Sensory-Motor Mechanisms Unify Psychology:

Motor Effort and Perceived Distance to Cultural Out-Groups

by

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A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Arts

Approved February 2013 by the
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ARIZONA STATE UNIVERSITY

May 2013

ABSTRACT

This thesis proposes that a focus on the bodily level of analysis can unify explanation of behavior in cognitive, social, and cultural psychology. To examine this unifying proposal, a sensorimotor mechanism with reliable explanatory power in cognitive and social psychology was used to predict a novel pattern of behavior in cultural context, and these predictions were examined in three experiments. Specifically, the finding that people judge objects that require more motor effort to interact with as farther in visual space was adapted to predict that people with interdependent self-construal(SC) , relative to those with independent SC, would visually perceive their cultural outgroups as farther relative to their cultural in-groups. Justifying this cultural extension of what is primarily a cognitive mechanism is the assumption that, unlike independents, Interdependents interact almost exclusively with in-group members, and hence there sensorimotor system is less tuned to cross-cultural interactions. Thus, interdependents, more so than independents, expect looming cross-cultural interactions to be effortful, which may inflate their judgment of distance to the out-groups. Two experiments confirmed these predictions: a) interdependent Americans, compared to independent Americans, perceived American confederates (in-group) as visually closer; b) interdependent Arabs, compared to independent Arabs, perceived Arab confederates (in-group) as closer; and c) interdependent Americans, relative to independent Americans, perceived Arab confederates (out-group) as farther. A third study directly established the proposed relation between motor effort and distance to human targets: American men perceived other American men as closer after an easy interaction than after a more difficult interaction. Together, these results demonstrate that one and the

same sensorimotor mechanism can explain/predict homologous behavioral patterns across the subdisciplines of psychology.

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Chapter 1

BACKGROUND AND HYPOTHESES

Toward a Unified Psychology

Academic psychology compartmentalized the mind into cognitive, social and cultural partitions, and developed for each a self-delimited conceptual paradigm and explanatory tradition. Typically, the cognitive, social, and cultural psychologists believe that they target three different mental structures in the minds of the same people. For the first, the research participants are computer-like information processors (e.g., Newell, 1980), for the second, they are social agents driven by basic motivations to fulfill interpersonal goals (Forgas et al., 2005), and, for the third, they are normative populations immersed each in their local system of values, beliefs, and world views (e.g., Shweder, 1996). With these disparate levels of construct specification, cross-talk over the epistemological fence is limited (e.g., Hong et al., 2000; Knoblic & Sebanz, 2006; Messick & Mackie, 1989; Nisbett, 2003). In these accounts, the levels of the mind may, at best, interact, but remain conceptually intact, much like billiard-balls that maintain their self-contained identities through their collisions.

The goal of the current thesis is to take steps towards a unified account of the human mind by finding theoretical units of analysis that apply equally to understanding the cognitive, social, and cultural aspects of behavior. Alongside others (e.g., Glenberg, 2010; Schubert & Semin, 2009), it is proposed here that the body has this unification potential; its sensorimotor mechanisms can explain behavior that plays out in a physical, social, or cultural context. The strategy is to use the bodily level of description to side-step the three different characterizations of the mind found in the three sub-

disciplines, and thereby demonstrate the possibility of specifying level-neutral mechanisms that could uniformly explain cognitive, social, and cultural behavior.

Specifically, the empirical plan is to identify a sensorimotor mechanism with proven explanatory power at one of these levels, then to examine whether this same mechanism can predict behavioral patterns that are well established at the other two levels. Fortunately, one such mechanism has already been characterized and its cognitive (Proffitt, 2006) and social (Schnall et al., 2008) effects successfully demonstrated. After reviewing these, an account is presented to explain how the same mechanism can generate plausibly-homologous predictions in a cultural context, then the results of three studies that generally confirmed these predictions are reported.

Motor Effort in Basic Cognitive and Social Processes

In cognitive psychology, Proffitt and his associates forged a link between two characteristics of the motor system, and they used this link to propose a novel reformulation of the mechanism of distance perception (Proffitt, 2006). On Proffitt's account, the voluntary muscle system is sensitive to the bioenergetic status of the body (Achten et al., 2004; Coyle, 2004; Davis et al., 1997) while being simultaneously tightly coupled with the visual system (Hommel et al., 2001). On the basis of this link, it was proposed that distance perception could not only be conceptualized as an algorithmic process determined exclusively by visual cues (e.g., Cutting & Vishton, 1995), but that it is an ecological integrative process in which the motor system plays an important role. Specifically, Proffitt predicts that visual perception of distance to a target should be scaled by the motor effort required to interact with (e.g., walk up to) that target.

The hypothesized effect of motor effort was confirmed (see Proffitt, 2006, for a

review): Participants reported inflated visual distance to targets that required more motor effort to reach. Participants who were wearing a backpack, exhausted, in poor fitness, elderly, or in ill-health reported hills to appear steeper when compared with their fit, healthy, younger, or rested counterparts.

