size of partial $\eta^2 = .137$, retrospective power = .790), while gender was not significant, $F(1,87) = .350$, $p = .556$. The interaction between group and gender was likewise not significant; $F(4,81) = .462$, $p = .764$. Levene's test and residual plots provided no reason to reject the homogeneity or normality assumptions. Multiple pairwise comparisons were performed using Tukey's HSD, which revealed that the cooperative to competitive interaction condition was the source of significance. The means of the cursor positions in the cooperative to competitive interaction condition were significantly different than the control condition ($M = -1337.8601$, $p = .013$) and were significantly different than the competitive to cooperative interaction group ($M = -1347.2698$, $p = .009$). A plot of the difference in cursor positions between groups and gender is provided in Figure 15, while a plot of the difference in cursor positions with standard error of means indicated is given in Figure 16.

Male				Female				Total			
Group	Mean	SD	N	Group	Mean	SD	N	Group	Mean	SD	N
Control	379.4	710.0	7	Control	844.1	790.5	9	Control	640.8	769.2	16
Coop	19.9	1319.9	8	Coop	368.9	770.0	9	Coop	204.6	1044.5	17
Comp	402.8	2144.2	5	Comp	-18.5	1302.1	11	Comp	113.2	1548.3	16
Coop → Comp	-593.8	1395.0	6	Coop → Comp	-738.3	1652.0	15	Coop → Comp	-697.0	1549.6	21
Comp → Coop	339.9	890.8	8	Comp → Coop	898.5	603.7	10	Comp → Coop	650.2	775.5	18
Total	117.2	1270.8	34	Total	159.7	1308.2	54	Total	143.3	1286.7	88

Table 2: Valence change descriptive statistics for Study 1. Values greater than zero indicate participants moved the cursor more frequently within the positive valence domain than the negative as the experiment progressed. Values below zero reflect that participants tended to move the cursor more within the negative valence domain as the experiment progressed.

The results from the valence measure match the results of participants' attitude change in terms of which group presented significant difference. The participants who experienced a feedback style transitioning from attitude similarity to dissimilarity (evoking a sense of cooperation switching to competition) reacted with mouse cursor positions that differed significantly from the mouse cursor positions of either the control group or the competitive to cooperative feedback group. The condition where participants encountered the cooperative to competitive switch placed the mouse cursor more often within the left region of the computer screen during the second half of the interaction session than did the participants in the control or competitive to cooperative feedback switch case. Per the instructions given to participants, the left side of the computer screen represented more negative, uncomfortable feelings. Therefore, the participants in the cooperative to competitive feedback scenario self-reported more negative valence than did participants in the control or competitive to cooperative scenario. Participants who experienced an interaction with a person who expressed similar attitudes only to switch to expressing dissimilar attitudes seem to have responded to the transition by feeling more negative following the switch.

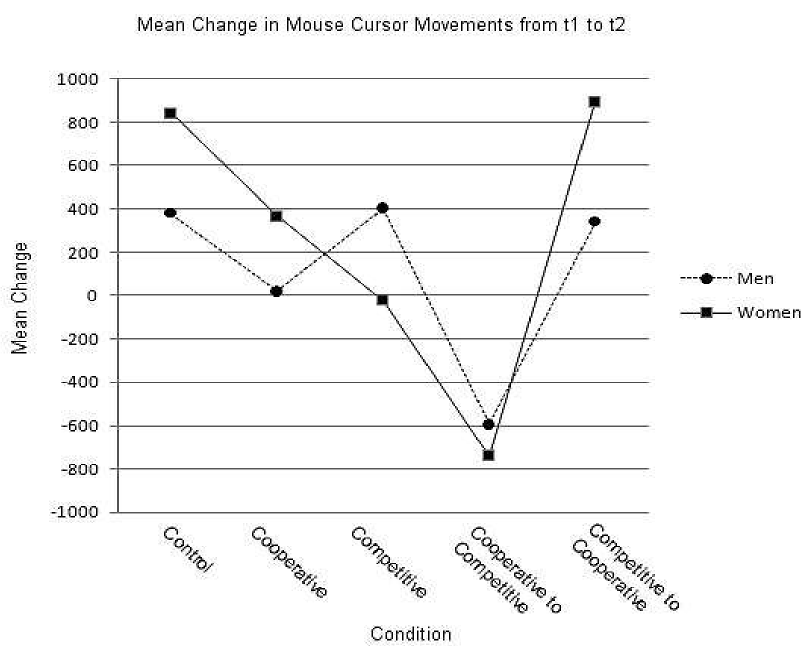

Figure 15: Mean change in mouse cursor positions (from the binary test) between the first and second half of the interaction session graphed by gender and by experimental condition.

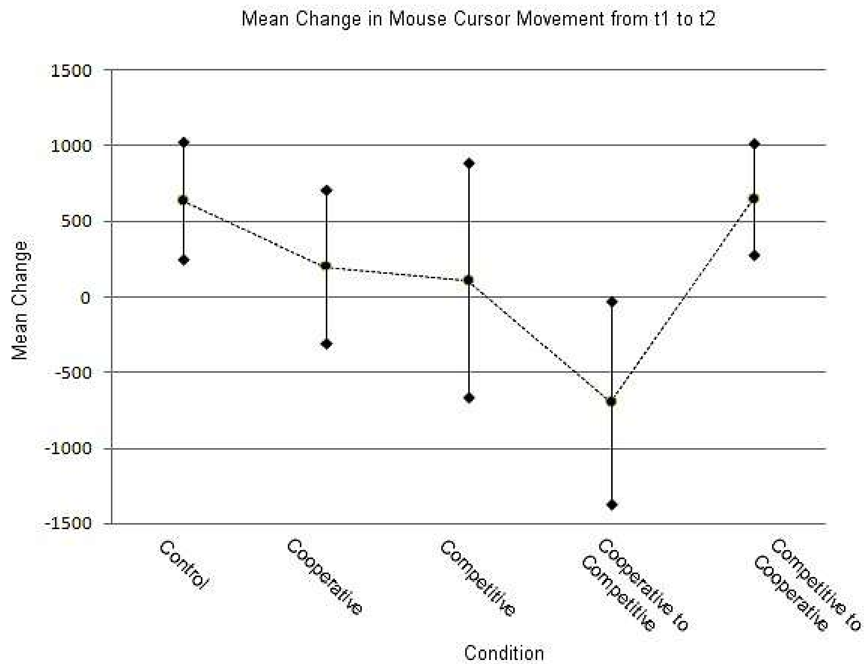

Figure 16: Mean change in mouse cursor positions (from the binary test) between the first and second half of the interaction session graphed experimental condition with +/- 2 standard error of mean shown.

Standardized Valence Measure Analysis

One limitation with the valence change measure is that it consists of a set of time series for individual participants such that each time series is of a different length. It is possible that there exists difference in the length of participants' time series measures of valence that contribute to the significant differences found in the previous analysis. In response to this possibility, a second ANOVA analysis was performed on the standardized binary transformed mouse paradigm data. The standardization was accomplished by dividing each participant' computed binary change in mouse cursor position by the length of his or her valence data time series. This standardizes the scores as a percentile, where the data represents the percentage of total time that each participant positioned the mouse cursor within the positive domain versus the negative domain of the computer monitor.

Preliminary inspection of the transformed data revealed heterogeneous variance with Levene's test (p = 0.013). Therefore, the assumption of equal variance necessary for ANOVA analysis was violated with the full data set. A box plot (Figure 17) revealed several outliers in various conditions. These outliers were assessed in detail and those that fell beyond two standard deviations of each condition's mean standardized valence change score were removed from the data set. Two participants' data were removed, and this restored homogeneous variance (Levene's test p = 0.135).

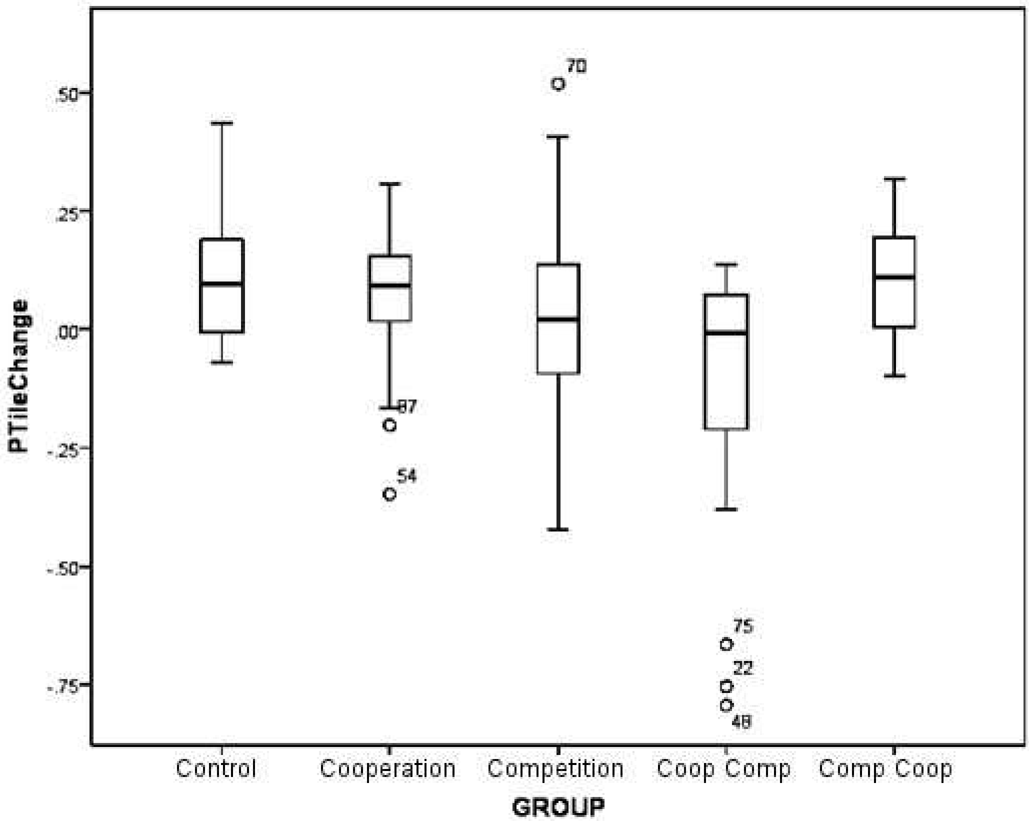

Figure 17: Boxplot for the standardized valence change measure across experimental groups showing the presence of outliers.

A one-way analysis of variance performed on the standardized valence change data with outliers removed revealed a significant difference in the valence change across interaction conditions, $F(4, 81) = 2.699$, $p = 0.036$ (effect size of partial $\eta^2 = .118$, retrospective power = .725). Multiple pairwise comparisons with Tukey's HSD indicated that significant differences existed between the cooperative switching to competition group versus the control ($p = .047$), with marginal significance versus the competition switching to cooperative group ($p = .057$). These results match what was found using the non-standardized valence change scores. Further consideration of the raw valence change scores versus the standardized valence change scores using scatterplots (Figure 18 and Figure 19) reveal that the length of participants' time series do not appear to significantly contribute to the data results nor the data variance structure. Similar data spread is observed in the raw scores (Figure 18) versus the standardized scores (Figure 19), suggesting that the scores may not need to be standardized. Interestingly, the score standardization increased the presence of data outliers and introduced problems with homogeneous variance. Overall, these findings suggest that it is permissible to analyze the valence data without standardizing the scores.

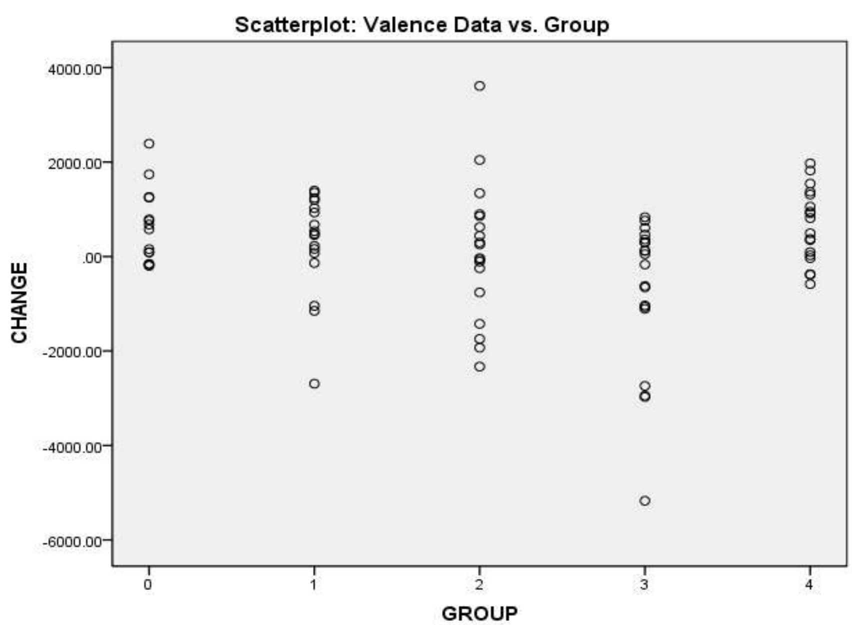

Figure 18: Raw valence change data scatterplot showing participants' individual valence change scores by experimental group. Group 1 = Control, 2 = Cooperation (constant), 3 = Competition (constant), 4 = Cooperation to Competition, and 5 = Competition to Cooperation.

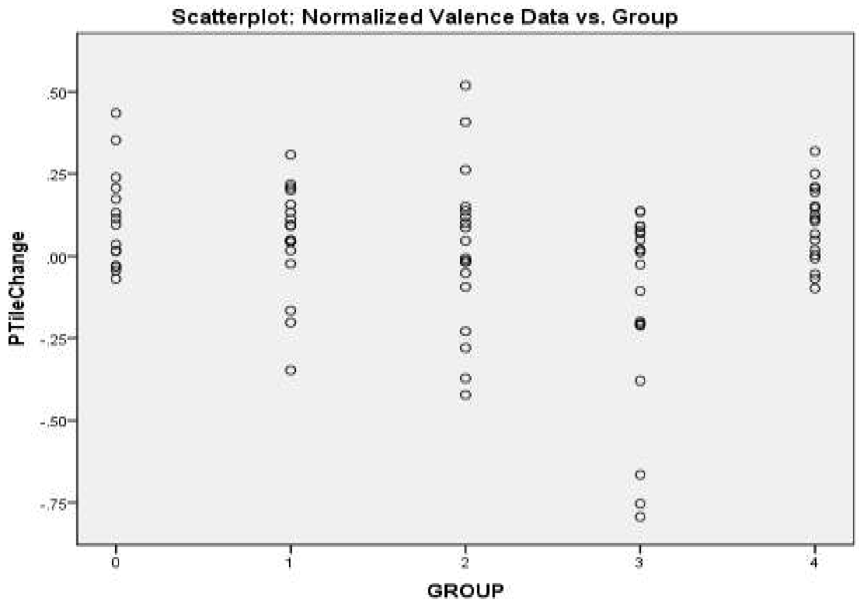

Figure 19: Standardized valence change data scatterplot showing participants' individual valence change scores by experimental group. Group 1 = Control, 2 = Cooperation (constant), 3 = Competition (constant), 4 = Cooperation to Competition, and 5 = Competition to Cooperation.

Correlation between Attitude Change and Valence Change

With attitude change and valence change both having significance, it is pertinent to consider whether these two factors are related. Results from a Pearson correlation were significant, $r = -.247$, $p = .024$, indicating that that attitude change and valence are weakly correlated. The direction of this correlation shows that greater change in attitude is correlated with more negative valence.

Variance in Attitude Change

Simulations using the non-linear model proposed by Liebovitch et al. (2010) portray oscillations in attitude and valence manifesting when an interaction where both actors share a congruent feedback style (i.e., either both cooperating or both competing) changes following only one actor switching to an incongruent feedback style. The model predicted oscillations may be reflected by greater variance in measured attitude and valence following a switch in feedback type. Participants who encountered either the control condition or a constant feedback type should have no significant difference in the variance of their attitude changes or valence between the first and second half of the interaction. Comparatively, participants who experienced the feedback style switch should present greater variance during the second half of the session, following the switch, than during the first half of the session.

To discern whether the variance in participants' attitudes was significantly different between the two experiment intervals (t_1, t_2) and between both groups and genders, the standard deviation of each participant's intra-item attitude change was computed for t_1 (note that t_1 = survey two items 1 - 20; t_2 = survey two items 21 - 40). These standard deviations were compared using a MANOVA comparing group, gender, t_1 attitude change SDs, and t_2 attitude change SDs. Box's test was insignificant ($p = .352$), indicating that the assumption of equal covariance matrices was justified. Results from Levene's test gave no reason to reject the assumption of homogeneous variances. Experimental group was significant, while gender and the interaction were not. Wilk's lambda statistics were $F(4,162) = 2.564$, $p = .012$ for experimental group (partial η^2 = .112, retrospective power = .908), $F(2,81) = .952$, $p = .390$ for gender, and $F(4,166)$ =

1.259, p = .269 for the interaction. The Pillai, Hotelling, and Roy statistics probabilities were all nearly identical to the Wilk's lambda statistics. Using Tukey's HSD to investigate multiple pairwise comparisons revealed that the main effects were caused by significant differences between a few of the experimental groups during only the second time interval (constant competition versus control, M = .360, p = .023 and cooperative to competitive versus control, M = .347, p = .031). A graph depicting the mean inter item standard deviations for each group during the second half of the interaction session is given in Figure 20.

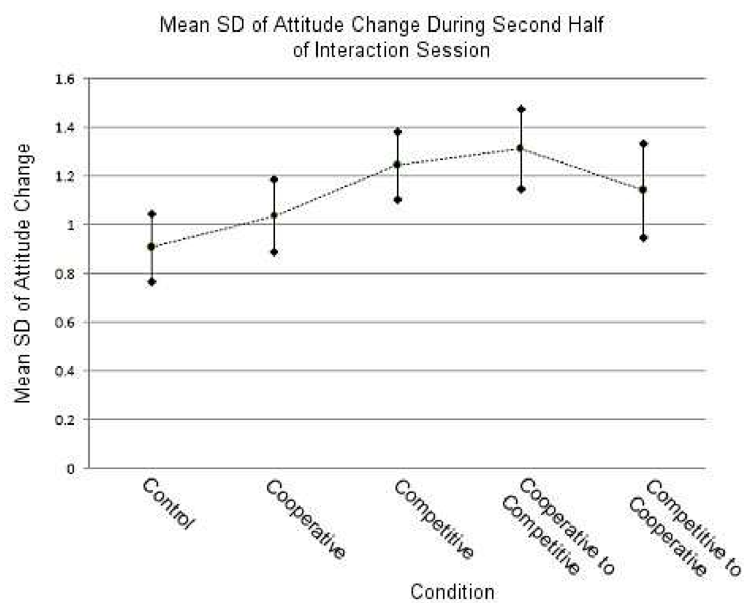

Figure 20: Means of the standard deviation of attitude change during the second half of the interaction session by group (+/- 2 SEM shown).

These results indicate that participants in the continually competitive and cooperative to competitive conditions had more variance in their attitudes between the first (pre manipulation) survey and the second survey. However, this variance was significant only for the second half of the interaction session. While the differences in attitude variance between groups are subtle, from the means plot (Figure 19), these results imply that people who experience an interaction that is competitive or an interaction transitioning from cooperation to competition are more prone to fluctuate their attitudes than are people who do not experience an interaction change. While not reaching statistical significance compared to any group but the control, the mean standard deviation of attitude change was highest for participants experiencing the cooperative to competitive switch condition. This observation lends support to the non-linear model's prediction of oscillatory fluctuations arising in cognition or affect when one of two actors engaged in an interaction transitions from a congruent feedback style to one that is incongruent.

Valence Measure Autocorrelation

Since the valence data were generated using a near continuous dynamical measuring system, this data could be analyzed using autocorrelation. Generally considered, autocorrelation works by taking the original set of data, shifting a piece of the data by an arbitrary amount of time (called the lag) and then determining the correlation between the original and shifted data. Thus, autocorrelation is effectively the correlation of some set of data with itself on different lags.

As an illustration of how the process works, suppose that we have a set of 10 pieces of data at 10 different points in time. We will call each of these time points as t_1, t_2, ... t_{10}. The first lag, then, will take the original data (t_1, t_2, ... t_{10}) and will remove the last piece of data. Thus the new data goes from t_1 to t_9. The data at t_{10} is removed. Next, a second set of data is formed by removing only the first piece of data. This second set includes data at the time points t_2, t_3, ... t_{10}. These two data sets, each consisting of nine data points now, are compared using the equation:

$$r = \frac{\sum_{t=1}^{N-k}(x_t - \bar{x})(x_{t+k} - \bar{x})}{\sum_{t=1}^{N-1}(x_t - \bar{x})^2} \tag{8}$$

Autocorrelation can inform whether or not a time series' data pattern was generated by a random process, especially when the individually computed correlations are plotted in a bar-like graph called a correlogram. The correlogram is a plot of the autocorrelation r -values over each successive time lag. In addition to the bars that represent the individual autocorrelations, the correlogram also shows +/- 2 standard deviations (SDs). These +/- 2 SDs are important as they help with discerning at which lags the autocorrelations are significant. Any autocorrelation that stretches beyond these dashed lines is significant. The presence of significant autocorrelations indicates that a given data set is significantly different from a random process. The one note to this, though, is that at the commonly used $\alpha = .05$ confidence level, about 1 in 20 autocorrelations are still expected to reach significance. Thus, the presence of one or two significant autocorrelations does not guarantee that the data is non-random. The pattern of the autocorrelations in the correlogram can help decipher a random from a non-random process. Random processes will usually generate autocorrelations that show variability within an autocorrelation value range restricted close to zero. Processes that are really non-random will often have lags whose autocorrelations are substantially different than zero.

To analyze each data set's autocorrelation lags, the first 50 autocorrelation lags where computed using MATLAB. Results from the initial analysis showed that most participants' valence time series exhibited significant lags for all 50 autocorrelations (Figure 22). While this finding suggests that participants' valence data exhibits a long memory, it also suggests that the data may be associated with a nonstationary process (Cryer & Chan, 2008). To assess for stationarity, the first difference of the time series data was computed, yielding the data set's first derivative, and this differenced data was used for a new autocorrelation analysis. The autocorrelation results from these differenced data typically presented rapid decay in the number of significant lags for each participant's valence data (Figure 23). This indicates that participants mouse cursor positions – indicative of expressed valence – operate according to longer time scales than the cursor movements, which are more instantaneous and are operating on short time scales. Since the number of significant autocorrelations where excessive, the number of significant lags found by the first difference of the original data was used to identify whether the number of significant lags could differentiate between experimental conditions.

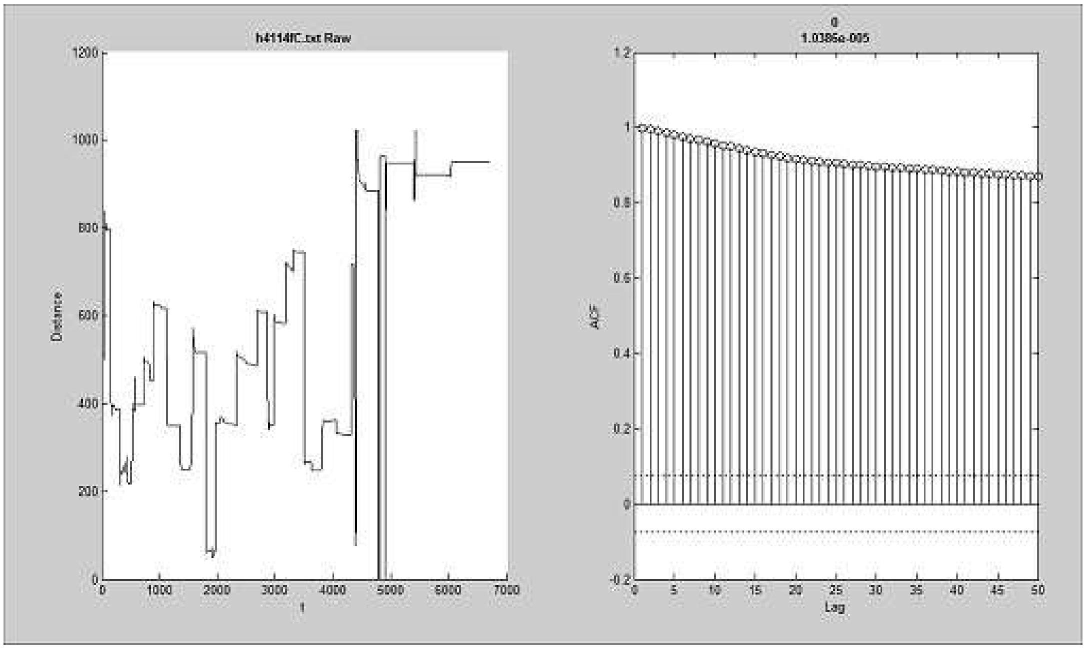

Figure 22: Time series plot (left panel) and 50 autocorrelation lags (right panel), all of which are significant.

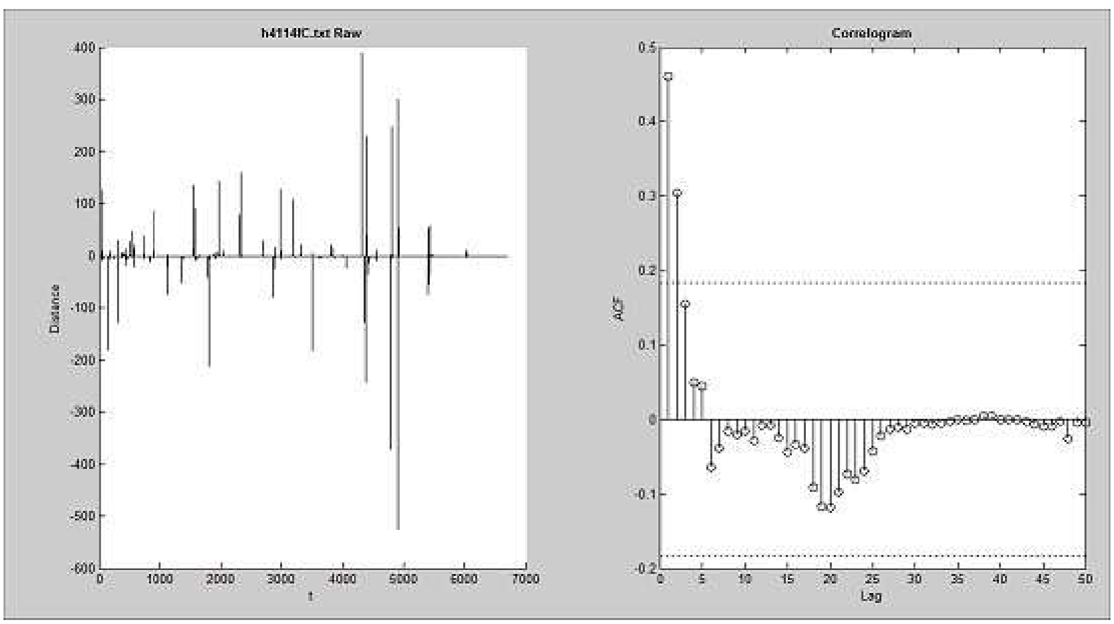

Figure 23: The first difference of the time series (left panel) and 50 lags of this differenced data (right panel) showing a rapid decay in the number of significant lags.

It was anticipated that there would be fewer significant lags for participants experiencing a switch in the confederate's feedback style because such a switch would create an inconsistency in the interaction pattern prompting participants to react. This inconsistency would disrupt the naturally developing relationship in each participant's valence time series resulting in autocorrelation analysis finding less relationship between the data points over a long period. ANOVAs were performed to test for differences in the number of significant lags between groups, genders, or the two combined, but no significant differences were found. A second analysis was then performed to identify whether there was a significant difference in the change in the number of significant lags within each participants' data from the first half to the second half of the interaction session. Testing for significance with such a change could reveal whether the data changed time scales between the two halves of the interaction session, with the expectation being that the feedback switch experienced by participants in the cooperative to competitive and in the competitive to cooperative conditions could contribute to such a change.

A one-way ANOVA with two fixed factors (experimental group and gender) was used to analyze the change in the number of significant autocorrelation lags from the first to the second half of the interaction session. Results showed that while there was no significant difference between experimental conditions, $F(4, 84) = .113$, $p = .978$, there was a significant difference between men and women, $F(4, 84) = 12.293$, $p = .027$ (effect size of partial $\eta^2 = .061$, retrospective power = .605). There was no basis for rejecting the homogeneity or normality assumptions per Levene's test and residual plots. Male participants, on average, generated valence measure data with more significant lags ($M =$

.447) during the second half of the interaction session than female participants, who generated fewer significant lags (*M* = -.335). These results suggest that the dynamical valence measure exhibits an increase in time scale for men and a decrease in time scale for women. For this study, these findings indicate that valence effects have a longer influence over men than women, though the less than one autocorrelation lag difference is admittedly negligible.

Valence Measure Fractal Analysis

The rapid decay in the differenced valence data autocorrelation lags suggests that the data may operate according to a complex chaotic process (Cambel, 1993). This possibility was assessed by computing the fractal dimension of each participant's valence data using a box counting algorithm that Liebovitch (unpublished) implemented in MATLAB. The program could not successfully compute the fractal dimension for one participant's data, likely because there were too few points in the data set. Participants' valence data exhibited fractal properties with dimension ranging from .926 to 1.83 (*M = 1.325, SD* = .165). In addition to the box counting algorithm, the Hurst exponent was computed for each valence data set using a separate MATLAB program developed by Liebovitch (unpublished). The Hurst exponent reveals whether time series data exhibits persistence (Hurst exponent > 0.5) or anti-persistence (Hurst exponent < 0.5). Data persistence is the tendency for a time series data set to exhibit a monotonic pattern. That is, each successive data value is either greater than or smaller than the previous value. Anti-persistence is the tendency for time series data to fluctuate, where one successive value is larger than the previous data point and the next value is then smaller than the prior. Accordingly, data that demonstrates persistence will show a constantly increasing or decreasing trend whereas data that demonstrates anti-persistence will tend to exhibit some form of oscillation. The computed Hurst exponents ranged from .468 to .841 (*M* = .660, *SD* = .074), showing that most participants' data demonstrated persistence over time. Taken together, these results combined with the autocorrelation results show that the valence measure data were not generated by random mouse cursor movements, but are fractal patterns. The reality of the mouse cursor movements as distinct from random motion is further verified by the autocorrelation lags structure. The first difference autocorrelation lags of a random process will decay to near zero with few, if any, of those lags reaching statistical significance, and this pattern was not found with data in this study.

The fractal dimension can be useful for classification purposes (Liebovitch, 1998). In this study, it was anticipated that there might be a difference in the fractal dimension exhibited by people experiencing a cooperative interaction and those experiencing a competitive interaction. Furthermore, it was thought that such a difference might show-up in the cases where participants experienced a switch in interaction feedback style. This possibility was assessed by splitting each participant's mouse cursor movement data file into two separate files, each representing half of the interaction session. The Hurst exponent and box count dimension were computed for each of these new data sets with the intent of comparing how participant's fractal dimension changed from the first to the second half of the experiment. Unfortunately, the resultant files contained too few data points for successful Hurst exponent computation. Therefore, only the box count dimension was computed. Even then, data from 17 participants contained too few data points for successfully finding the box count dimension. For the remaining 72 participants, the change in box count dimension from the first to the second half of the experiment was found by an ANOVA to be non-significant between either different groups or between men and women.

Phase Space Analysis

To assess for data patterns, the valence measure time series was converted into a phase space set by plotting the mouse cursor position versus the change in position, which corresponds to plotting the position against its first derivative. Constructing the phase space requires consideration of proper time scaling (Liebovitch, 1998). The proper time scale was determined by using the number of significant autocorrelation lags in the first difference of each time series. The number of significant lags, *n*, were used to form a new time series from each data set that included only each *n*th data point of the original series.

For quantitatively comparing participants' valence data phase space, the convex hull area was computed for each data set. The convex hull is the convex geometric shape with the smallest area needed to fully enclose all points of any given set (see Gruber, 2007; Webster, 1994). Convex hull was computed in MATLAB using an algorithm developed by Barber, Dobkin, and Huhdanpaa (1996).

Participants' unique individual patterns of mouse cursor movement make comparing raw convex hull areas difficult, but discerning how each participant's convex hull area changed during the experiment and then comparing this across participants as normalized by converting it to percentile-form could reveal whether certain groups of participants were more prone to transition from a more expansive phase space to a more restricted phase space (or vice versa). Dynamically considered, a restriction in phase space may suggest development of a fixed point attractor, as over time the given trajectories (mouse cursor movements) spread across a smaller region, potentially approaching an asymptotic limit suggestive of a dissipative process (Nowak & Lewenstein, 1994). The precise method to investigate this possibility involved separating each participant's time series valence data into two sets, computing the number of significant autocorrelation lags from the first difference of the original data, using the lag information to choose the proper time scale for data point sampling, and then using the time scale corrected data set to generate the phase space. The convex hull and its area were finally computed for each phase space. This was done for both halves of each participant's valence data, allowing the convex hull area from the first half of the interaction session to be compared with the convex hull area from the second half of the interaction session. This comparison was carried out by subtracting the convex hull area of the second half of the session from the convex hull area of the first half, noting that such would indicate whether a phase space contraction occurred (i.e., the value from this subtraction would be negative if the phase space contracted). Lastly, to factor out the unique scale each participant generated for himself or herself while moving the mouse cursor and allow the individual data to be more readily compared, a percentile transformation was used that involved dividing the convex hull area change by the sum of the convex hull areas computed for the first and second halves of the session.

Separate one-way ANOVAs were used to test whether there existed significant differences in the change of convex hull areas between the different experimental conditions and between men and women. Neither the actual convex hull change nor the percentile change reached significance.

Relation between Autocorrelation Lags and Phase Space

Final data analysis involved investigating the relationship between the number of autocorrelation lags, the change in the number of significant autocorrelation lags, the convex hull area of phase space, and the fractal dimension as obtained through Hurst exponent and box count dimension computation. Using Pearson correlation, the percentile change in the convex hull area and the change in the number of significant autocorrelation lags were found to have a moderate negative correlation (r = -.370, p = .001). This result lends support to how the data are interpreted dynamically. A greater number of significant autocorrelation lags indicate greater predictability in the time series and imply a longer duration relationship between the data. In dynamical systems theory, a system that is operating with a fixed point attractor should demonstrate greater relationship between time-distant data points than a system governed by some other phase space structure, as the fixed point attractor forces all of the possible trajectories (different data points) to converge on the attractor over time. The spread in the trajectories therefore decreases in time. This decrease in phase space area should be revealed in the convex hull area, and this is found in the correlation analysis. A decrease in the convex hull area is moderately related with an increase in the number of significant autocorrelation lags, implying that a more constricted phase space is associated with greater dependency between the data points over time.

Study 1: Discussion

Collectively, the results from Study 1 provide some evidence to support predictions from the non-linear model of two-actor cooperation and competition. One key model prediction is that in the face of an interaction transitioning from cooperation to competition, or vice-versa, people should experience fluctuations in cognitive and emotional response. This prediction was verified when participants encountered an interaction with a person who appeared cooperative with initially have similar attitudes transitioned to a competitive exchange with dissimilar attitudes. In this scenario, participants exhibited significantly more attitude change than several other groups (control and constant attitude dissimilarity) and also exhibited significantly more negative valence than several other groups (control and attitude dissimilarity switching to attitude similarity). As expected from the model predictions, conditions where an individual experienced constant cooperative (attitude similar) or constant competitive (attitude dissimilar) feedback failed to generate any significant fluctuation in attitudes or valence as compared against a control condition that lacked feedback.

Per the model predictions, significant attitude and valence change should have been observed in the condition where participants experienced an interaction with a confederate who transitioned from expressing dissimilar to expressing similar attitudes. This was not the case. Participants who communicated with a confederate who shared initially dissimilar attitudes that eventually became similar presented no significant difference in attitude or valence change as compared with the control group or constant feedback groups.

There are many possibilities why participants in the competition to cooperation (attitude dissimilar to similar) group did not exhibit significantly attitude change compared to the control or constant feedback groups. One possibility is that the participants in this group initially realized that their attitudes were divergent from their interaction partner's early in the experiment. Upon recognizing this, the participants may have shifted their attitudes towards the confederate instead of shifting the content of their attitudes. This possibility fits balance theory (Heider, 1958), and self-affirmation research, which indicates that when faced with personally threatening information, people minimize the threat through information-processing alteration (e.g. Munro & Stansbury, 2009; Munro & Ditto, 1997). When faced with an individual perceived as having drastically different attitudes, participants may engage in an automatic stereotyping of the confederate, deciding that he or she is "different than I am." If this takes place, the confederate may be perceived as an outgroup member (e.g., Andersen, Moskowitz, Blair & Nosek, 2007), leading the participant to disengage from the interaction and dismiss the confederate's responses. This possibility fits findings from research on automatic thought processes, where priming effects found when participants are in a positive mood state are often less robust when participants are in a negative mood state (Andersen et al., 2007). More recent work has demonstrated that this is a broad effect, with negative mood limiting the influence of contextual information ranging from judgments about a target to perceptions of another person's emotional state (Avramova, Stapel, & Lerouge, 2010). The influence of an anticipated positive, cooperative, or negative, competitive, interaction was tested in Study 2.

STUDY 2

The second study examined whether participant's attitude and valence change depends on whether perception of the interaction partner (confederate) is positive or negative. To test this hypothesis, participants were primed to believe that they would interact with someone who is agreeable, evoking expectancy of a positive interaction, or someone who is disagreeable, evoking expectancy of a negative interaction. From the results in Study 1, we predicted that participants who believed they would encounter a disagreeable stranger would show little attitude or valence change regardless of whether the interaction began with similar or dissimilar attitudes. Comparatively, we anticipated that participants expecting to interact with an agreeable stranger would demonstrate attitude and valence change coinciding with when the stranger (confederate) began expressing dissimilar attitudes.

Method

Participants

Data from a total of 89 participants (36 men and 53 women) was used in this study. An additional 33 participants' data was not used due to their not returning to complete the second part of the study ($N = 28$) or their not following instructions in completing the survey materials ($N = 5$). All participants were Florida Atlantic University undergraduates who received research credit for taking part in the experiment.

Procedure

The procedure used in this study was generally the same as that used in Study 1. The differences included a minor update to the first attitude survey and use of a prime to cause participants to perceive that they would interact with either an agreeable or disagreeable individual.

The first attitude survey was updated to include several personality measures (Appendix 2) including the Behavioral Identification Form for Action Identification (Vallacher & Wegner, 1989), the Regulatory Focus Questionnaire (Higgins, et al., 2001), and the Need for Cognitive Closure scale (Webster & Kruglanski, 1994). In addition, the certainty and importance measures were eliminated since these items provided no results in Study 1. This was most likely due to participants indicating continually high level of importance and certainty with each item.

The procedural steps matched those used in the first study, except that a prime was given to the participants at the start of the second session, before they received detailed instructions from a research assistant about how to complete the interaction session. The prime consisted of a print-out (Appendix 3) that supposedly provided a brief personality profile of the person that the participant would interact with during the session. The first part of the profile identified five trait-like categories including assertiveness, extroversion, compassion, group oriented, and leadership. Alongside each category was a series of marks indicating how high the trait was expressed, ranging from "low" to "high" on a five point scale. In the positive, agreeable partner prime, the scale for assertiveness was low while the scales for compassion and group oriented traits were high. Inversely, for the negative, disagreeable partner prime, the scale for assertiveness was high while the scales for compassion and group oriented traits were low. The extroversion and leadership traits were both moderate in each priming condition. Following the graph-like trait category information, each prime had a short paragraph supposedly describing participant's interaction partners. The text for the paragraph was identical in each priming condition; only the descriptive content of the interaction partner changed. Copies of the two priming forms are provided in Appendix 3.

Since the focus of this study was to examine why no significant attitude change took place in the condition where participants encountered a confederate whose attitudes transitioned from dissimilarity to similarity, this study used only three main conditions: control, attitude similarity switching to dissimilarity, and attitude dissimilarity switching to similarity.

Independent Variable

This was a 2 x 3 study with interaction partner prime and interaction condition as independent variables. Gender differences were initially explored but yielded no significant difference and contributed to data heteroscedasticity issues. Therefore, gender was omitted as a variable in the final analyses. For the interaction partner prime, participants were randomly assigned to either believe they would interact with an agreeable partner or a disagreeable partner. For the interaction condition, each participant was randomly assigned to experience an interaction that was either cooperative switching to competitive (attitudes are similar, switching to dissimilar), competitive switching to cooperative (attitudes are dissimilar, switching to similar), or control (no attitude exchange).

Dependent Variables

As with Study 1, there were two dependent variables measured in this study: participant's attitudes and participant's retrospective valence. Each of these variables was measured in the same way as Study 1.

Results

Attitude Measure

The attitude measure was used to discern whether or not participants altered their attitudes depending on the type of priming and interaction they experienced. As with Study 1, overall attitude change scores were computed for all participants by computing the absolute difference between Likert-scale responses of comparable items from survey one to survey two for each participant. Then, the total amount of attitude change for the second half of the second survey was subtracted from the total amount of change for the first half of the survey. This provided with a measure of total attitude change where values < 0 indicate less attitude change late in the experiment and values > 0 indicate more attitude change later in the experiment. Descriptive statistics for participant's attitude change based on experimental groups (priming and interaction condition) are provided in Table 3.