Could the same sensorimotor mechanism extend to the realm of the social? Schnall and her colleagues (Schnall et al., 2008) argued that a supportive other is construed by the body as a potential resource, either providing a surplus of energy or easing the burden on internal resources. Thus, social support enhances the efficacy of the individual's motor and cognitive systems during task performance. To test this hypothesis, a group of solo participants and another group accompanied by their friends were asked to estimate the slope of hills. Others were asked to imagine the presence of a friend, a neutral individual, or a disliked person before offering their estimates. In both experiments, the real or imagined presence of a (potentially) supportive other led to smaller estimates of the hill's slope.

The Cultural Motor-Effort Hypothesis

To push the explanatory and predictive power of this mechanism into the domain of cultural behavior, findings from several lines of research are stringed together. The first is that the motor system is involved in interpersonal interactions. While the motor system is needed primarily to talk, to observe (e.g., move the eyes), to move toward, and to cooperate in physical tasks, it is additionally used to help recognize the goals of

others through a simulation process based on their movements (Blakemore & Frith, 2005; Rizzolatti et al., 2001; Wilson & Knoblich, 2005). When the relevant motor program does not exist in our own repertoire, or when it cannot be fluently implemented, our recognition of the other's behavior is impaired, perhaps because of the more energetic investment the motor system requires to simulate the perceived action (Calvo-Merino et al., 2005; Casile & Giese, 2006; Petroni et al., 2010). For example, perception of familiar actions that the participant can fluently reproduce is accompanied by a reduced BOLD signal at the motor cortex, which is an index of low energy demands for simulating the action (Muhlau et al., 2005; Tanaka et al., 2001).

It is proposed that interactions with cultural out-group members are expected to be more effortful than interactions with in-group members. Note that out-group members potentially differ from in-group members in gestures, postures, and facial expressions, and if they speak the same language, the pronunciation and jargon of out-group members may be atypical. All these are taxing for the motor system as it attempts to simulate observed actions.

But cross-cultural psychology points to a potential moderator to the above. People may develop an interdependent cultural orientation that stresses relatedness and harmony with their in-groups, or an independent one that emphasizes the uniqueness of their individual selves (Markus & Kitayama, 1991). People with interdependent self-construals tend to live in societies with fairly homogenous ethnic composition (e.g., East Asia), and exhibit lower levels of mobility within these settings, whereas independents typically live in ethnically diverse populations (e.g., North America) and are much more mobile relative to their interdependent counterparts (Schug et al., 2010;

Oishi, 2010; Oishi & Kisling, 2009; Triandis et al., 1988).

Thus, we come to the major hypothesis that drives the empirical work, namely the cultural motor-effort hypothesis. First, it is supposed that cultures, and the self-construals they engender, should be conceived more as a continuum than as categories. Thus, what is described next for interdependent and independent self-construals should be considered the ends of the continuum. Second, people who live in a predominately collectivist culture (and develop interdependent self-construals) tend to interact with family, friends, and an in-group consisting of ethnically and culturally similar people. Consequently, the motor system is strongly tuned to resonate to the behaviors of the in-group, and interaction with the in-group is smooth and relatively effortless. However, for two reasons, these interdependents are at a disadvantage when it comes to interacting with members of the out-group. Because they have little experience with out-group members, they have had little opportunity to tune their motor systems to the behaviors of out-group members. Also, because of the strong tuning or specialization for the in-group, their motor systems will have even more difficulty resonating to the different accents, gestures, etc. of the out-group than a non-tuned system. [This is seen as analogous to the development of speech perception. Before an infant is strongly tuned to its native language, it can perceive phonetic distinctions that are not incorporated into the native language (Aslin et al., 1998). However, once the infant has had considerable experience with the native language, the ability to perceive non-native distinctions is lost.] Thus, interdependents experience a costly demand for motor control and prediction during cross-cultural episodes of interaction.

Third, people who live in a predominately individualistic society are forced to interact with a diversity of others. Although not as strongly tuned as interdependents to interactions with the in-group, interactions with out-group members allow these people to develop moderate skill to process and respond to people with different accents, different communicative gestures and postures, different smells and so on. Thus, in contrast with interdependents, for independents interactions with out-group members are literally less effortful.

This hypothesis predicts that (a) interdependents anticipate motor effort upon the prospect of interacting with out-group members. This, in turn, modulates their subjective visual experience of the distance to out-group members such that their estimates of distance are inflated relative to estimates of distance to in-group members. (b) People with independent orientations should show a smaller difference in estimated distance to in-group and out-group members; they anticipate much less differential effort to interact with out-group individuals owing to the diversity of their motor social repertoire acquired by immersion in ethnically diverse settings.