Interaction	Priming		N	Mean	Std. Deviation
Control	Dislike	AttChang	15	2.1000	6.18812
		Valid N (listwise)	15		
	Like	AttChang	16	-2.8750	6.94622
		Valid N (listwise)	16		
Coop → Comp	Dislike	AttChang	16	8.8750	10.07224
		Valid N (listwise)	16		
	Like	AttChang	12	7.0000	13.58475
		Valid N (listwise)	12		
Comp → Coop	Dislike	AttChang	15	-.5333	16.00387
		Valid N (listwise)	15		
	Like	AttChang	15	-1.9333	10.95749
		Valid N (listwise)	15		

Table 3: Attitude change descriptive statistics for Study 2. Positive values indicate participants exhibited greater attitude change and fluctuation as the experiment progressed. Negative values indicate participants' attitudes became more stable with less change as the experiment progressed.

Examining the amount of attitude change expressed by each participant with a 3 (interaction type) x 2 (priming manipulation) ANOVA revealed a main effect only for interaction type, $F(2, 76) = 6.742$, $p = .002$, with an effect size of $\eta_p^2 = .151$, retrospective power = .907. There were no significant differences in amount of attitude change for gender ($F(1, 76) = .648$, $p = .423$) or for the priming manipulation ($F(1, 76) = .269$, $p = .606$). There were also no significant interaction effects. Analysis using Tukey's HSD revealed that the participants experiencing an interaction that transitioned from cooperation (similar attitudes) to competition (dissimilar attitudes) exhibited significantly more attitude change than did participants in the control condition (mean difference = 7.5789, p = .023) and more attitude change than did participants in the competition (dissimilar) to cooperation (similar) condition (mean difference = 8.3444, p = .012). A means plot is provided in Figure 24, while descriptive statistics for attitude change grouped by interaction condition only are provided in Table 4. Box's Test and Levene's Test suggested no reason to believe that the data violated the ANOVA assumption of homogeneous variance.

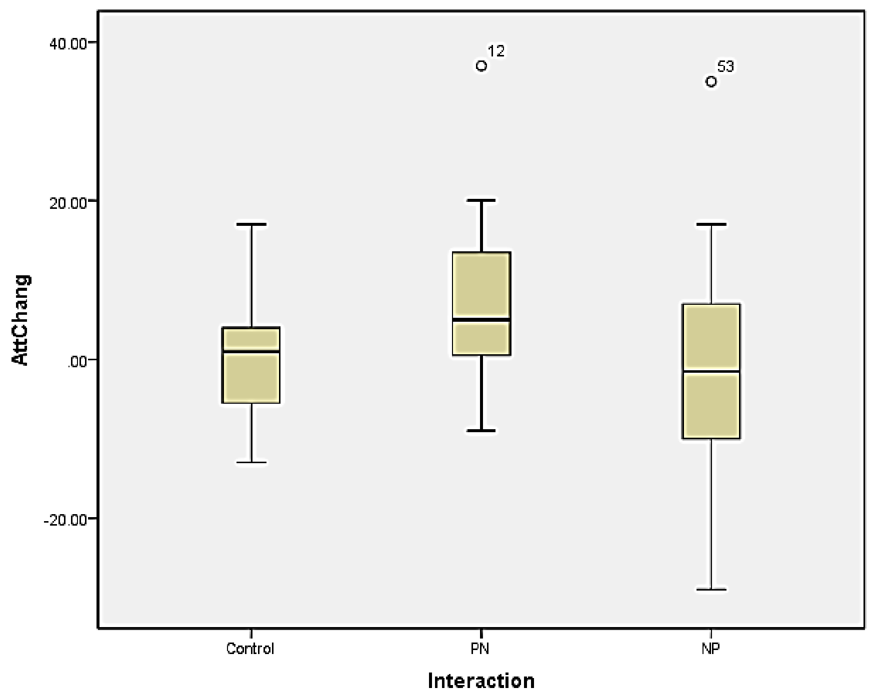

Figure 24: Box plot of mean total attitude change by type of interaction (feedback) participants received. PN = Cooperation to Competition, NP = Competition to Cooperation.

Interaction		N	Mean	Std. Deviation
Control	AttChang	31	-.4677	6.95574
	Valid N (listwise)	31		
Coop → Comp	AttChang	28	8.0714	11.50822
	Valid N (listwise)	28		
Comp → Coop	AttChang	30	-1.2333	13.49504
	Valid N (listwise)	30		

Table 4: Attitude change descriptive statistics for Study 2, grouped by the only statistically significant main effect. Positive values indicate participants exhibited greater attitude change and fluctuation as the experiment progressed. Negative values indicate participants' attitudes became more stable with less change as the experiment progressed.

The attitude survey results from the second study replicate what was found in Study 1. Participants who encountered a confederate who initially expressed similar attitudes before transitioning to dissimilar attitudes exhibited greater attitude change than did participants in a control case or in a case involving transition from attitude dissimilarity to attitude similarity. While this result enhances confidence in the reliability of Study 1, it does not help to explain why the model predictions fail in a case where the dyadic exchange shifts from competition (attitude dissimilarity/negative feedback) to cooperation (attitude similarity/positive feedback). The interpretation that participants disengaged from the interaction upon encountering a person perceived to be markedly different does not seem supported since the priming tool did not appear to affect the results in Study 2.

Valence Measure Analysis

Valence data obtained from the mouse paradigm was transformed using the same technique as described in Study 1. Then, the difference in mouse cursor position was obtained to discern whether participants moved the cursor more within the positive (right-side) domain or negative (left-side) domain during the latter part of the experiment. One participant did not wish to be video recorded during the second session, so data was available for only 88 participants in this study.

Results from an ANOVA initially indicated that the difference in cursor position was significantly different based on the type of interaction participants experienced, $F(2, 85) = 3.158$, $p = .048$ (effect size of partial $\eta^2 = .069$, retrospective power = .591). Multiple pairwise comparisons using Tukey's HSD revealed that the amount of cursor position change was marginally significantly different between the group experiencing an interaction transitioning from attitude similarity to dissimilarity versus the group experiencing an interaction transitioning from attitude dissimilarity to dissimilarity ($p = .051$). Participants who experienced an interaction initiating with attitude similarity before switching to dissimilarity had marginally more negative valence based on cursor position ($M = -185.333$) than participants who experienced an interaction varying from attitude dissimilarity to dissimilarity ($M = 454.333$). Levene's test indicated no reason to reject the assumption of homogeneous variance. Descriptive statistics for the valence changes are given in Table 5, while the changes are plotted in Figure 25.

Interaction		N	Mean	Std. Deviation
Control	Valence Change	31	336.7097	908.97694
	Valid N (listwise)	31		
Coop → Comp	Valence Change	27	-185.3333	1086.64324
	Valid N (listwise)	27		
Comp → Coop	Valence Change	30	454.3333	1051.49078
	Valid N (listwise)	30		

Table 5: Valence change descriptive statistics for Study 2. Values greater than zero indicate participants moved the cursor more frequently within the positive valence domain than the negative as the experiment progressed. Values below zero reflect that participants tended to move the cursor more within the negative valence domain as the experiment progressed.

The mouse cursor position data in Study 2 was similar to what was found in Study 1. Marginally significant differences existed between participants who experienced an interaction change from similarity to dissimilarity versus those who experienced an interaction change from dissimilarity to similarity. These data show that participants who experienced an interaction transitioning from one with initial attitude similarity to later attitude dissimilarity report more negative valence following the interaction transition.

Unlike results from the valence change measure obtained in Study 1, the significance values from the ANOVA and its post-hoc tests were marginal for Study 2. Since the only difference in the interaction session between Study 1 and Study 2 is the use of a prime in the second study, it seems probable that the prime somehow influenced participants. Comparing the means for the valence data obtained in Study 2 to the valence data from the analogous conditions in Study 1, there was less cursor position change (Table 6) observed in the Study 2 data than in the Study 1 data. The interaction session procedure for both studies was identical save for the inclusion of the prime in Study 2, so it appears that the prime may have dampened some of the cursor position change (see Table 6),

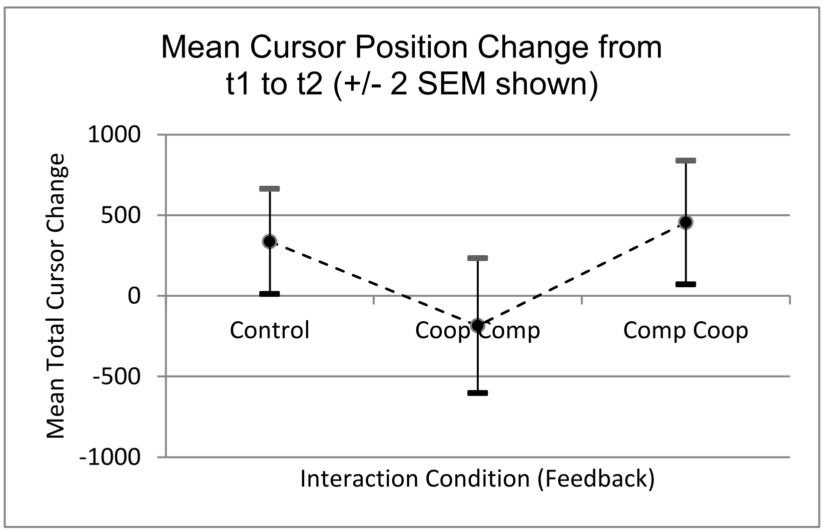

Figure 25: Mean change in mouse cursor positions (from the binary test) between the first and second half of the interaction session graphed by experimental condition with +/- 2 standard error of mean shown.

		STUDY 1			STUDY 2		
Interaction		N	Mean	S.D.	N	Mean	S.D.
Control	AttChang	16	640.8	769.2	31	336.7	909.0
	Valid N (listwise)	16			31		
Coop → Comp	AttChang	21	-697.0	1549.6	27	-185.3	1086.6
	Valid N (listwise)	21			27		
Comp → Coop	AttChang	18	650.2	775.5	30	454.3	1051.5
	Valid N (listwise)	18			30		

Table 6: Binary cursor position change for analogous experimental conditions in Study 1 and in Study 2; participants in Study 2 demonstrated less cursor change (nearer to zero) across all conditions in Study 2. Values greater than zero indicate participants moved the cursor more frequently within the positive valence domain than the negative as the experiment progressed. Values below zero reflect that participants tended to move the cursor more within the negative valence domain as the experiment progressed.

Correlation between Attitude Change and Valence Change

In Study 1, it was found that greater attitude change during the course of the experiment was significantly correlated with more negative valence. This result was not replicated in Study 2, $r = -.053$, $p = .616$. It appears that the prime again had an influence on this outcome since there was less cursor position change (Table 6) observed in the Study 2 data than in the Study 1 data.

Correlations with Personality Measures

Three personality measures were included in the first session survey packet for exploratory purposes: Behavioral Identification Form for Action Identification (Vallacher & Wegner, 1989), the Regulatory Focus Questionnaire (Higgins, et al., 2001), and the Need for Cognitive Closure scale (Webster & Kruglanski, 1994). Correlating participants' scores from these measures with their attitude and valence change revealed only one significant correlation. Participant's Action Identification was negatively correlated with the change in the difference of moment to moment cursor position from the first half to the second half of the experiment (r = -.308; p = .004). The moment to moment cursor change difference was computed using a binary transform. Any cursor position towards the left side of the computer monitor was coded "-1" and any cursor position towards the right side of the computer monitor was coded "+1." Therefore, the measure reveals whether a participant tends to indicate a more positive or more negative valence with each cursor movement. Once the sum of the transformed cursor change data was obtained for the first and second half of the experiment, the difference was taken. This differencing reveals whether a participant's cursor movements trended more towards the positive domain or more towards the negative domain as the study progressed.

From the significant negative correlation between Action Identification and momentary cursor change, participants who exhibit a higher level of Action Identification tend to move the cursor more towards the negative domain in response to the later part of the interaction. Comparatively, participants who have a lower level of Action Identification tend to move the cursor more towards the positive domain when viewing the latter half of the interaction. One possible explanation for this correlation is that the interaction task most likely operates a low level of Action Identification. In the interaction, participants merely take turns reading a series of statements with a confederate. The survey forces participants to attend to the simple details of whether they agree or disagree with each item and whether the confederate's attitude matches the participant's. If this is the case, participants who are operating at low level Action Identification should find the task congruent with their cognitive style. Therefore, these participants should exhibit less distress – evidenced by more positive emotion – when completing the experiment. Comparatively, participants who are operating at high level Action Identification should find the experimental task incongruent with their cognitive style, which can enhance negative emotions due to non-optimal identification (c.f. Vallacher & Wegner, in press). This hypothesis was examined more fully using a *t*-test.

Optimal Action Identification: Evidence in Valence Measure

According to Action Identification theory, people understand their actions in terms of detail-focused, low-level identities or broader meaning, high-level identities. In general, people try to think of their actions in terms of the highest level possible, as higher level identities are more informative about the purpose or consequence of the action. However, when faced with a difficult or novel task, people tend to shift to a lower level of cognition to attend to the details of the task rather than the bigger meaning (Vallacher & Wegner, 1985; Wegner, Vallacher, Kiersted, & Dizadji, 1986). In this sense, Action Identification poses that there exists an optimal level of identification for task performance, and that people feel more positive emotion when their actions are optimally construed in light of the task demands. Comparatively, when people's level of cognition pertaining to an action is too high or too low, they experience distress and negative emotions (Vallacher & Wegner, in press). There is evidence for the effects of non-optimal arousal in the data from Study 2.

An Action Identification score was computed for all participants using their responses to the Behavioral Identification Form for Action Identification (Vallacher & Wegner, 1989). The questionnaire presents a forced-choice response to an item, e.g. "Pushing a doorbell" where participants choose one of two options to indicate which option better describes the item (e.g. "Moving a finger" versus "Seeing someone's home"). Low level responses were coded "-1" while high level responses were coded "+1". Participants' responses to all 25 Behavioral Identification survey items were summed for a total Action Identification score. Next, a median split was performed with participants who scored below the median were grouped as having Low Level Action Identification and participants who scored above the median were grouped as having High Level Action Identification. Once these groups were created, the difference in the amount of momentary cursor position changes from the first half to the second half of the study were compared using an independent *t*-test.

The independent *t*-test revealed that there was a significant difference in the difference of momentary cursor position change across the duration of the experiment, $t(84) = 2.529$, $p = .013$. Participants who were included in the high level Action Identification group had more negative moment to moment cursor movements in the later part of the experiment as compared to the first, $M = -10.51$. Participants who were included in the low level Action Identification group tended to have moment to moment cursor positions that exhibited little change in the second part of the experiment as compared to the first part, *M* = .21 (Figure 26). This outcome reveals that participants who were identified as having a lower level Action Identification tended to express a relatively consistent moment to moment valence throughout the experiment (since the mean difference was near zero). This is different from the high level Action Identification group, which tended to express more negative momentary cursor movements in the latter part of the experiment. Since the experiment involved participants attending to low level survey details and response throughout the interaction session, it makes sense that participants who engage with a higher level Action Identification expressed progressively more negative momentary valence. These participants likely did not find the experimental procedure optimal in terms of their Action Identification level.

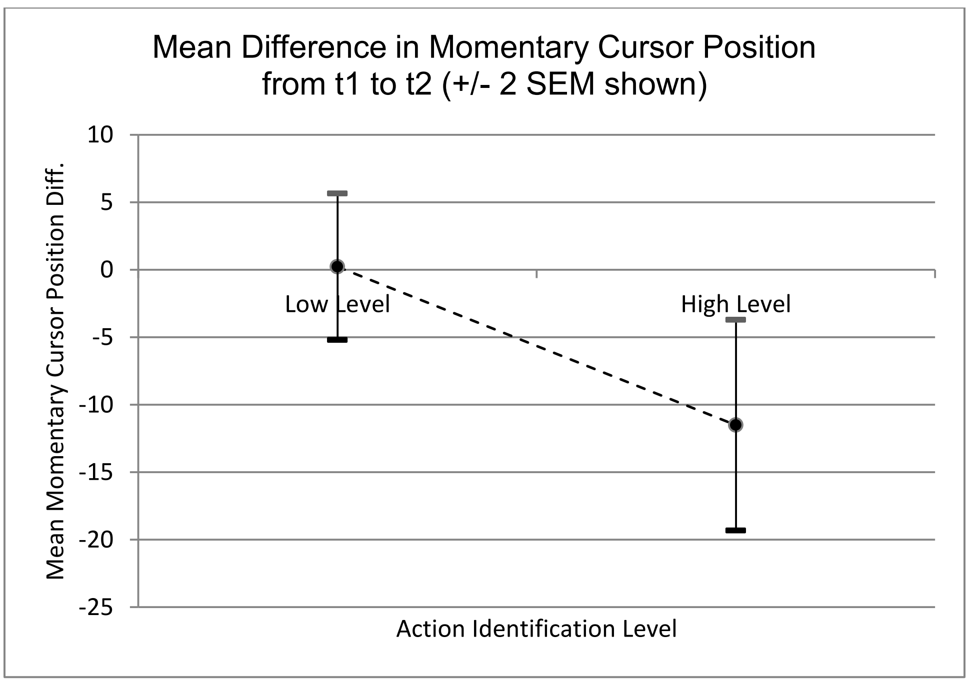

Figure 26: Mean difference in momentary cursor position from the first to the second half of the experiment, grouped by Action Identification level.

Study 2: Discussion

Overall, Study 2 successfully replicated many of the results obtained in Study 1. The replicated findings include that participant experiencing an interaction transitioning from cooperative, similar feedback to an interaction with negative, dissimilar feedback expressed more attitude change and more negative valence than did participants in either the control condition or condition involving negative, dissimilar feedback that shifted to positive, similar feedback. Unlike Study 1, however, there was no significant correlation between attitude change and valence change in Study 2. It appears that this lack of significance may have been a result of the prime, which dampened the amount of valence change, as recorded by the mouse-paradigm in many conditions.

The results from Study 2 do not support the hypothesis posed at the conclusion of Study 1 that participants merely disengage from the interaction given an initially oppositional partner. Both Study 1 and Study 2 demonstrated that participants who experience an exchange that begins with the confederate expressing negative feedback (non-matching attitudes) do not show significant attitude or valence change. This finding goes against the model predictions, which indicate an equivalent amount of cognitive or emotional reactivity should take place in any interaction that transitions from cooperation to competition, or vice versa.

One explanation for the asymmetric attitude and emotional responses is that it reflects a difference in the amount of time that must pass before a previously competitive interaction can successfully transition to cooperation. It is generally acknowledged that it is easier for two individuals, or groups, to shift from cooperation to conflict than to shift from conflict to cooperation. As Vallacher et al. (2010a) note, conflicts may arise from a perception of incompatibilities between individuals or groups, but that merely addressing and resolving this incompatibility does not lead to conflict resolution. People seem more reactive of negative information than positive information when it comes to social exchanges. For instance, in his marital relationship research Gottman notes that there is a "triumph of negative over positive," where stable couples who have a good relationship share roughly 5 positive events for every 1 negative event, whereas unstable couples who tend to eventually divorce share less than 1 positive event for every 1 negative (Gottman et al., 2005, p. xv). People readily respond well to harmonious exchanges, but once a conflict emerges and becomes sustained, direct attempts to restore cooperation tend to fail as the conflict reasserts its power over the interaction (e.g., Vallacher, Coleman, Nowak, & Bui-Wrzosinska, 2010a). People's resistance of positive information once an interaction becomes negative suggests that negative information has an asymmetric and more significant social influence than positive information. This asymmetry was found in Study 1 and Study 2 where people reacted most strongly when an interaction developed sudden competing, dissimilar attitudes but showed little reaction when an interaction developed sudden similar attitudes.

Another possibility for participants' asymmetric response in Study 1 and Study 2 is that it may reflect a synchrony process. In cases where participants begin the interaction with a cooperative partner who expresses similar attitudes, the participants may develop a synchrony with the interaction partner. At the onset of the partner's expression of dissimilar attitudes, this synchrony is challenged, causing participants distress that is revealed through their more negative valence and attitude changes (to presumably try to restore the synchrony). This speculation fits well with ideas from balance theory and dissonance reduction (Festinger, 1957; Heider, 1958).

The idea that the significant changes in attitude and valence emerged from a synchrony effect also make sense in light of findings about behavioral mimicry. For example, Chartrand and Bargh (1999) found that simple motor behavior tends to synchronize with strangers and evokes a sense of liking. The mimicry effect likely extends beyond behaviors such as bodily movements, facial expressions, or postures and influences cognition as well. Carver, Ganellen, Froming, and Chambers (1983) demonstrated mimicry effects though participants' perceptual interpretation of observed behaviors. While mimicry and synchrony influence emotions, social judgments can influence tendency to mimic others. For example, Leighton, Bird, Orsini, and Heyes (2010) found that people who are primed with positive, pro-social attitudes exhibit more behavioral mimicry than people who are primed with negative, anti-social attitudes. The top-down effect of cognition on behavior may have played a role in this study.

The procedure used in this research limited the information participants received regarding their interaction partner. It is probable that participants used confederates' attitude responses to try to form a social judgment. Many studies have demonstrated that people use available cues to automatically form judgments about situations and other individuals and that the automatic processing is especially tuned to evaluative judgments (Andersen, et al., 2007; Bargh, Chaiken, Govender, & Pratto, 1992). This automatic judgment helps people identify ingroup versus outgroup membership and stereotype based on available cues (Andersen, et al., 2007). In this study, when confederates expressed attitude similarity at the start of the interaction it may have led participants to perceive their partner as an ingroup member. Comparatively, when confederates expressed attitude dissimilarity it may have led to a perception of outgroup membership. In cases where participants encountered a partner who expressed initially dissimilar attitudes, the participants may have automatically judged the confederate negatively, as an outgroup member, thus reducing potential for future synchronization as the interaction evolved into one of shared attitude similarities. This explanation fits well with recent research that has shown that imitation actions are influenced by group membership. Bourgeois & Hess (2008) found that people are more likely to mimic an ingroup member and expressions associated with positive valence. People are less likely to mimic outgroup members or expressions associated with negative valence.

Finally, in Study 2, there was a significant correlation between participant's level of Action Identification and their moment-to-moment shifts in valence. A median split was used to divide participants into a high level Action Identification or low level Action Identification, and this revealed a statistically significant difference in participants' momentary cursor position changes based on their level of Action Identification. Participants having an Action Identification score above the 50-th percentile tended to move the cursor more towards the negative valence domain a the experiment progressed. This finding makes sense in terms of Action Identification theory. In the experiment, participants were forced to attend to the details of the interaction by way of reading statements and, in the non-control conditions, focusing on whether their own attitudes were the same or different than the confederate's. This detail-focused, low-level exchange may have been optimal for participants having lower Action Identification, but was likely non-optimal for participants having higher Action Identification. According to theory, non-optimality between a task and a person's level of Action Identification results in aversive arousal and negative emotions (Vallacher & Wegner, in press). The results in Study 2 provide evidence to support this non-optimality theory.

STUDY 3

The first two studies found that people exhibit attitude and valence destabilization when confronted with an interaction that transitions from similarity and cooperation to dissimilarity and competition. However, since these initial studies used only a single shift in the interaction, it is unclear whether the results are generalizable to interactions that progress through multiple shifts. In social encounters, people rarely experience an interaction that is strictly cooperative or strictly competitive. What happens to attitude and valence patterns as people encounter multiple shifts in an interaction?

This question is critical in-light of the Liebovitch et al. (2008) model. Based on interpretations of the simulation results, if only one person switches his or her interaction style temporarily before reverting to the original interaction type, then both actors' attitudes and emotions will reflect temporary destabilization that will be replaced by stability. This simulation result is interesting and important for conflict resolution, as it suggests that once two individuals (or groups) are locked in a conflict, efforts by only one actor to change the interaction style can result in the conflict unfreezing. This unfreezing, reflected in the destabilization of attitudes and emotions, can allow new stable states to emerge – potentially even a new stable peace (see Liebovitch, Vallacher, & Michaels, 2010). Addressing the model predictions and question of how attitude and valence patterns change over the course of an interaction that goes through multiple feedback shifts., the third experiment exposed participants to two interaction shifts.

Method

Participants

While 137 participants took part in at least the first session of this study, a total of 90 participants completed all parts of the experiment (39 males and 51 females). Participants were recruited from the FAU Psychology Department subject pool and received course credit in exchange for their participation.

Procedure

The overall procedure was the same as in Study 2, except now participants were randomly assigned to one of three conditions based on the pattern of interaction style switching they experienced (or a control condition that did not include switching).

Independent Variable

For the interaction condition, each participant was randomly assigned to one of three conditions: 1) control group (no interaction switches), 2) initial cooperation (similarity) followed by competition (dissimilarity) finally returned to cooperation (similarity), or 3) initial competition (dissimilarity) followed by cooperation (similarity) finally returned to competition (dissimilarity). To maintain comparability with the previous studies, an additional twenty survey items were added in this experiment (Appendix 4). Thus, a response style persisted through the course of twenty survey items.

Dependent Variables

Like the previous studies, there were two dependent variables measured in this study: participant attitudes and participant retrospective valence. Each of these variables was measured in the same way as in the prior studies, except each participant's attitude change was measured at two individual time points to examine attitude change between the initial and middle third of the interaction and then between the middle and final third.

Results

Attitude Survey

Participants' attitude survey responses were examined with the same procedures and logic as employed with Study 1 and Study 2. Briefly, the amount of response change to identical items between each participant's first and second surveys was computed. Then, the sum of the absolute amount of change was computed for every twenty survey items. This computation would show whether participants exhibited attitudes that remained stable and consistent between the two surveys (sum near zero) or showed greater attitude change for a particular set of items. Since the main interest with the attitude responses was whether participants came to express more or less attitude change as the interaction progressed, the difference of the absolute attitude change sums was obtained between the first and middle portion of the interaction session and between the middle and last portion of the session. Descriptive statistics for the attitude change in each experimental condition between the first and second part of the interaction and between the second and third part of the interaction are given in Table 7.

Descriptive Statistics

Condition		N	Mean	Std. Deviation
Control	T1T2Change	30	-2.4667	7.79360
	T2T3Change	30	-.6333	7.33195
	Valid N (listwise)	30		
Coop → Comp → Coop	T1T2Change	30	6.5000	11.66708
	T2T3Change	30	-5.8333	10.13728
	Valid N (listwise)	30		
Comp → Coop → Comp	T1T2Change	30	-7.1000	11.40584
	T2T3Change	30	4.1667	10.12025
	Valid N (listwise)	30		

Table 7: Attitude change descriptive statistics for Study 3, grouped by condition. Data from two participants was identified as outliers and was excluded from final analyses to avoid problems with statistical analysis (detailed in this section). As with prior studies, positive values indicate participants exhibited greater attitude change and fluctuation as the experiment progressed. Negative values indicate participants' attitudes became more stable with less change as the experiment progressed.

Since participants' attitude change was measured at two time points over the course of the experiment, a repeated-measures ANOVA was used with one within-subjects factor (attitude change with first and with second interaction switch) and one between-subjects factor (experimental condition). The inferential test revealed a significant interaction effect between attitude change corresponding to the first and second interaction shifts versus experimental condition, $F(2, 87) = 12.742$, $p < .001$ (effect size of partial $\eta^2 = .227$, retrospective power = .996). The between-subjects factor, interaction condition, achieved near marginal statistical significance, $F(2, 117) = 2.518$, $p = .104$ (effect size of partial $\eta^2 = .051$, retrospective power = .460). Considering the pattern of attitude change across the three conditions (Figure 27), it appears probable that the repeated measure ANOVA's linear combinations of the means across the first and second attitude change samples reduced the true observed variations between the groups. Therefore, two separate univariate ANOVA were used to examine only the attitude changes between experimental conditions. To reduce statistical error, these ANOVA were performed with a Bonferroni correction such that significant $\alpha = 0.025$ instead of the typical $\alpha = 0.05$.

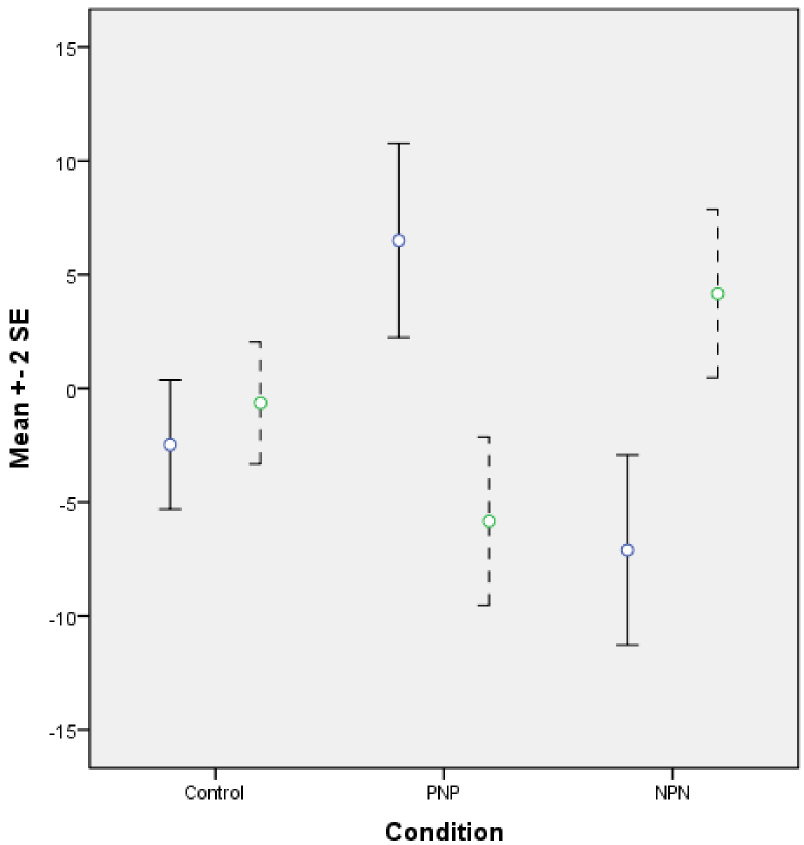

Figure 27: Attitude change from the initial to middle third of the interaction (solid line) and from the middle to final third of the interaction (dashed line) by condition. The amount of attitude change across the interaction remained unchanged for the control group. The greatest amount of attitude change in the each non-control group matches when the interaction switched from cooperation to competition (labeled 1 for the cooperation-competiton-cooperation group; labeled 2 for the competition-cooperation-competition group). These results are consistent with previous findings.

With the Bonferroni correction (adjusted $\alpha = 0.025$), univariate ANOVAs indicated statistically significant differences in participants' attitude changes between the experimental conditions associated with the first interaction shift period (T1 → T2), $F(2, 87) = 13.159$, $p < .001$ (effect size of partial $\eta^2 = .232$, retrospective power = .997),and second interaction shift period (T2 → T3), $F(2, 87) = 8.964$, $p < .001$ (effect size of partial $\eta^2 = .167$, retrospective power = .965). In both cases, Levene's test gave no reason to reject the assumption of equal variances.

Further examination of the group differences in attitude change between the initial and middle third of the interaction using Tukey's HSD revealed significant differences between all conditions. Overall, people who experienced the initial interaction shift from cooperation (similarity) to competition (dissimilarity) exhibited greater attitude change ($M = 6.50$) than the control group ($M = -2.47$, $p = .004$) and the group experiencing a shift from competition to cooperation ($M = -7.10$, $p < .001$).

Tukey's procedure was also used to assess the source of significant group-level differences in attitude change between the middle and final third of the interaction. The results were consistent with all experimental findings up to this point. Participants who experienced an interaction shift from cooperation to competition later in the study exhibited marginally greater attitude change ($M = 4.17$) than the control group, ($M = -.633$, $p = .083$) and significantly more attitude change than the competition to cooperation group ($M = -5.83$, $p < .001$). These results replicate what was generally found with Study 1 and Study 2: attitudes become unstable when people are faced with sudden competition and incompatibility from a previously cooperative, compatible partner.

Valence Measure Analysis

Participants' valence was measured using the mouse paradigm, with the data transformed for analysis exactly as described for Study 1 and Study 2. Briefly considered, the raw data was recoded to indicate whether participants positioned the cursor predominantly within the left (negative) half of the computer monitor or right (positive) half of the monitor during the first, second, and third period of the interaction session. Next, the differences between the first and second then second and third periods were taken to compute the amount of change in cursor location between interaction switches. Finally, data was normalized by dividing the transformed data by the total duration of each participants' valence time series. This normalization was necessary as participants' time series length varied slightly due to differences in the interaction session duration. Summary data for participants' valence change based on condition is provided in Table 8.

Descriptive Statistics

Condition		N	Mean	Std. Deviation
Control	T1T2Dom_Norm	24	.0292	.12082
	T2T3Dom_Norm	24	.0149	.12616
	Valid N (listwise)	24		
Coop →	T1T2Dom_Norm	29	.0332	.20724
Comp →	T2T3Dom_Norm	29	.0473	.09872
Coop	Valid N (listwise)	29		
Comp →	T1T2Dom_Norm	26	.0898	.12404
Coop →	T2T3Dom_Norm	26	-.0406	.13763
Comp	Valid N (listwise)	26		

Table 8: Valence change descriptive statistics for Study 3, grouped by condition. Data from two participants was identified as outliers and was excluded from final analyses to avoid problems with statistical analysis (detailed in this section). Values greater than zero indicate participants moved the cursor more frequently within the positive valence domain than the negative as the experiment progressed. Values below zero reflect that participants tended to move the cursor more within the negative valence domain as the experiment progressed.

Initially a repeated-measures ANOVA was used to assess whether there was a significant difference in participants' valence change between the two interaction switches. However, Box's *M* test indicated that the repeated-measures ANOVA assumption of equal covariances may have been violated (p = .004). Conservatively, a violation in Box's test suggests that the ANOVA result may not be accurate due to the tendency for Fisher statistic inflation when equal variance assumptions are not met (e.g.

Bergh, 1985). However, Box's test is known to be over sensitive to deviations from normality (Layard, 1974) and may indicate a lack of equal covariance when there is only a symmetry violation (LaTour & Miniard, 1983). Some methods exist for resolving covariance symmetry or data homogeneity of variance issues such as the Huynh-Feldt procedure (LaTour & Miniard, 1983) or data adjustment using logarithmic or other transforms (Todman & Dugard, 2007). However, one alternative is to assess the data using Friedman's Chi-Square test. By operating with data ranks, the Friedman's Chi-Square test does not rely on equal variance assumptions and may thus be applied in cases when these assumptions are violated (Friedman, 1937).

A new repeated measures analysis using Friedman's Chi-Square test revealed a statistically significant difference in participants' valence between the first interaction shift and second interaction shift ($\chi^2 = 6.696$, $p = .010$). In order to better assess the statistical differences in valence between the experimental conditions, two univariate ANOVA were used with a Bonferroni correction (adjusted $\alpha = 0.025$). Levene's test for each ANOVA gave no reason to reject assumption of equal variance, suggesting that the initial repeated measures ANOVA issues were sourced in the covariance matrices' equality. The ANOVA procedures revealed that while there were no statistically significant differences in valence change during the first interaction shift, $F(2, 87) = 1.328$, $p = .270$, there was a statistically significant difference in valence change during the second interaction shift, $F(2, 87) = 4.598$, $p = .013$, partial $\eta^2 = .096$, retrospective power = .765. Further analysis using Tukey's HSD indicated that the group experiencing an interaction switching from competition to cooperation then to competition was the source of difference. This particular group exhibited significantly more negative valence

(M = -.0466, p = .009) following the second interaction shift (from cooperation to competition) than the group experiencing the opposite interaction shift pattern (M = .0415). The valence change for each group based on condition and interaction shift period is evident from Figure 28.

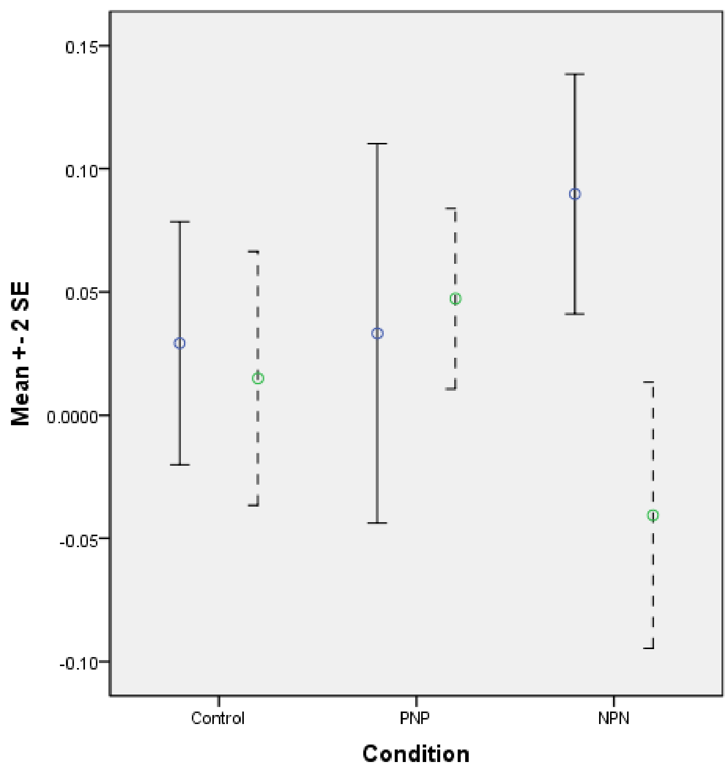

Figure 28: Valence change from the initial to middle third of the interaction (solid line) and from the middle to final third of the interaction (dashed) by condition.

While no significant differences were found in the valence changes with the first interaction shift, descriptive statistics suggested that one group exhibited noticeably greater data variance than the others. Specifically, the group experiencing an interaction shifting from cooperation to competition with the first interaction shift exhibited a greater range of valence change than did the other groups. This is evident by comparing the minima and maxima valence change values for each group (Table 9), noting that this particular group's minimum and maximum are nearly twice that of the other groups. The difference is further apparent with a data scatterplot (Figure 29).

Condition		N	Minimum	Maximum
Control	T1T2Dom_Norm	24	-.24	.31
	Valid N (listwise)	24		
Coop → Comp → Coop	T1T2Dom_Norm	29	**-.42**	**.65**
	Valid N (listwise)	29		
Comp → Coop → Comp	T1T2Dom_Norm	26	-.18	.38
	Valid N (listwise)	26		

Table 9: Minimum and maximum valence change scores based on experimental condition for the first interaction shift. The group experiencing an initial interaction shift from cooperation to competition (bold font) exhibited minimum and maximum values approximately twice as large as the other groups.

Although Levene's test with the ANOVA indicated likely equal variance, a separate Kruskal-Wallis *H* test was performed to examine whether the data variance structure significantly contributed to the null findings. The non-parametric test – by operating on data ranks – is less influenced by outliers and significant differences in group data variance. The Kruskal Wallis *H* test indicated marginally significant difference, $\chi^2 = 4.926$, $p = .085$ in valence change between the experimental conditions with the first interaction shift. The same test indicated significant difference in valence change between conditions with the second shift, $\chi^2 = 7.632$, $p = .022$. The non-parametric procedure and ANOVA procedure both reveal the same results for the second interaction shift. Later in the interaction session, participants exhibited significantly different patterns of valence change depending on the type of interaction shift they experienced. Comparatively, the considerable difference in statistical significance between the non-parametric procedure (p = .085) and ANOVA procedure (p = .313) for the valence change differences with the first interaction shift are more difficult to interpret. Conservatively, these results suggest that larger variations in participants' valence earlier in the experiment cloud the results and make any conclusion of statistically significant difference unwarranted.

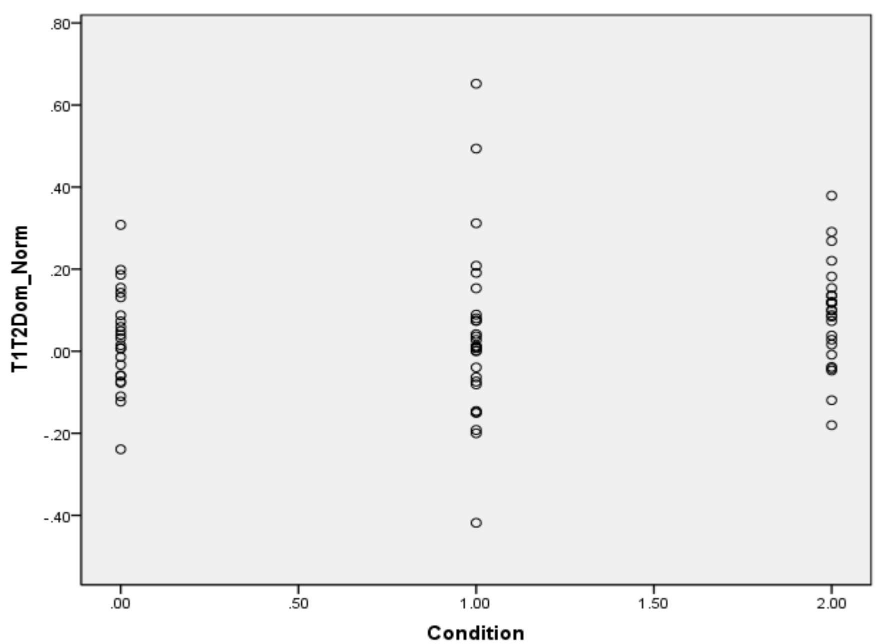

Figure 29: Scatterplot showing the differences in data variability across the groups. The group experiencing an interaction shift from cooperation to competition (middle) exhibits greater variation.

Correlation between Attitude Change and Valence Change

Noting the similar patterns of attitude change and valence change within some of the experimental conditions, a Pearson correlation was employed to assess whether any significant relationship existed between these two variables. While there were no significant relationships between attitude and valence change associated with the first interaction shift, there was a significant relationship with the changes associated with the second interaction shift (r = -0307, p = .006). This finding replicates what was found with the first study – greater attitude change is associated with more negative valence.

Study 3: Discussion

Results from the third experiment are generally consistent with the first two studies. Participants who experienced an interaction shift from cooperation to competition presented the greatest attitude change regardless of whether the shift took place earlier or later in the experiment. Comparatively, a significant difference in valence was observed only for the later interaction shift. Specifically, participants who experienced a late interaction shift from cooperation to competition tended to position the computer cursor more often in the left, negative domain. Accordingly, these participants expressed a more negative valence following the final interaction shift to competition. In comparison, there was little statistical difference in participants' cursor-indicated valence with the early interaction shift. While previous results anticipated a valence reaction to sudden competition following cooperation no matter when such a shift took place, in the third study a significant difference was found only during the latter part of the interaction session. Based on descriptive data, participants experiencing an initial interaction shift from cooperation to competition exhibited greater variability in their valence change scores than participants in other conditions. Based on substantial *p*-value changes between parametric and non-parametric procedures, it appears likely that the variability differences did influence statistical results. However, with no clear basis for rejecting the parametric (ANOVA) outcome there is no statistical basis to assume a significant difference did exist between groups' valence change with the first interaction shift. The key point to this brief discussion is that the data structure seems to have contributed to the null results.

STUDY 4

One key question raised from prior results is whether the findings are a result of an asymmetric response to competition versus cooperation. People tend to show greater psychological reaction to conflict than to cooperation (e.g. Gottman et al., 2005). Conceivably, once an interaction becomes defined by competitiveness and conflict peace can only be achieved if cooperation persists for a long duration or is sufficiently strong. The prediction that the pathway out of an established conflict requires sufficiently strong cooperation over a sustained period fits with model predictions (Liebovitch, Vallacher, & Michaels, 2010) and is the guiding prediction for Study 4. In this study, participants experienced either limited feedback (control case) or a transition in the interaction from cooperation to competition or vice-versa. However, unlike previous studies, the interaction persisted for twice as many survey items. That is, instead of the interaction involving twenty survey items before and twenty items after the interaction shift, Study 4 had participants in the non-control conditions read and respond to twenty items prior to the shift and forty after the shift. This update to the experiment would reveal whether cooperation that persisted for double the interaction duration following a competitive exchange resulted in any attitude or valence influence.

Method

Participants

There were 83 participants (39 males and 44 females) who completed all parts of the fourth study. As with all other studies in this line of research, participants were recruited from the FAU Psychology Department subject pool and received course credit.

Procedure

The overall procedure was the same as in Study 3, except that participants experienced only a single interaction switch, save for the control condition which experienced a continuous interaction with no attitude feedback. The interaction switch took place one-third into the interaction (at survey item number 21).

Independent Variable

Participants were each randomly assigned to one of three interaction conditions: 1) control group (no interaction switches), 2) initial cooperation (similarity) switched to competition (dissimilarity), or 3) initial competition (dissimilarity) switched to cooperation (similarity). Like the previous studies, the interaction shift occurred at the 21^{st} item in the survey. However, instead of participants proceeding through the interaction for the same duration after the switch took place as before it happened, there were 40 survey items read following with shift. For example, if a participant's interaction began with a cooperative confederate who expressed similar attitudes for the first 20 survey items, the last 40 items involved a competitive exchange with the confederate indicating oppositional beliefs.

Dependent Variables

The same two dependent variables were used in this study: participant attitude and participant retrospective valence (based off of the mouse paradigm task). There were no changes to how these variables were measured, except that attitude change was computed for three time points (second survey items 1 through 20, items 21 through 40, and items 41 through 60) to facilitate more ready comparison to prior work that computed attitude change across an interval of 20 survey items. Of note, the only interaction shift in this study transpired at survey item 20 to item 21. There was no shift in any condition between item 40 and 41. Again, the data were grouped in units of 20 survey items to facilitate more consistent comparison to previous studies.

Results

Attitude Survey

The attitude survey data were prepared for analysis using the same procedures used with the previous three studies. As with those experiments, the amount of each participant's identical item response change from Survey 1 to Survey 2 was computed. Next, the sum absolute difference of response from the first to the second survey was calculated. This computation indicates whether participants' attitudes remained stable (near zero score) or changed (above zero) between the surveys. As with prior studies, the main interest was whether participants indicated greater or less attitude change as the interaction progressed. Therefore, the difference of the absolute attitude change sums was computed between the each of one third of the interaction (first portion versus middle portion; middle portion versus late portion). Basic descriptive statistics with the attitude changes based on experimental condition are provided in Table 9.

Although only one interaction switch took place in this final study, the attitude change scores were obtained at two time points (between the first one-third and second one-third; between the middle one-third and final one-third) to maintain consistency in comparisons across the experiments, especially with Study 3.

Descriptive Statistics

Condition		N	Mean	Std. Deviation
Control	T1T2Change	30	-.6000	8.07123
	T2T3Change	30	-.1000	8.07871
	Valid N (listwise)	30		
Coop → Long Comp	T1T2Change	25	6.7200	15.30392
	T2T3Change	25	.4400	7.52263
	Valid N (listwise)	25		
Comp → Long Coop	T1T2Change	28	-.7143	9.85396
	T2T3Change	28	.1071	7.79049
	Valid N (listwise)	28		

Table 7: Attitude change descriptive statistics for Study 4, grouped by condition. Positive values indicate participants exhibited greater attitude change and fluctuation as the experiment progressed. Negative values indicate participants' attitudes became more stable with less change as the experiment progressed.

As in Study 3, the attitude change data were initially assessed using a repeated measures ANOVA. Once again data variance proved a problem with the assumptions of homogeneity and sphericity violated. Therefore, Friedman's Chi-Square was used as a non-parametric test of whether the attitude changes were significantly different. This test revealed no significant difference ($\chi^2 = .097$, $p = .756$), however a graph of data means and variation (Figure 30) suggested that linearizations may have hidden true between-subjects differences. This suspicion was verified by a between subjects ANOVA (variance homogeneity confirmed via Levene's test) that examined differences between attitude change based on condition alone, where this procedure indicated a likely statistically significant difference, $F(2, 80) = 4.020$, $p = .022$ (partial $\eta^2 = .091$, retrospective power = .702).

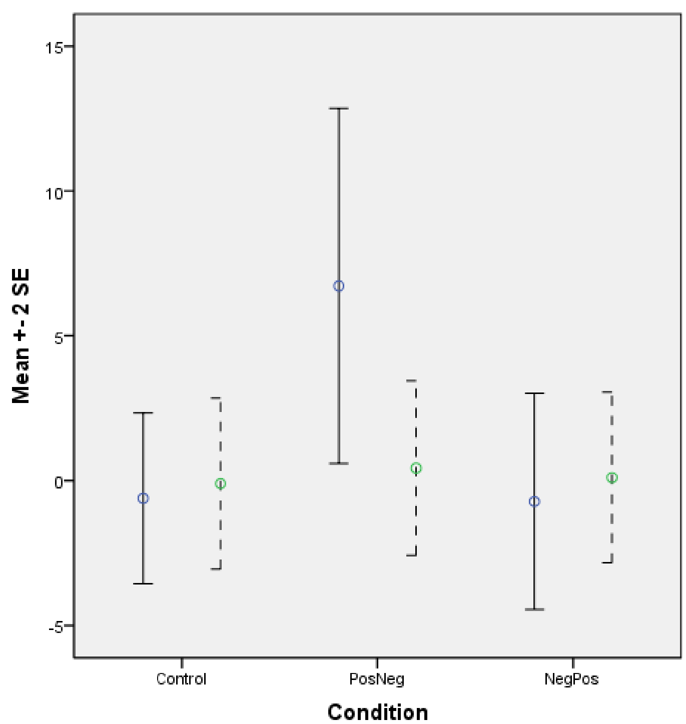

Figure 30: Attitude change from the initial to middle third of the interaction (solid) and from the middle to final third of the interaction (dashed) by condition.

In order to better address the problem of linear combinations in the within subjects ANOVA procedure, two univariate ANOVA were used to compare attitude changes across the experimental conditions. The first ANOVA tested for difference in attitude change associated with the interaction switch (or from the first twenty to the second twenty survey items), while the second ANOVA examined difference in attitude change with the later experiment (from survey items 21 through 40 versus 41 through 60).

The ANOVA revealed a statistically significant difference exists between conditions with the interaction shift (attitude change between items 1 through 20 versus 21 through 40), $F(2, 80) = 3.752$, $p = .028$ (partial $\eta^2 = .086$, retrospective power = .670). Post-hoc analysis using Tukey's HSD revealed that the difference existed between the cooperation switching to competition condition ($M = 6.72$) versus the control ($M = -.60$, $p = .048$) and versus the competition switching to cooperation condition ($M = -.71$, $p = .049$). Consistent with previous studies, participants in the fourth study who experienced an interaction shift from cooperation to competition exhibited attitude destabilization. These participants tended to have greater attitude change in the interaction session following the switch from a cooperative, similar exchange to a competitive, dissimilar exchange. In contrast, there were no significant differences between groups in terms of attitude change during the latter part of the interaction, $F(2, 80) = .033$, $p = .968$. Since feedback remained consistent between survey items 21 through 40 and items 41 through 60, no significant changes were expected, and these results are highly consistent with what was found in previous studies. This is especially true when comparing the results to those from Study 1, as the continual cooperative or continual competitive feedback cases from that study are analogous to what participants in the non-control condition experienced in the latter portion of Study 4.

Valence Measure Analysis

Valence data was obtained using the mouse paradigm and transformed exactly as described in the Study 3. Summary data for participants' valence change based on condition is provided in Table 10.

Descriptive Statistics

	Condition	Mean	Std. Deviation	N
Valence Change (Early Period)	Control	.0215	.14422	30
	Coop → Comp	.0191	.12785	25
	Comp → Coop	.0871	.18321	28
	Total	.0429	.15556	83
Valence Change (Late Period)	Control	-.0027	.13692	30
	Coop → Comp	-.0181	.12931	25
	Comp → Coop	.0091	.07991	28
	Total	-.0034	.11724	83

Table 10: Valence change descriptive statistics for Study 4, grouped by condition. Values greater than zero indicate participants moved the cursor more frequently within the positive valence domain than the negative as the experiment progressed. Values below zero reflect that participants tended to move the cursor more within the negative valence domain as the experiment progressed.

A repeated-measures ANOVA was applied to assess differences in participants' valence change associated with the interaction shift (shift taking place at survey item number 21) versus later part of the experiment coinciding with a consistent exchange. Using the Huyndt-Feldt corrected ANOVA due to problems with data sphericity, significant differences in valence change were found over time, $F(1, 80) = 4.010$, $p = 0.049$ (partial $\eta^2 = .048$, retrospective power = .507). The lack of significant difference across experimental conditions and the lack of significant interaction suggests the potential that this result reflects a stochastic effect. Examining the data means and standard errors (Figure 31) reveals similarity in the valence change patterns across all groups and over the different time periods.

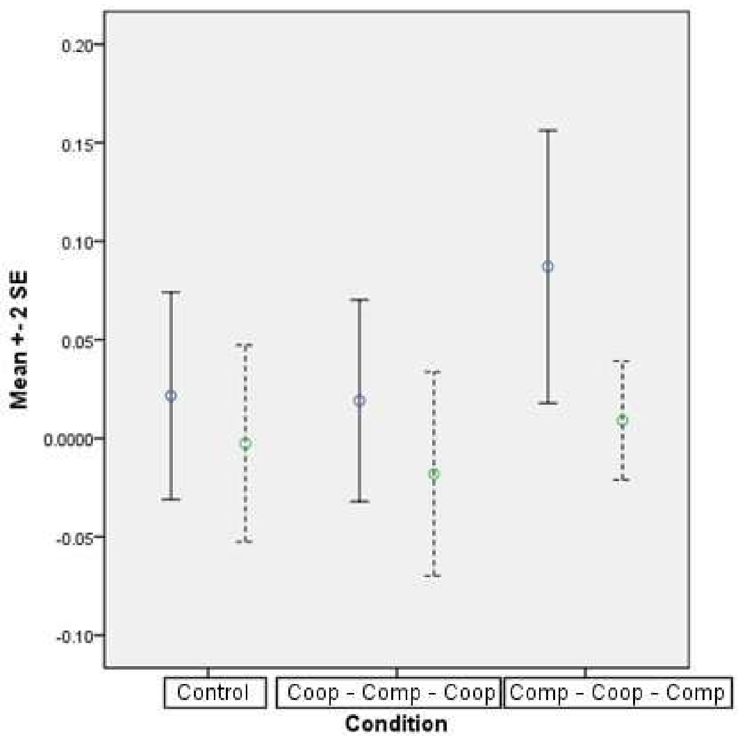

Figure 31: Valence domain change averages from the initial to middle third of the interaction (solid) and from the middle to final third of the interaction (dashed) by condition. PosNeg = Cooperation to Competition back to Cooperation, NegPos = Competition to Cooperation back to Competition.

Statistical results in the fourth study therefore do not find the same significantly more negative valence in the cases where participants experienced an interaction shifting from cooperation to competition. It is unclear why results in this last study's valence data were inconsistent; however, the valence data tend to exhibit subtle differences in data means that are susceptible to problems with data structure (e.g. non-normality or inhomogeneous variance). The sphericity problem detected with the within-subjects ANOVA suggests provides some evidence supportive of this conjecture.

Study 4: Discussion

The final experiment in this line of research replicates the results about people's attitude change found from previous studies. As has been consistent with all research in these studies, people exhibit the greatest attitude instability and change when confronted with an interaction shifting from cooperation to competition. However, the finding from the first three studies that such unstable attitudes coincide with more negative valence was not replicated. Although it is unclear why there was a lack of replication from the valence data, it seems likely that data variability and noise contributed to the null result.

RESULTS: SUMMARY DISCUSSION

Summary of Attitude Change Results

A series of four experiments tested key predictions made by a non-linear model of two-actor cooperation/competition (Liebovitch et al., 2008; 2010). Results from all four studies were highly consistent and collectively provide the first empirical evidence that verifies the simulation outputs. Based on qualitative interpretation of model generated phase spaces representative of how attitudes and emotions evolve according to different interaction scenarios, participants' attitude patterns predominantly matched model predictions across all four studies.

In Study 1, participants who experienced a neutral (control) interaction exhibited stable attitudes analogous to the model prediction of a fast attitude stabilization. In this study, participants' attitudes were also stable over the course of the interaction regardless of participants experiencing a consistently cooperative or consistently competitive interaction. More interesting empirical results were found with the two feedback switch scenarios in the first study. While empirical results did match the model prediction that an interaction switch from cooperation to competition would result in perturbed, fluctuating attitudes over time, the model's prediction that the same would happen in a switch from competition to cooperation was not verified. In order to simplify the experimental studies and to further investigate the inconsistency between the model and this result, the remaining three studies did not include the continual cooperation or continual competition feedback scenarios. Instead, subsequent studies examined only the control case versus the two feedback switching cases.

From Studies 2 through 4 a similar result emerged. Participants who experienced a neutral (control) interaction marked by minimal feedback exhibited highly stable attitudes, which matched confirmed model predictions. Model predictions were further verified in the final three studies with respects to the condition where participants experienced initial cooperation replaced by competition. Encountering this interaction shift resulted in these participants exhibiting fluctuating, unstable attitudes. However, Studies 2 through 4 participants who encountered an interaction proceeding from competition to cooperation failed to react to the shift. These participants' attitudes remained just as stable as those of participants in the control scenario. These findings were replicated across all four studies, as summarized in Table 11.

	Attitude Pattern				
Condition	**Control**	**Cooperation**	**Competition**	**Cooperation → Competition**	**Competition → Cooperation**
Study 1	Stable*	Stable*	Stable*	Unstable*	Stable
Study 2	Stable*	*Not tested*	*Not tested*	Unstable*	Stable
Study 3	Stable*	*Not tested*	*Not tested*	Unstable*	Stable
Study 4	Stable*	*Not tested*	*Not tested*	Unstable*	Stable

* Indicates model predictions were verified

Table 11: Summary of attitude patterns identified from the attitude surveys across all four studies. The results exhibit high consistency and confirmed a majority of the model predictions.

In Studies 2, 3, and 4 different manipulations were used in an attempt to identify whether specific factors were causing the discrepancy between the model predictions and empirical findings. One possible source for the discrepancy could have been that participants entered the interaction expecting a mildly positive exchange. It is well-known that when anticipating outcomes people are generally optimistic, especially when initial feedback is limited (e.g. Taylor & Armor, 1996). If participants began the interactions expecting a cooperative exchange with the confederates, then the scenario where they confronted an initially dissimilar, competitive confederate may have resulted in some sort of mental shift that influenced the experimental results. Such a shift may reflect "bracing for bad news" (Sweeny, Shepperd, & Carroll, 2009) or threat diminishing through information-processing alteration (e.g. Munro & Stansbury, 2009; Munro & Ditto, 1997). Alternatively, the experience of a strongly dissimilar other at the onset of an interaction may have led the participant to judge the confederate as an outgroup member, leading the participant to have a diminished engagement in the interaction. Study 2 was designed to examine whether anticipation of a positive exchange influenced the results. Prior to the interaction, participants were provided with a short prime, an alleged survey result that framed the confederate as a likeable, cooperative individual or as a dislikeable, competitive individual. Despite the prime, the same pattern of attitude change emerged in Study 2 as in Study 1. Accordingly, it seems likely that the anticipation of a positive, cooperative exchange had little bearing on the results.

Study 3 and Study 4 examined whether the timing of the interaction shift played a role in participants' attitude change. For the third study, participants in the non-control conditions experienced a double shift (cooperation to competition back to cooperation, or competition to cooperation back to competition). This was a natural follow-up to the second study, as it was thought that perhaps the priming was too weak and allowed for greater control in terms of how participants' came to perceive the confederate at specific time points. If participants do merely disengage from an interaction with an initially dissimilar confederate, then the confederate's response style should evoke little change in participants' attitudes over the course of the interaction. In Study 3, this was not found. Instead, participants consistently exhibited increased attitude change whenever the interaction transitioned from similarity and cooperation to dissimilarity and competition. Likewise, participants consistently had little attitude change in response to a shift from competition to cooperation. These results replicated what was found in Study 1 and Study 2 and led to the same general conclusion: people react strongly to sudden competition but do not react proportionately to sudden cooperation, even when that competition is mild.

Finally, Study 4 sought to identify whether people would react to cooperation following competition provided the cooperation was sustained for a longer duration. Results from this study replicated previous findings. Participants' attitudes showed reactivity only when the interaction shifted from cooperation to competition. Sustained cooperation yielded no appreciable attitude fluctuation over time. In sum, a majority of the model predictions about how people's attitudes would respond to or neutral feedback, cooperation, competition, or mixed cooperation/competition were verified, as illustrated in Figure 32.

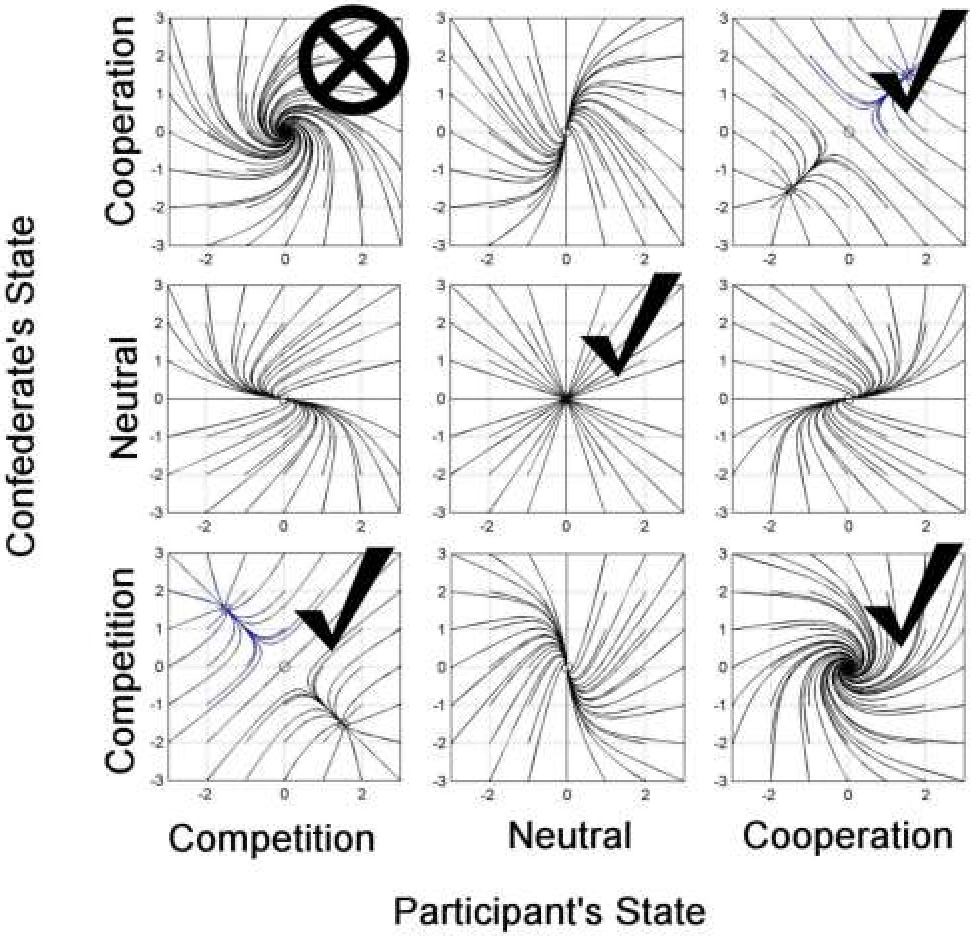

Figure 32: The possible interaction configurations according to the model with experimentally verified cases indicated (check marks). In all scenarios examined, the model predictions of how people's attitudes should evolve were accurate. However, the model failed in the case when a person was lead into a competitive state and then encountered cooperation (crossed out mark). Note: see Figure 10 for explanation on the different model scenarios.

Summary of Valence Change Results

Similar to findings from the attitude change measure, participants' valence exhibited changes anticipated by model predictions. In Study 1, participants' valence exhibited a tendency to become mildly more positive over the duration of the experiment regardless of encountering a neutral feedback (control), constantly cooperative, or constantly competitive condition. The lack of significant difference in these conditions may reflect the benign nature of the interaction participants experienced. The model predicts that in cases of consistent cooperative or competitive feedback at a low intensity levels, people's emotions should evolve to a steady neutral state (Liebovitch et al., 2008; 2010). In comparison, the model predicts that people's emotions should progress through fluctuations over some duration when encountering an interaction that transitions from cooperation into competition, or vice-versa. Empirical evidence for this was expected to be revealed by participants' valence states presenting some sort of significantly different change pattern when encountering a feedback switch as compared to those encountering a steady feedback scenario. However, experimental results were mixed.

Foremost, the valence pattern over time was significantly different for people who encountered an interaction that progressed from cooperation to competition. With Study 1, these participants experienced significantly more negative valence than did those in most other conditions. In contrast, participants who experienced an interaction shifting from competition to cooperation did not exhibit any unusual valence pattern compared to the majority of other groups. Similar to what happened for attitude change, valence change is minimal when people encounter an interaction shifting from competition to cooperation.

These results were replicated in Study 2 and in Study 3. In the second study, participants' valence became more negative after an interaction switched from cooperation to competition regardless of whether they were led to believe they would communicate with a likeable, cooperative partner or a disagreeable, competitive partner. Subsequently, the third study provided further replication and demonstrated that the more negative valence arises regardless of an interaction's history. Any switch in an interaction from cooperation to competition evokes more negative valence. Finally, valence changes in Study 4 were found to exhibit little statistical significance. The lack of replication in the final study seems to be a problem partially rooted in the extreme variations in participants' valence data. Main valence findings are summarized in Table 12.

Comparing the valence data results to the model predictions is not as straightforward as the attitude data. One key reason for this is that participants' valence tended to change over the course of the experiment regardless of what experimental condition they experienced. While in many experimental conditions the change over the course of the experiment was modest, there was a tendency for participants to indicate a more positive valence as the session progressed. The one difference was that in the majority of the studies, participants indicated a significantly more negative valence when encountering an interaction that shifted from cooperation to competition. The nonlinear model predicts that valence perturbation should result from such a shift. However, the model also predicts a more rapid stabilization in valence than was found experimentally. The model did not account for the gradual positive valence trend observed in many of the conditions, including the control. One explanation for the positivity trend is that participants engaged in a positivity bias as the experiment progressed. Participants could likely gauge how much time in the experiment had elapsed by monitoring questions in the video recording playback. Therefore, they may have had a general sense of when the session was nearing an end. This time perception may have contributed to increased positivity due to a perceptual shift (e.g. O'Brien & Ellsworth, 2012) or to their merely being glad to be almost done with the study.

	Valence Change Pattern				
Condition	**Control**	**Cooperation**	**Competition**	**Cooperation → Competition**	**Competition → Cooperation**
Study 1	↑ Positive	↑ Positive	↑ Positive	↑ Negative	↑ Positive
Study 2	↑ Positive	*Not tested*	*Not tested*	↑ Negative	↑ Positive
Study 3	↑ Positive	*Not tested*	*Not tested*	↑ Negative	↑ Positive
Study 4	↑ Positive	*Not tested*	*Not tested*	↑ Positive	↑ Positive

Table 12: Summary of valence change patterns identified from the attitude surveys across all four studies. Generally, participants expressed a slightly more positive valence as the interaction progressed. The exception was in conditions where participants experienced a transition from a cooperative interaction to a competitive interaction. In the majority of the studies, this type of shift resulted in participants having more negative valence.

An additional discrepancy between the simulation predictions and experimental results was identified in the case where participants experienced an interaction involving transition from dissimilarity and competition to cooperation. Like attitudes, the model predicted such an interaction feedback change would result in perturbed valence. However, this again was not the case empirically. This finding makes sense considering the results from the attitude surveys. Participants exhibited little cognitive change via their attitudes when experiencing interaction shifts from competition to cooperation. The contrast in participants' attitude and emotion reaction in response to feedback transitioning from cooperation to competition versus competition to cooperation is insightful. The rise of cooperation in a previously competitive interaction fails to yield significant short term consequences on broader cognitive dynamics. In contrast, sudden conflict following cooperation is impactful across a variety of cognitive domains even in a benign interaction.

Correlations Summary

Several significant correlations were found in the experimental data across the different studies. One of the most important correlation results was the finding that greater attitude change scores were associated with a tendency to express more negative valence over the course of the experiment. The negative correlation between attitude change and valence was identified in both Study 1 ($r = -.247$, $p = .024$) and in Study 3 ($r = -.307$, $p = .006$). The same correlations were not found in Study 2 or Study 4. In the second experiment, participants' valence data exhibited diminished reactivity in response to interaction shifts. Apparently, priming participants to anticipate either a similar, cooperative or dissimilar, competitive interaction partner resulted in some sort of valence damping. Finally, in Study 4, the lack of correlation makes sense considering that this data did not exhibit statistically significant condition differences in the valence data.

The detailed analysis of valence data dynamics performed in Study 1 reveal an interesting correlation between the range of valences participants expressed as the experiment progressed and the number of significant autocorrelation lags identified in each individual's valence data. Specifically, there was a negative correlation between the autocorrelation lags and range of valence (r = -.370, p = .001). This result follows the dynamical systems interpretation of valence range. Greater stability (indicated by a greater number of significant autocorrelation lags) is associated with a more restricted, stable range of valence.

One final correlation of note was the relationship between action identification (Behavioral Identification / BIF) scores and the moment to moment valence change in Study 2. Here, a negative correlation between BIF scores and and momentary valence change was identified (r = -.308, p = .004). This indicates that a higher level of action identification was associated with diminished moment to moment valence change. Dynamically, this result suggests people who frame information in more abstract, higher level terms exhibit less moment to moment valence variation.

DISCUSSION

Consistent with the predictions derived from the non-linear model, participants who encountered a neutral, continually cooperative, or continually competitive exchange exhibited relatively stable attitudes while those who experienced an interaction that transitioned from cooperation to competition displayed increased cognitive reaction following the interaction shift. In contrast, the model prediction that participants encountering a shift from competition to cooperation would exhibit similar reaction was not verified. These general findings were consistent across all four studies and appear to be independent of interaction expectancy (Study 2), multiple shifts in the interaction feedback style (Study 3), or longer duration of consistent feedback following a shift (Study 4).

Similar patterns were identified with participants' valence. In the majority of the studies (1 through 3) participants who encountered an interaction transitioning from cooperation competition expressed significantly more negative valence than other experimental groups. In Study 1 and Study 3, this progression to a more negative emotional state was correlated with the increased attitude perturbation observed when people experienced a cooperative interaction transitioning into competition. While Study 4 did not replicate these findings, it appears that the significant amount of individual difference in the mouse cursor movements used to track valence over time may have factored into the final study's null finding. Generally considered, the studies were consistent in identifying a transition to more negative valence following an interaction shift from cooperation and similarity to competition and dissimilarity.

These results offer two important insights into the cognitive and affective processes at work in cooperative versus competitive interactions. Foremost, across the four studies participants consistently exhibited limited attitude and emotional reaction to persistently competitive interactions. This result indicates why the evolution of interactions is so critical to basic research pertaining to psychological processes and social exchanges. Conflict by itself, per-se, was not a source for attitude and emotion disturbance.

The lack of reaction to cooperation following a competitive exchange fits with numerous theoretical interpretations. One possibility is that the participants who experienced an outright competitive exchange quickly realized that their attitudes were divergent from their interaction partner's and with this realization the participants changed their attitude towards the confederate as a least costly course of action. Such a shift in judgment towards the other (confederate) would mitigate the threat instilled by the dissimilar attitudes and thereby reduce the participants' need to engage in other meaning threat reduction processes. For instance, this interpretation fits with Heider's (1958) balance theory, which suggests that given a balanced negative exchange, a person will either change his or her view of the other individual or will change his or her attitude so that it becomes more congruent. From the experimental data, participants did not change their attitudes in respects to the targets (the survey items). Accordingly, participants may have instead merely changed their perception of their interaction partner.

Alternatively, participants who encountered initially negative feedback in the interaction may have simply detached from the interaction, choosing to ignore or reduce the importance of the feedback. This possibility is well studied in self-affirmation research, where participants exposed to information that threatens personally important attitudes minimize the threat through information-processing alteration (e.g. Heine, Proulx, & Vohs, 2006; Munro & Stansbury, 2009; Munro & Ditto, 1997). By changing their attitudes towards the confederate or by minimizing the importance of the information exchanged, participants who began the interaction session by receiving competitive feedback could reduce cognitive dissonance. This possible explanation gains support from the experimental finding that participants exhibited little attitude or emotion reaction in the interactions that shifted from competition to cooperation. If participants dismissed the confederate and/or the confederate's feedback following a period of competition and dissimilarity, then the restoration of cooperation and similarity would be expected to generate little effect.

The principal results that people exhibit greater attitude instability when experiencing a competition following a cooperative exchange and no appreciably greater instability when encountering an interaction marked by cooperation after competition may also be understood as a coordination effect. Coordination is an especially powerful social force. Once established, the coordination can become a core feature of a social exchange such that those involved in the interaction actively resist disruption of the coordination (Richardson, Marsh, & Baron, 2007). Coordination further evokes prosocial behaviors (van Baaren, Holland, Kawakami, & van Knippenberg 2004), closeness (LaFrance & Broadbent, 1976), and a sense of belonging (Chartrand & Bargh, 1999). It is well known that attitude similarity provides many of these same effects and provides for a sense of similarity and coordinated exchange (e.g. Byrne, 1971) that facilitate interaction stability (e.g. Davis & Rusbult, 2001). Cooperative exchanges, in particular, may enhance social coordination since positive, cooperative feedback is known to promote behavioral mimicry (e.g. Huntsinger, Lun, Sinclair, & Clore, 2009; Leighton, Bird, Orsini, & Heyes, 2010). Accordingly, it is plausible that the initially cooperative exchange facilitated a sense of interaction coordination for participants. When the coordinated, similar attitudes were disrupted upon the interaction transition into competition, participants may have reacted in response to the coordination loss. The fact that participants experiencing such a scenario reacted with negative valence and fluctuation of their own expressed attitudes suggests the transition was experienced as unpleasant. The attitude response changes may reflect an attempt to restore the stability (c.f. Byrne, 1971) and resist the dissolution of the coordination (c.f. Richardson, Marsh, & Baron, 2007).

Comparatively, the lack of attitude or valence effect when the interaction progressed from competition into cooperation may indicate that the initially competitive exchange failed to evoke a sense of coordination. The onset of cooperation may have coincided with newly formed interaction coordination in participants' minds. This assessment seems valid considering that in Study 3, participants experienced a double interaction shift. That is, they experienced an exchange progressing from cooperation to competition back to cooperation – and – an exchange progressing from competition to cooperation back to competition. In this study, participants exhibited increased attitude change and more negative valence whenever the interaction transitioned from cooperation to competition. In the benign, highly controlled social interactions used in this and the other three studies, it appears that the sense of similar attitudes led to powerful attitude and valence effects that are well explained by the idea of social coordination. This general interpretation fits well with the findings in Study 1, where no attitude or valence effect was found in cases where people experienced continually cooperative or continually competitive feedback. In the first case, continuous cooperation via similar attitude expression led to a balanced, coordinated exchange without disruption. Participants had no reason to cognitively or affectively react. Likewise, in a continuous competition via dissimilar attitude expression, participants never established a sense of coordination with the confederate. Therefore, they exhibited little attitude or affect reaction as the interaction was never perceived as proceeding with a fluid, smooth coordination.

Results and Human Conflict

Results from all four studies indicate that the primary attitude and valence effects manifested whenever participants experienced an interaction transitioning from cooperation to competition. Participants who experienced a transition in the confederate's feedback that progressed from cooperation to competition were more prone to react with larger shifts in attitude and more negative valence than the other experimental groups in nearly all of the experimental cases. Interestingly, the participants in the constantly competitive feedback group did not express a similarly more negative valence over the duration of the interaction session in any of the experiments. Indeed, participants in the constantly competitive interactions ended the experiment with a valence similar to what was expressed by participants who experienced cooperative interactions or interactions that shifted from competition to cooperation. Taken together, these findings provide new insight into the psychological processes involved in conflict. People do not necessarily react to competition, dissimilarity, and conflict alone. Rather, psychological reaction manifests in response to changes in an interaction, particularly when a previously harmonious interaction transitions into conflict.

A fundamental conclusion from this study is that there exists an asymmetry in terms of response shifts in a social interaction. The fact that participants responded to the dissolution of a cooperative interaction into a competitive situation more strongly in attitude and valence measures than to the transition of an interaction from a competitive to cooperative circumstance reveals that people express greater psychological response to the onset of unexpected conflict than to unexpected cooperation. This finding merges with existing literature that broadly finds people exhibit a disproportionate psychological response in response to negative information as opposed to positive. For example, these results match with Gottman's (1994) well known finding that marriage partners are more reactive to negative information from their husband or spouse than to positive information. Outside of marriage, people have a tendency to place greater emphasis on negative traits (e.g. attitude disagreement) when trying to form an evaluation of a person (Kanouse & Hanson, 1971). Intuitively, it may be that with the development of a persistently cooperative situation, people let down their guard so that the onset of competition prompts substantially more reaction. Some form of social coordination, as previously discussed, may be at work in this case. Alternatively, the cooperation experienced from an interaction with a similar other may yield a mild positive affect and elicited a sense of agreeableness between the participant and confederate. If this were the case, the positive affect and implicit cognitive-affective matching experienced in the interaction may cause people to be more susceptible to attitude change (c.f., Clarkson, Tormala, & Rucker, 2011). Similarly, the sense of an agreeable other and agreeable exchange may have caused participants greater reaction to changes in the social exchange due to regulatory mechanisms. The sudden competition could then trigger a psychological compensation mechanism in participants, leading them to regulate their attitudes in an attempt to control their negative affect (c.f. Kammrath & Scholer, 2011). That attitude change arises in response to emotion seems further supported by empirical research indicating that conflict reduction may be facilitated through focus on identity affirmation (Boudreau, 2003) and that the losing side in a conflict become motivated to take revenge or force their adversary to acknowledge their loss (Shnabel, Nadler, Ullrich, Dovidio, & Carmi, 2009).

Further exploration of exactly why this asymmetry was observed is of particular interest from a dynamical systems perspective as it may indicate hysteresis, which is a hallmark of non-linear systems (Nowak and Vallacher, 1998). Identifying hysteresis from the experimental data would thus further validate use of non-linear equations to model human cooperation and conflict.

The results from this study lend support to cautious conflict resolution procedures like Osgood's GRIT strategy, where one group engaged in an intractable conflict engages in initiatives to reduce conflict while maintaining active communication with the adversary (Blumberg, 2006a). The success of the GRIT is related to one of the previously competing groups (or individuals) responding cooperatively to a single side's conflict reducing gestures. Effectively, the GRIT strategy gradually extracts a mutually cooperative interaction between previously competing rivals. In the alternative feedback switching case, when a constantly competitive interaction suddenly ceases by one side expressing cooperation, the party that did not initiate the cooperation may continue to engage with defensiveness and suspicion. Some support for this possibility is provided by Leng's (1993) findings on conflict resolution where cooperative initiatives (as those suggested by the GRIT) were typically merely offers to negotiate, were usually delivered with some sort of a threat. The joint conclusion from the experimental results and Leng's (1993) work is that it is easier to start a conflict than to cease one and the defensiveness arising from a betrayal will dull the impact of the betrayer's attempts at reconciliation. Finally, the results from this study combined with the simulations link affective response to conflict (through the onset of competition), which is a connection that has not been extensively studied (Nair, 2008).

Limitations

One important limitation to this research is that it is unclear on exactly how all of the model parameters should be translated into operational usage. Liebovitch, et al. (2008) describe the parameters as representing "inertia to change," the "uninfluenced state," and "the influenced state" of the individuals or groups involved in the modeled interaction. Precisely what these states are, especially quantitatively, remains unresolved. For this study, mood – in the form of valence – and attitude on a variety of topics were used as logical approximations of the participant's psychological state, as these could capture cognitive and affective elements. The decision to test the model predictions using attitudes and valence was not made arbitrarily. Gottman's (2005) own research models of how husbands and wives interacted were heavily focused on emotional aspects of positive and negative interaction. Therein, the valence measure seemed a natural inclusion for this study. One motivation for the attitude measure inclusion was that it could be first utilized as a means to have participants interact with the confederate. A second motivation was that the attitude survey results could provide useful data about whether changes in the confederate's response style would evoke changes in the participants' attitudes.

In addition, it is also unclear as to what the precise time-dependent outputs from the non-linear model represent. The interaction sessions lasted for only a short time (typically about 5 to 10 minutes), and it is likely that the interaction did not last long enough to yield results capable of complete reconciliation with the model outputs.

Another limitation is that the data do not allow precise formulation of what underlying psychological mechanisms facilitated changes in participants' attitudes and valence (or lack of changes). Since the participant and confederate took turns in reading and responding to each attitude survey item, it is further unclear if the participant was adjusting his or her attitudes in response to perceived ingratiation by the confederate (when attitudes matched) or in response to weak will (when attitudes did not match). In short, the precise mental dynamics responsible for the results observed in this study are ambiguous. This limitation noted, it should be emphasized that this particular study focused on identifying broad patterns and demonstrating the validity of a model-inspired paradigm. The specific mechanisms influencing the patterns observed can be explored with future research.

Future Studies

There are three key areas for future research derived from the present work. First, it is important to generalize these results into a broader range of cooperation and conflict scenarios. There was minimal interaction between participants and confederates in all of the studies and the sense of cooperation or competition evoked by the interaction feedback styles was likely very mild. Future research should determine whether the collective results hold in cases of more intense, realistic cooperation or competition. This is especially true of the case when a competitive interaction transitions into cooperation. A key question future work can answer is how much cooperation is necessary to overcome an interaction marred by a history of competition?

Finally, the mathematical model used to guide this research should be further explored. Critically, a modification to the model to adjust for the asymmetric response to competitive versus cooperative feedback seems warranted. The modification may likely be achieved by adjusting the feedback coupling parameter (the *c*-terms in the equations) so that these are simple functions rather than constants.

Conclusion

These four studies offer the first empirical support for predictions offered the non-linear model of two-actor coperation and conflict formulated by Liebovitch et al. (2008). The majority of interaction simulation results from the model were verified experimentally, with the exception being the scenario when a participant experienced competition transitioning into cooperation. The results suggest that the non-linear model successfully captures the time-course trajectory of attitude and valence in many different types of social interactions, at least for a short time period. By further understanding the precise factors that influence how people respond to an unanticipated change in an interaction in terms of cognition and valence, it is possible to better understand how psychological reactions lead to the development and sustainment of conflict. Results from this and future studies can further examine the qualitative patterns of cooperation and conflict given by the Liebovitch et al. (2008) non-linear model, and the combined result from the empirical work and simulations can lead to new ways to understand how conflict develops, persists, and how may it may be resolved.

APPENDIX 1:

ATTITUDE SURVEY USED IN STUDY 1

INSTRUCTIONS: Read each sentence carefully and think "Is this important to me, and do I agree with it?"

If you *agree strongly* put a circle around………………..	1 2 3 4 5 6 [7]
If you are *not certain* put a circle around ……………….	1 2 3 [4] 5 6 7
If you *disagree strongly* put a circle around …………….	[1] 2 3 4 5 6 7
If it is *very important* to you put a circle around…………	1 2 3 4 5 6 [7]
If you are *not certain* put a circle around ………………..	1 2 3 [4] 5 6 7
If it is *not at all important* to you put a circle around……	[1] 2 3 4 5 6 7
If you are *very certain* about your (dis)agreement put a circle around….	1 2 3 4 5 6 [7]
If you are *very* ***un****certain* about your (dis)agreement put a circle around…	[1] 2 3 4 5 6 7

1. Sunny days are the best.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

2. People should strongly protect animal rights.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

3. Marriage is a sacred right.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

4. Math is a worthwhile subject.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

5. The death penalty is just.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

6. Textbooks cost too much.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

7. Family is more important than friends.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

8. All students should be required to take a calculus class.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

9. Florida is the best state.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

10. Sport utility vehicles should be outlawed.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

11. Business classes are interesting.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

12. Communication is the most important thing in a relationship.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

13. People should think before doing.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

14. War should always be an option for dealing with tough enemies.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

15. Winter is better than summer.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

16. Women are treated equally in school and at jobs.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

17. Students who don't perform should be expelled.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

18. We need more public transportation.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

19. Pepsi is better than Coke.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

20. Youths should always obey their parents.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

21. Accessible healthcare is a right.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

22. Mondays are a great days.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

23. Each person should give to charity regularly.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

24. Good people attend church.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

25. Classes should be scheduled for earlier in the day.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

26. Students should be required to serve their school.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

27. The beach is nicer than the mountains.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

28. Nuclear weapons are necessary to protect our nation.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

29. Laws should be strictly enforced.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **un**certain	1 2 3 4 5 6 7	Very certain

30. Gold looks nicer than silver.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

31. We must conserve water.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

32. Cities should look after homeless people.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

33. Students should be made to volunteer during the summer.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

35. There is plenty of parking on campus.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

36. Cookies are better than cake.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

37. Parents should fully arrange their children's marriages.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

38. Laws should be based on faith.

Disagree strongly	1 2 3 4 5 6 7	Agree strongly
Not at all important	1 2 3 4 5 6 7	Very important
Very **<u>un</u>**certain	1 2 3 4 5 6 7	Very certain

39. Basketball is the most interesting sport.

Disagree strongly	1	2	3	4	5	6	7	Agree strongly
Not at all important	1	2	3	4	5	6	7	Very important
Very **<u>un</u>**certain	1	2	3	4	5	6	7	Very certain

40. Grades should be decided by class attendance.

Disagree strongly	1	2	3	4	5	6	7	Agree strongly
Not at all important	1	2	3	4	5	6	7	Very important
Very **<u>un</u>**certain	1	2	3	4	5	6	7	Very certain

THANK YOU! THIS IS THE END OF THE SURVEY.

APPENDIX 2:

PERSONALITY SURVEYS USED IN STUDY 2

Instructions: Read each sentence carefully and think "Is this important to me, and do I agree with it?"

If you *agree strongly* put a circle around………………..	1 2 3 4 5 [6]
If you *disagree strongly* put a circle around …………….	[1] 2 3 4 5 6

1. Sunny days are the best.

Disagree strongly 1 2 3 4 5 6 Agree strongly

2. People should strongly protect animal rights.

Disagree strongly 1 2 3 4 5 6 Agree strongly

3. Marriage is a sacred right.

Disagree strongly 1 2 3 4 5 6 Agree strongly

4. Math is a worthwhile subject.

Disagree strongly 1 2 3 4 5 6 Agree strongly

5. The death penalty is just.

Disagree strongly 1 2 3 4 5 6 Agree strongly

6. Textbooks cost too much.

Disagree strongly 1 2 3 4 5 6 Agree strongly

7. Family is more important than friends.

Disagree strongly 1 2 3 4 5 6 Agree strongly

8. All students should be required to take a calculus class.

Disagree strongly 1 2 3 4 5 6 Agree strongly

9. Florida is the best state.

Disagree strongly 1 2 3 4 5 6 Agree strongly

10. Sport utility vehicles should be outlawed.

Disagree strongly 1 2 3 4 5 6 Agree strongly

11. Business classes are interesting.

Disagree strongly 1 2 3 4 5 6 Agree strongly

12. Communication is the most important thing in a relationship.

Disagree strongly 1 2 3 4 5 6 Agree strongly

13. People should think before doing.

Disagree strongly 1 2 3 4 5 6 Agree strongly

14. War should always be an option for dealing with tough enemies.

Disagree strongly 1 2 3 4 5 6 Agree strongly

15. Winter is better than summer.

Disagree strongly 1 2 3 4 5 6 Agree strongly

16. Women are treated equally in school and at jobs.

Disagree strongly 1 2 3 4 5 6 Agree strongly

17. Students who don't perform should be expelled.

Disagree strongly 1 2 3 4 5 6 Agree strongly

18. We need more public transportation.

Disagree strongly 1 2 3 4 5 6 Agree strongly

19. Pepsi is better than Coke.

Disagree strongly 1 2 3 4 5 6 Agree strongly

20. Youths should always obey their parents.

Disagree strongly 1 2 3 4 5 6 Agree strongly

21. Accessible healthcare is a right.

Disagree strongly 1 2 3 4 5 6 Agree strongly

22. Mondays are a great days.

Disagree strongly 1 2 3 4 5 6 Agree strongly

23. Each person should give to charity regularly.

Disagree strongly 1 2 3 4 5 6 Agree strongly

24. Good people attend church.

Disagree strongly 1 2 3 4 5 6 Agree strongly

25. Classes should be scheduled for earlier in the day.

Disagree strongly 1 2 3 4 5 6 Agree strongly

26. Students should be required to serve their school.

Disagree strongly 1 2 3 4 5 6 Agree strongly

27. The beach is nicer than the mountains.

Disagree strongly 1 2 3 4 5 6 Agree strongly

28. Nuclear weapons are necessary to protect our nation.

Disagree strongly 1 2 3 4 5 6 Agree strongly

29. Laws should be strictly enforced.

Disagree strongly 1 2 3 4 5 6 Agree strongly

30. Gold looks nicer than silver.

Disagree strongly 1 2 3 4 5 6 Agree strongly

31. We must conserve water.

Disagree strongly 1 2 3 4 5 6 Agree strongly

32. Cities should look after homeless people.

Disagree strongly 1 2 3 4 5 6 Agree strongly

33. Students should be made to volunteer during the summer.

Disagree strongly 1 2 3 4 5 6 Agree strongly

34. It is better to eat a big breakfast.

Disagree strongly 1 2 3 4 5 6 Agree strongly

35. There is plenty of parking on campus.

Disagree strongly 1 2 3 4 5 6 Agree strongly

36. Cookies are better than cake.

Disagree strongly 1 2 3 4 5 6 Agree strongly

37. Parents should fully arrange their children's marriages.

Disagree strongly 1 2 3 4 5 6 Agree strongly

38. Laws should be based on faith.

Disagree strongly 1 2 3 4 5 6 Agree strongly

39. Basketball is the most interesting sport.

Disagree strongly 1 2 3 4 5 6 Agree strongly

40. Grades should be decided by class attendance.

Disagree strongly 1 2 3 4 5 6 Agree strongly

Read each of the following statements and decide how much you agree with each according to your beliefs and experiences. Please respond according to the following scale:

1 strongly disagree
2 moderately disagree
3 slightly disagree
4 slightly agree
5 moderately agree
6 strongly agree

---

01. I think that having clear rules and order at work is essential for success.

Disagree strongly 1 2 3 4 5 6 Agree strongly

02. Even after I've made up my mind about something, I am always eager to consider a different opinion.

Disagree strongly 1 2 3 4 5 6 Agree strongly

03. I don't like situations that are uncertain.

Disagree strongly 1 2 3 4 5 6 Agree strongly

04. I dislike questions which could be answered in many different ways.

Disagree strongly 1 2 3 4 5 6 Agree strongly

05. I <u>like</u> to have friends who are unpredictable.

Disagree strongly 1 2 3 4 5 6 Agree strongly

06. I find that a well ordered life with regular hours suits my temperament.

Disagree strongly 1 2 3 4 5 6 Agree strongly

07. I enjoy the uncertainty of going into a new situation without knowing what might happen.

Disagree strongly 1 2 3 4 5 6 Agree strongly

08. When dining out, I like to go to places where I have been before so that I know what to expect.

Disagree strongly 1 2 3 4 5 6 Agree strongly

09. I feel uncomfortable when I don't understand the reason why an event occurred in my life.

Disagree strongly 1 2 3 4 5 6 Agree strongly

10. I feel irritated when one person disagrees with what everyone else in a group believes.

Disagree strongly 1 2 3 4 5 6 Agree strongly

11. I hate to change my plans at the last minute.

Disagree strongly 1 2 3 4 5 6 Agree strongly

12. I would describe myself as indecisive.

Disagree strongly 1 2 3 4 5 6 Agree strongly

13. When I go shopping, I have difficulty deciding exactly what it is I want.

Disagree strongly 1 2 3 4 5 6 Agree strongly

14. When faced with a problem I usually see the one best solution very quickly.

Disagree strongly 1 2 3 4 5 6 Agree strongly

15. When I am confused about an important issue, I feel very upset.

Disagree strongly 1 2 3 4 5 6 Agree strongly

16. I tend to put off making important decisions until the last possible moment.

Disagree strongly 1 2 3 4 5 6 Agree strongly

17. I usually make important decisions quickly and confidently.

Disagree strongly 1 2 3 4 5 6 Agree strongly

18. I have never been late for an appointment or work.

Disagree strongly 1 2 3 4 5 6 Agree strongly

19. I think it is fun to change my plans at the last moment.

Disagree strongly 1 2 3 4 5 6 Agree strongly

20. My personal space is usually messy and disorganized.

Disagree strongly 1 2 3 4 5 6 Agree strongly

21. In most social conflicts, I can easily see which side is right and which is wrong.

Disagree strongly 1 2 3 4 5 6 Agree strongly

22. I have never known someone I did not like.

Disagree strongly 1 2 3 4 5 6 Agree strongly

23. I tend to struggle with most decisions.

Disagree strongly 1 2 3 4 5 6 Agree strongly

24. I believe orderliness and organization are among the most important characteristics of a good student.

Disagree strongly 1 2 3 4 5 6 Agree strongly

25. When considering most conflict situations, I can usually see how both sides could be right

Disagree strongly 1 2 3 4 5 6 Agree strongly

26. I don't like to be with people who are capable of unexpected actions.

Disagree strongly 1 2 3 4 5 6 Agree strongly

27. I prefer to socialize with familiar friends because I know what to expect from them.

Disagree strongly 1 2 3 4 5 6 Agree strongly

28. I think that I would learn <u>best</u> in a class that <u>lacks</u> clearly stated objectives and requirements
.

Disagree strongly 1 2 3 4 5 6 Agree strongly

29. When thinking about a problem, I consider as many different opinions on the issue as possible
.

Disagree strongly 1 2 3 4 5 6 Agree strongly

30. I don't like to go into a situation without knowing what I can expect from it.

Disagree strongly 1 2 3 4 5 6 Agree strongly

31. I like to know what people are thinking all the time.

Disagree strongly 1 2 3 4 5 6 Agree strongly

32. I dislike it when a person's statement could mean many different things.

Disagree strongly 1 2 3 4 5 6 Agree strongly

33. It's annoying to listen to someone who cannot seem to make up his or her mind.

Disagree strongly 1 2 3 4 5 6 Agree strongly

34. I find that establishing a consistent routine enables me to enjoy life more.

Disagree strongly 1 2 3 4 5 6 Agree strongly

35. I enjoy having a clear and structured mode of life.

Disagree strongly 1 2 3 4 5 6 Agree strongly

36. I <u>prefer</u> interacting with people whose opinions are very different from my own.

Disagree strongly 1 2 3 4 5 6 Agree strongly

37. I like to have a plan for everything and a place for everything.

Disagree strongly 1 2 3 4 5 6 Agree strongly

38. I feel uncomfortable when someone's meaning or intention is unclear to me.

Disagree strongly 1 2 3 4 5 6 Agree strongly

39. I believe that one should never engage in leisure activities.

Disagree strongly 1 2 3 4 5 6 Agree strongly

40. When trying to solve a problem I often see so many possible options that it's confusing.

Disagree strongly 1 2 3 4 5 6 Agree strongly

41. I always see many possible solutions to problems I face.

Disagree strongly 1 2 3 4 5 6 Agree strongly

42. I'd rather know bad news than stay in a state of uncertainty.

Disagree strongly 1 2 3 4 5 6 Agree strongly

43. I feel that there is no such thing as an honest mistake.

Disagree strongly 1 2 3 4 5 6 Agree strongly

44. I do not usually consult many different options before forming my own view.

Disagree strongly 1 2 3 4 5 6 Agree strongly

45. I dislike unpredictable situations.

Disagree strongly 1 2 3 4 5 6 Agree strongly

46. I have never hurt another person's feelings.

Disagree strongly 1 2 3 4 5 6 Agree strongly

47. I dislike the routine aspects of my work (studies).

Disagree strongly 1 2 3 4 5 6 Agree strongly

Any behavior can be described in many ways. For example, one person might describe a behavior as "writing a paper," while another person might describe the same behavior as "pushing keys on the keyboard." Yet another person might describe it as "expressing thoughts." This form focuses on your personal preferences for how a number of different behaviors should be described. Below you will find several behaviors listed. After each behavior will be two different ways in which the behavior might be identified. For example:

EXAMPLE: **1. Attending class**

_____a. sitting in a chair

_____b. looking at a teacher

Your task is to choose the identification, a or b, that best describes the behavior for you. Simply place a checkmark next to the option you prefer. Be sure to respond to every item. Please mark only one alternative for each pair. Remember, mark the description that you personally believe is more appropriate for each pair.

1. Making a list

_____a. Getting organized

_____b. Writing things down

2. Reading

_____a. Following lines of print

_____b. Gaining knowledge

3. Joining the Army

_____a. Helping the Nation's defense

_____b. Signing up

4. Washing clothes

_____a. Removing odors from clothes

_____b. Putting clothes into the machine

5. Picking an apple

_____a. Getting something to eat

_____b. Pulling an apple off a branch

6. Chopping down a tree

_____a. Wielding an axe

_____b. Getting firewood

7. Measuring a room for carpeting

_____a. Getting ready to remodel

_____b. Using a yard stick

8. Cleaning the house

_____a. Showing one's cleanliness

_____b. Vacuuming the floor

9. Painting a room

_____a. Applying brush strokes

_____b. Making the room look fresh

10. Paying the rent

_____a. Maintaining a place to live

_____b. Writing a check

11. Caring for houseplants

_____a. Watering plants

_____b. Making the room look nice

12. Locking a door

_____a. Putting a key in the lock

_____b. Securing the house

13. Voting

_____a. Influencing the election

_____b. Marking a ballot

14. Climbing a tree

_____a. Getting a good view

_____b. Holding on to branches

15. Filling out a personality test

_____a. Answering questions

_____b. Revealing what you're like

16. Toothbrushing

_____a. Preventing tooth decay

_____b. Moving a brush around in one's mouth

17. Taking a test

_____a. Answering questions

_____b. Showing one's knowledge

18. Greeting someone

_____a. Saying hello

_____b. Showing friendliness

19. Resisting temptation

_____a. Saying "no"

_____b. Showing moral courage

20. Eating

_____a. Getting nutrition

_____b. Chewing and swallowing

21. Growing a garden

_____a. Planting seeds

_____b. Getting fresh vegetables

22. Traveling by car

_____a. Following a map

_____b. Seeing countryside

23. Having a cavity filled

_____a. Protecting your teeth

_____b. Going to the dentist

24. Talking to a child

_____a. Teaching a child something

_____b. Using simple words

25. Pushing a doorbell

_____a. Moving a finger

_____b. Seeing if someone's home

THANK YOU! THIS IS THE END OF THE SURVEY.

APPENDIX 3:

PRIMING USED IN STUDY 2

[Agreeable Condition]

1. Assessment Scores

	Low 0 1 2 3 4 High
Assertiveness	*****
Extroversion	***********
Compassion	*********************
Group Oriented	*********************
Leadership	***********

2. Profile

Based on survey responses, 4155C0 is sensitive and compassionate in her interactions with others, which leads to a tendency to be kind to most people. Overall, she tends to be cooperative in her group interactions. She is moderately extroverted with some potential for leadership, but she is likely to react passively and be submissive when confronted.

[Disagreeable Condition]

1. Assessment Scores

	Low 0 1 2 3 4 High
Assertiveness	*********************
Extroversion	***********
Compassion	*****
Group Oriented	*****
Leadership	***********

2. Profile

Based on survey responses, 4155C0 is insensitive and inconsiderate in her interactions with others, which leads to a tendency to be unkind to most people. Overall, she tends to be competitive in her group interactions. She is moderately extroverted with some potential for leadership, but she is likely to react aggressively and be self-assertive when confronted.

APPENDIX 4:

ATTITUDE SURVEY USED IN STUDY 3 AND STUDY 4

Instructions: Read each sentence carefully and think "Is this important to me, and do I agree with it?"

If you *agree strongly* put a circle around………………..	1 2 3 4 5 6
If you *disagree strongly* put a circle around ……………	1 2 3 4 5 6

01. It is more fun to watch movies at home rather than at the theater.

Disagree strongly 1 2 3 4 5 6 Agree strongly

02. Multiple choice questions are better than essay questions on exams.

Disagree strongly 1 2 3 4 5 6 Agree strongly

03. There are not enough places to eat on campus.

Disagree strongly 1 2 3 4 5 6 Agree strongly

04. It is better to buy things locally than to buy from online retailers.

Disagree strongly 1 2 3 4 5 6 Agree strongly

05. Group projects are rewarding.

Disagree strongly 1 2 3 4 5 6 Agree strongly

06. Smaller class sizes make for a better learning environment.

Disagree strongly 1 2 3 4 5 6 Agree strongly

07. The government should provide more funding for space exploration.

Disagree strongly 1 2 3 4 5 6 Agree strongly

08. Full body x-ray machines are necessary to make air-travel safe.

Disagree strongly 1 2 3 4 5 6 Agree strongly

09. It is easier to read from a book than a computer screen.

Disagree strongly 1 2 3 4 5 6 Agree strongly

10. It is better to use paper bags than plastic bags when shopping.

Disagree strongly 1 2 3 4 5 6 Agree strongly

11. The new stadium will greatly enhance the university status.

Disagree strongly 1 2 3 4 5 6 Agree strongly

12. Placing cameras at traffic lights makes for safer roadways.

Disagree strongly 1 2 3 4 5 6 Agree strongly

13. There are plenty of computer labs on campus.

Disagree strongly 1 2 3 4 5 6 Agree strongly

14. The university library is a great place to study.

Disagree strongly 1 2 3 4 5 6 Agree strongly

15. It is important to strictly balance the Federal government budget.

Disagree strongly 1 2 3 4 5 6 Agree strongly

16. Students should be allowed to use their laptop computers on tests.

Disagree strongly 1 2 3 4 5 6 Agree strongly

17. Starbucks has the best coffee.

Disagree strongly 1 2 3 4 5 6 Agree strongly

18. It is essential to prepare for each hurricane season.

Disagree strongly 1 2 3 4 5 6 Agree strongly

19. Universities should require students to write more term papers.

Disagree strongly 1 2 3 4 5 6 Agree strongly

20. There should be more online classes offered.

Disagree strongly 1 2 3 4 5 6 Agree strongly

21. Sunny days are the best.

Disagree strongly 1 2 3 4 5 6 Agree strongly

22. People should strongly protect animal rights.

Disagree strongly 1 2 3 4 5 6 Agree strongly

23. Marriage is a sacred right.

Disagree strongly 1 2 3 4 5 6 Agree strongly

24. Math is a worthwhile subject.

Disagree strongly 1 2 3 4 5 6 Agree strongly

25. The death penalty is just.

Disagree strongly 1 2 3 4 5 6 Agree strongly

26. Textbooks cost too much.

Disagree strongly 1 2 3 4 5 6 Agree strongly

27. Family is more important than friends.

Disagree strongly 1 2 3 4 5 6 Agree strongly

28. All students should be required to take a calculus class.

Disagree strongly 1 2 3 4 5 6 Agree strongly

29. Florida is the best state.

Disagree strongly 1 2 3 4 5 6 Agree strongly

30. Sport utility vehicles should be outlawed.

Disagree strongly 1 2 3 4 5 6 Agree strongly

31. Business classes are interesting.

Disagree strongly 1 2 3 4 5 6 Agree strongly

32. Communication is the most important thing in a relationship.

Disagree strongly 1 2 3 4 5 6 Agree strongly

33. People should think before doing.

Disagree strongly 1 2 3 4 5 6 Agree strongly

34. War should always be an option for dealing with tough enemies.

Disagree strongly 1 2 3 4 5 6 Agree strongly

35. Winter is better than summer.

Disagree strongly 1 2 3 4 5 6 Agree strongly

36. Women are treated equally in school and at jobs.

Disagree strongly 1 2 3 4 5 6 Agree strongly

37. Students who don't perform should be expelled.

Disagree strongly 1 2 3 4 5 6 Agree strongly

38. We need more public transportation.

Disagree strongly 1 2 3 4 5 6 Agree strongly

39. Pepsi is better than Coke.

Disagree strongly 1 2 3 4 5 6 Agree strongly

40. Youths should always obey their parents.

Disagree strongly 1 2 3 4 5 6 Agree strongly

41. Accessible healthcare is a right.

Disagree strongly 1 2 3 4 5 6 Agree strongly

42. Mondays are a great days.

Disagree strongly 1 2 3 4 5 6 Agree strongly

43. Each person should give to charity regularly.

Disagree strongly 1 2 3 4 5 6 Agree strongly

44. Good people attend church.

Disagree strongly 1 2 3 4 5 6 Agree strongly

45. Classes should be scheduled for earlier in the day.

Disagree strongly 1 2 3 4 5 6 Agree strongly

46. Students should be required to serve their school.

Disagree strongly 1 2 3 4 5 6 Agree strongly

47. The beach is nicer than the mountains.

Disagree strongly 1 2 3 4 5 6 Agree strongly

48. Nuclear weapons are necessary to protect our nation.

Disagree strongly 1 2 3 4 5 6 Agree strongly

49. Laws should be strictly enforced.

Disagree strongly 1 2 3 4 5 6 Agree strongly

50. Gold looks nicer than silver.

Disagree strongly 1 2 3 4 5 6 Agree strongly

51. We must conserve water.

Disagree strongly 1 2 3 4 5 6 Agree strongly

52. Cities should look after homeless people.

Disagree strongly 1 2 3 4 5 6 Agree strongly

53. Students should be made to volunteer during the summer.

Disagree strongly 1 2 3 4 5 6 Agree strongly

54. It is better to eat a big breakfast.

Disagree strongly 1 2 3 4 5 6 Agree strongly

55. There are plenty of classrooms on campus.

Disagree strongly 1 2 3 4 5 6 Agree strongly

56. Cookies are better than cake.

Disagree strongly 1 2 3 4 5 6 Agree strongly

57. Parents should fully arrange their children's marriages.

Disagree strongly 1 2 3 4 5 6 Agree strongly

58. Laws should be based on faith.

Disagree strongly 1 2 3 4 5 6 Agree strongly

59. Basketball is the most interesting sport.

Disagree strongly 1 2 3 4 5 6 Agree strongly

60. Grades should be decided by class attendance.

Disagree strongly 1 2 3 4 5 6 Agree strongly

REFERENCES

Andersen, S. M., Moskowitz, G. B., Blair, I. V., and Nosek, B. A. (2007). Automatic thought. In Kruglanski, A. W., & Higgins, E. T. (Eds.) *Social psychology: Handbook of basic principles* (2^{nd} ed.). New York: Guilford.

Avramova, Y. R., Stapel, D. A., & Lerouge, D. (2010). Mood and context-dependence: Positive mood increases and negative mood decreases the effects of context on perception. *Journal of Personality and Social Psychology, 99*, 203-214.

Axelrod, R. (1984). *The Evolution of Cooperation*. New York: Basic.

Axelrod, R. & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211*, 1390-1396.

Barber, C. B., Dobkin, D. P. & Huhdanpaa, H. (1996). The quickhull algorithm for conex hulls. Transactions on Mathematical Software, 22, 469-483.

Bargh, J. A., Chaiken, S., Govender, R., & Pratto, F. (1992). The generality of automatic attitude activation effect. *Journal of Personality and Social Psychology, 62*, 893-912.

Bergh, D. D. (1985). Problems with repeated measures analysis: Demonstration with a study of diversification and performance relationships. *Academy of Management Journal, 36*, 1692-1706.

Betz, B. (1991). Response to stategy and communication in an arms race-disarmament dilemma. *Journal of Conflict Resolution, 35*, 678-690.

Bhavnani, R., & Miodownik, D. (2009). Ethnic polarization, ethnic salience, and civil war. *Journal of Conflict Resolution, 53*, 30-49.

Blumberg, H. H. (2006a). Trends in peace psychology. In H. H. Blumberg, A. P. Hare, & A. Costin (Eds.), *Peace psychology: A comprehensive introduction* (pp. 3-16). New York: Cambridge.

Blumberg, H. H. (2006b). Government policy and international relations. In H. H. Blumberg, A. P. Hare, & A. Costin (Eds.), *Peace psychology: A comprehensive introduction* (pp. 19-30). New York: Cambridge.

Bodtker, A. M. & Jameson, J. K. (2001). Emotion in conflict formation and its transformation: Application to organizational conflict management. *The International Journal for Conflict Management, 12*, 259-275.

Boulding, K. B. (1962). *Conflict and defense*. New York: Harper and Row.

Bourgeois, P. & Hess, U. (2008). The impact of social context on mimicry. *Biological Psychology, 77*, 343-352.

Byrne, D. (1971). *The attraction paradigm*. New York: Academic Press.

Cambel, A. B. (1993). *Applied chaos theory: A paradigm for complexity*. San Diego, CA: Academic Press.

Carver, C. S., Ganellen, R. J., Froming, W. J., & Chambers, W. (1983). Modeling: An analysis in terms of category accessibility. *Journal of Experimental Social Psychology, 19*, 403-421.

Centola, D., Willer, R., & Macy, M. (2005). The emperor's dilemma: A computational model of self-enforcing norms. *American Journal of Sociology, 110*, 1009-1040.

Chartrand, T. L. & Bargh, J. A. (1999). The chameleon effect: The perception-behavior link and social interaction. *Journal of Personality and Social Psychology, 76*, 893-910.

Cinquin, O. (2002). Roles of positive and negative feedback in biological systems. *Comptes rendus biologies, 325*, 1085-1095.

Clarkson, J. J., Tormala, Z. L., & Rucker, D. D. (2011). Cognitive and affective matching effects in persuasion: An amplification perspective. *Personality and Social Psychology Bulletin, 37*, 1415-1427.

Cleveland, W. L. (2004). *A history of the modern Middle East* (3rd ed.). Oxford: Westview.

Coleman, P. T. (2000). Intractable conflict. In M. Deutsch & P. T. Coleman (Eds.), *The handbook of conflict resolution: Theory and practice* (pp. 428-450). San Francisco: Jossey-Bass.

Coleman, P. T. (2003). Characteristics of protracted, intractable conflict: Toward the development of a metaframework-I. *Peace and Conflict: The Journal of Peace Psychology, 9*, 1-37.

Coleman, P. T., Vallacher, R. R., Nowak, A., & Bui-Wrzosinska, L. (2007). Intractable conflict as an attractor: A dynamical systems approach to conflict escalation and intractability. American Behavioral Scientist, 50, 1454-1475.

Cryer, J. D., & Chan, K. (2008). *Time series analysis: With applications in R*. New York: Springer.

Davis, J.L., & Rusbult, C.E. (2001). Attitude alignment in close relationships. *Journal of Personality and Social Psychology, 81*, 65–84.

Deutsch, M. (1973). *The resolution of conflict: Constructive and destructive processes*. New Haven, CT: Yale University Press.

Deutsch, M. (1994). Constructive conflict management for the world today: *The International Journal of Conflict Management, 5*, 111-129.

Deutsch, M. 2006. Cooperation and competition. In M. Deutsch, P. T. Coleman, & E. C. Marcus (Eds.). *The handbook of conict resolution: Theory and practice*. (pp. 23-42), San Francisco: John Wiley & Sons.

Dupuy, T. N. (1978). *Elusive victory: The Arab-Israeli wars 1947-1974*. New York: Harper & Row.

Festinger, L. (1957) *A theory of cognitive dissonance*. Evanston, IL: Row & Peterson.

Filsinger, E. E., & Thoma, S. J. (1988). Behavioral antecedents of relationship stability and adjustment: A five-year longitudinal study. *Journal of Marriage and the Family, 50*, 785-795.

Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association, 32*, 675-701.

Gottman, J. M. (1993). The roles of conflict engagement, escalation, and avoidance in marital interaction: A longitudinal view of five types of couples*.* *Journal of Consulting & Clinical Psychology, 61*, 6-15.

Gottman, J., Swanson, C., & Murray, J. (1999). The mathematics of marriage: Dynamic mathematical nonlinear modeling of newlywed marital interaction. *Journal of Family Psychology, 13*, 3-19.

Gottman, J. M., Murray, J. D., Swanson, C. C., Tyson, R., & Swanson, K. R. (2005). *The mathematics of marriage: Dynamic nonlinear models*. Cambridge, MA: MIT Press.

Gottman, J.M., Swanson, C., & Swanson, K. (2002). A general systems theory of marriage: Non-linear difference equation modeling of marital interaction. *Personality & Social Psychology Review ,6,* 326-340.

Gruber, P. M. (2007). Convex and discrete geometry. New York: Springer.

Gullahorn, J., & Gullahorn, J. E. (1963). A computer model of elementary social behavior. *Behavioral Science, 8*, 354-362.

Haefner, J. W. (2005). *Modeling biological systems: Principles and applications*. New York: Springer.

Hare, P. A. (2006). Conflict resolution. In H. H. Blumberg, A. P. Hare, & A. Costin (Eds.), *Peace psychology: A comprehensive introduction* (pp. 97-132). New York: Cambridge.

Heider, F. (1946). Attitudes and cognitive organization. *The journal of psychology, 21*, 107-112.

Heider, F. (1958). *The psychology of interpersonal relations.* New York: Wiley.

Heine, S. J., Proulx, T., & Vohs, K. D. (2006). The meaning maintenance model: On the coherence of social motivations. *Personality and social psychology review, 10*, 88 -110.

Higgins, E. T., Friedman, R. S., Harlow, R. E., Idson, L. C., Ayduk, O. N., & Taylor, A. (2001). Achievement orientations from subjective histories of success: Promotion pride versus prevention pride. *European Journal of Social Psychology, 31*, 3-23.

Holtz, R., & Miller, N. (2001). Intergroup competition, attitude projection, and opinion certainty: Capitalizing on conflict. *Group Processes and Intergroup Relations, 4*, 61-73.

Hunt, E. (2007). *The mathematics of behavior*. New York: Cambridge University Press.

Johnson, S. (2001). *Emergence*. New York: Scribner.

Kalik, S. M., & Hamilton, T. E. (1986). The matching hypothesis reexamined. *Journal of Personality and Social Psychology, 51*, 673-682.

Kammrath, L. K. & Scholer, A. A. (2011). The Pollyanna myth: How highly agreeable people judge positive and negative relational acts. *Personality and Social Psychology Bulletin, 37*, 1172-1184.

Kitayama, S., Ishii, K., Imada, T., Takemura, K., & Ramaswamy, J., (2006). Voluntary settlement and the spirit of independence: Evidence from Japan's "Northern Frontier". *Journal of Social and Personality Psychology, 91*, 369-384.

Kolb, D. M. & Putnam, L. L. (1992). The multiple faces of organizational conflict. *Journal of Organizational Behavior, 13*, 311-324.

Kozan, M. K. (1997). Culture and conflict management: A theoretical framework. *The International Journal of Conflict Management, 8*, 338-360.

Kriesberg, L. (1980). Interlocking conflicts in the middle east. Research in Social Movements, Conflicts and Change, 3, 99-119.

LaFrance, M., & Broadbent, M. (1976). Group rapport: Posture sharing as a nonverbal indicator. *Group & Organization Studies, 1*(3), 328-333.

Layard, B. W. J. (1974). A monte carlo comparison of tests for equality of covariance matrices. *Biometrica, 16*, 461-465.

Leighton, J., Bird, G., Orsini, C., & Heyes, C. (2010). Social attitudes modulate automatic imitation. *Journal of Experimental Social Psychology, 46*, 905-910.

Lewin, K. (1936). *Principles of topological psychology*. New York: McGraw-Hill.

Liebovitch, L. L. (1998). *Fractals and chaos: Simplified for the life sciences*. New York: Oxford University Press.

Liebovitch, L. L., Vallacher, R. R., & Michaels, J. (2010). Dynamics of cooperation-competition interaction models. *Peace and Conflict: Journal of Peace Psychology, 16*, 175-188.

Liebovitch, L. L., Naudot, V., Vallacher, R. R., Nowak, A., Bui-Wrosinska, L., & Coleman, P. T. (2008). The dynamics of two-actor cooperation-competition conflict models. *Physica A: Statistical Mechanics and Its Applications, 387*, 6360-6378.

Lim, M., Metzler, R., & Bar-Yam, Y. (2007). Global pattern formation and ethnic/cultural violence. *Science, 317*, 1540-1544.

Losada, M. (1999). The complex dynamics of high performance teams. *Mathematical and Computer Modeling, 30*, 179-192.

Losick, R. & Desplan, C. (2008). Stochasticity and cell fate. *Science, 320*, 65-68.

Lucas, R. E., Clark, A. E., Georgillis, Y., & Diener E. (2003). Reexamining adaptation and the set point model of happiness: reactions to changes in marital status. *Journal of Personality and Social Psychology, 84*, 527-539.

Marcus, E. C. (2006). Change and conflict: Motivation, resistance, and commitment. In M. Deutsch, P. T. Coleman, & E. C. Marcus (Eds.), *The handbook of conflict resolution: Theory and practice* (pp. 436 – 454). Hooboken, NJ: Wiley.

Mason, T. D. (2004). *Caught in the crossfire: Revolutions, repression, and the rational peasant.* Lanham, MD: Rowman & Littlefield.

Maio, G. R. & Haddock, G. (2007). Attitude change. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (pp. 565-586). New York: Guilford Press.

McNeel, S. P. & Reid, E. C. (1975). Attitude similarity, social goals, and cooperation. *Journal of Conflict Resolution, 19*, 665-681.

Michaels, J. L., Naudot, V., & Liebovitch, L. L. (2011). Dynamic stabilization in the PU1-GATA1 circuit using a model with time-dependent kinetic change. *Bulletin of Mathematical Biology*, 73, 2132-2151.

Munro, G. D., & Ditto, P. H. (1997). Biased assimilation, attitude polarization, and affect in reactions to stereotyped-relevant scientific information. *Personality and Social Psychology Bulletin, 23*, 636-653.

Munro, G. D., & Stansbury, J. A. (2009). The dark side of self-affirmation: Confirmation bias and illusory correlation in response to threatening information. *Personality and Social Psychology Bulletin, 35*, 1143-1153.

Nair, N. (2007) Towards understanding the role of emotions in conflict: A review and future directions. International Journal of Conflict Management, 19(4), 359-381.

Newtson, D. (1994). The perception and coupling of behavior waves. In R. R. Vallacher & A. Nowak (Eds.), *Dynamical systems in social psychology* (pp. 251-277). San Diego: Academic Press.

Nowak, A., & Lewenstein, M. (1994). Dynamical systems: A tool for social psychology? In Vallacher, R. R. & Nowak, A. (Eds.) *Dynamical systems in social psychology* (17-53). San Diego, CA: Academic Press.

Nowak, A., & Vallacher, R. R. (1998). *Dynamical social psychology*. New York: Guilford.

Nowak, A., Vallacher, R. R., Bui-Wrzosinska, L., & Coleman, P. T. (2007). Attracted to conflict: A dynamical perspective on malignant social relations. In Golec & Skarzynska (Eds.), *Understanding social change: Political psychology in Poland.* Haauppague, NY: Nova Science Publishers Ltd.

Nowak, A., Szamrej, J., & Latane, B. (1990). From private attitude to public opinion: A dynamic theory of social impact. *Psychological Review, 97*, 362-376.

Nowak, M. A. (2006). Five rules for the evolution of cooperation. *Science, 314*, 1560-1563.

Nowak, M.A. & Sigmund, K. (1993). A strategy of win-stay, lose-shift that outperforms tit-for-tat in the Prisoner's Dilemma game. *Nature, 364*, 56-58.

O'Brien, E. & Ellsworth, P. C. (2012). Saving the last for best: A positivity bias for end experiences. *Psychological Science, 23*, 163-165.

Pruitt, D. G., & Olczak, P. V. (1995) Beyond hope: Approaches to resolving seemingly intractable conflict. In B. B. Bunker, J. Z. Rubin, & Associatees (Eds.), *Conflict, cooperation, and justice: Essays inspired by the work of Morton Deutsch* (59-89). San Francisco: Jossey-Bass.

Prazskier, R., Nowak, A., & Coleman, P. T. (2010). Social entrepreneurs and constructive change: The wisdom of circumventing conflict. *Peace and Conflict: The Journal of Peace Psychology, 16*, 153-174.

Richardson, M. J., Marsh, K. L., Isenhower, R. W., Goodman, J. R. L., & Schmidt, R. C. (2007). Rocking together: Dynamics of intentional and unintentional interpersonal coordination. *Human Movement Science, 26*(6), 867-891.

Rogge, R. D., Bradbury, T. N., Hahlweg, K., Engel, J., & Thurmaier, F. (2006). Predicting marital distress and dissolution: Refining the two-factor hypothesis. *Journal of Family Psychology, 20*(1), 156-159.

Rusbult, C. E., Verette, J., Whitney, G. A., Slovik, L. F., & Lipkus, I. (1991). Accommodation processes in close relationships: theory and preliminary empirical evidence. *Journal of Personality and Social Psychology, 40*, 53-78.

Rouhana, N. N. (2004). Identity and power in reconciliation of national conflict. In A. H. Eagly, R. M. Baron, & V. L. Hamilton (Eds.) *The social psychology of group identity and social conflict* (173-187). Washington, D. C.: APA.

Schmidt, S. M. & Kochan, T. A. (1972). Conflict: Toward conceptual clarity. *Administrative Science Quarterly, 53*, 3-12.

Strogatz, S. H. (1994) *Nonlinear dynamics and chaos*. Cambridge, MA: Westview Press.

Sweeney, K., Shepperd, J. A., & Carroll, P. J. (2009). Expectations for others' outcomes: Do people display compassionate bracing? *Personality and Social Psychology Bulletin, 35*, 160-171.

Taylor, S. E. & Armor, D. A. (1996). Positive illusions and coping with adversity. *Journal of Personality, 64*, 873-898.

Vallacher, R. R., Coleman, P. T., Nowak, A., & Bui-Wrzosinska, L. (2010a). Rethinking intractable conflict: The perspective of dynamical systems. *American Psychologist, 65*, 262-278.

Vallacher, R. R., Coleman, P. T., Nowak, A., & Bui-Wrzosinska, L. (2010b). Dynamical foundations of intractable conflict: Introduction to the special issue. *Peace and Conflict: Journal of Peace Psychology, 16*, 113-125.

Vallacher, R. R., & Nowak. A. (1994b). The stream of social judgement. In Vallacher, R. R. & Nowak, A. (Eds.) *Dynamical systems in social psychology* (251-278). San Diego, CA: Academic Press.

Vallacher, R. R., & Nowak, A. (1997). The emergence of dynamical social psychology. *Psychological Inquiry, 8*(2), 73-99.

Vallacher, R. R., Nowak, A., Froehlich, M., & Rockloff, M. (2002). The dynamics of self-evaluation. *Personality and Social Psychology Review, 6*, 370-379.

Vallacher, R. R, & Wegner, D. M. (1985). *A theory of action identification.* Hillsdale, NJ: Erlbaum.

Vallacher, R.R., & Wegner, D.M. (1989). Levels of personal agency: Individual variation

in action identification. *Journal of Personality and Social Psychology, 57*, 660-671.

Vallacher, R. R. & Wegner, D. M. (in press). Action identification theory: The highs and lows of personal agency. In P. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories in social psychology*. London: Sage.

van Baaren, R. B., Holland, R. W., Kawakami, K., & van Knippenberg, A. (2004). Mimicry and prosocial behavior. *Psychological Science, 15*(1), 71-74.

von Neumann, J. & Morgenstern, O. (1944). *Theory of games and economic behavior*. Princeton, NJ: Princeton University Press.

Webster, R. (1994). *Convexity*. New York: Oxford University Press.

Webster, D., & Kruglanski, A. (1994) Individual differences in need for cognitive closure*. Journal of Personality and Social Psychology, 67*, 1049-1062

Wegner, D. M., Vallacher, R. R., Kiersted, G. W. & Dizadji, D. (1986). Action identification in the emergence of social behavior. *Social Cognition, 4*, 18-38.

Weldon, E. & Jehn, K. A. (1995). Examining cross-cultural differences in conflict management and behavior. *International Journal of Conflict Management, 6*, 387-403.

Wiggins, S. (2000). *Introduction to applied nonlinear dynamical systems and chaos*. 2^{nd} ed. New York: Springer.

Zwick, R., Erev, I., & Budescu, D. (1999). The psychological and economical perspectives on human decisions in social and interactive contexts. In D. V. Budescu, I. Erev, and R. Zwick (Eds.), *Games and human behavior: Essays in honor of Amnon Rapoport* (3-20). Mahwah, NJ: Lawrence-Erlbaum.