Chapter 2

EXPERIMENTS

Study 1: Distance to Americans as perceived by Americans

Design and Procedure

American participants (n=33) were first trained on estimating distances to a human target in terms of seconds needed to walk to the target. Besides inducing a more motor-oriented perception of distance, using seconds also minimized any potential effect of the culture-specific distance measurement units (e.g., feet vs. meters) on the reporting of perceived distance to the target, a tack that was especially important in the second study, and used here to maintain the use of a uniform DV throughout the three experiments. The training comprised three trials. In each, the participant estimated the time to walk to the experimenter, then actually walked up to her, and finally received feedback on accuracy of the initial estimate.

Immediately after training, and in a different location, the participant made 36 distance estimates (three 12-trial blocks) to two Caucasian (i.e., in-group) confederates.[1] The confederates stood at marks along two (imaginary) axes that intersected where the participant stood to make the estimates. The marks on each of the axes were pre-set to be at 6 different distances from the intersection: The short-distance marks were at 6.77m and 8.77m from the participant's location at the intersection, the medium distances were at 10.43m and 12.43m, and the long distances were at 20.43m and

[1] The three blocks corresponded to three types of barriers behind which the participants stood: a physical barrier (a fence), a symbolic barrier (a caution tape), and no barrier. This independent variable was included to test another hypothesis. Because the effect of barrier was not significant and did not interact with other variables, it will not be discussed further.

22.43m. The use of two distances for each of the distance ranges was meant to discourage participants from copying earlier estimates in later trials.

On any given trial, the experimenter asked the participant to turn away from both axes, one of the two confederates would position herself at a mark, then the experimenter signaled to the participant to face the confederate. The participant was then immediately asked to estimate, in seconds, the time it would take her to walk to the confederate (half of the trials), or given a 2.5 foot-long stick and asked to estimate the number of sticks it would take her to touch the confederate. On the next trial, the same process repeated, except that the other confederate would position herself on another mark on the other axis. The assignment of the two confederates to the two axes, and the order of distance presentation (i.e., short, medium or long) were independently counterbalanced within blocks and across participants. Finally, after completing their distance estimates, the participants filled out the Interdependence and Independence subscales of the Self-Construal Survey (SCS) (Singalis, 1994).

Analysis and Results

Multi-level modeling (MLM) with maximum likelihood estimates of the parameters is used to take advantage of a) the continuous nature of the six distances and the measure of cultural orientation, and b) to obviate potential problems with the sphericity assumption. MLM is similar to regression in that it estimates regression parameters, however, maximum likelihood is used as the estimation procedure and estimated along with each parameter is its own standard error. Thus the test for statistical significance is a simple t-test of the parameter divided by the standard error; degrees of freedom may be fractional due to the use of Welch-Satterthwaite estimates.

Separate MLMs were run for the two estimates of distance, namely number of seconds to walk and number of sticks. Four participants were dropped from the analysis of number of sticks, one for providing stick estimates more than 3 sd below the mean and three for stick estimates more than 2 sd above the mean.

The participants' cultural orientation scores were computed as the ratio of their responses to the interdependent and independent subscales of the SCS (Int:Ind). As is recommended for regression analyses that involve interaction terms (Aiken & West, 1991), all of the independent variables were centered around their respective means.

Table 1 contains the important results from the MLMs, and Figure 1 plots the regression-estimated marginal means for the Time estimates in seconds (on the left) and Sticks (on the right) as a function of the actual distance. For both dependent variables, the effect of Distance was significant. (For Time, the parameter value of .858 indicates that the estimate grew by .858 seconds for each one meter increase in actual distance; likewise for Sticks, the parameter of .874 indicates an increase of .874 sticks for each meter of distance.)

More importantly, the predictions were confirmed in the form of significant interactions of cultural orientation (Int:Ind) and Distance for both the Time estimate and the Sticks estimate. Rather than arbitrarily breaking the sample into those with interdependent and independent self-construals and losing the statistical power inherent in the continuous variable, the regression parameters were used to estimate means for interdependents and independents. The data for interdependents were obtained by using a value one SD above the mean Int:Ind ratio (Aiken & West, 1991). The values for independents were obtained by using a value one SD below the mean Int:Ind ratio.

Turning to Figure 1, the reason for the interaction becomes evident. Interdependents, compared to independents, judge distance to in-group confederates as smaller. Furthermore, the difference between interdependents and Independents grows with actual distance. This finding is consistent with the proposed cultural-effort hypothesis. Namely, interdependents, compared to independents, spend more time interacting with their in-group and tuning their motor system toward those interactions. Then, because expected motor effort contributes to distance estimation (Proffitt, 2006), interdependents judge distance as smaller than independents.

Table 1
Parameter estimates (in seconds, upper panel) or stick-number estimates (lower panel) to walk to or touch American confederates

		Seconds		
Factor	Parameter	df	t	p
Int:Ind	-3.000	29	-0.77	.45
Distance	0.858	493	37.07	.001
Int:Ind*Distance	-0.384	493	-3.00	.003
		Sticks		
Int:Ind	-3.09	29	-1.23	.23
Distance	0.874	493.02	40.9	.001
Int:Ind*Distance	-0.47	493.02	-4.41	.001

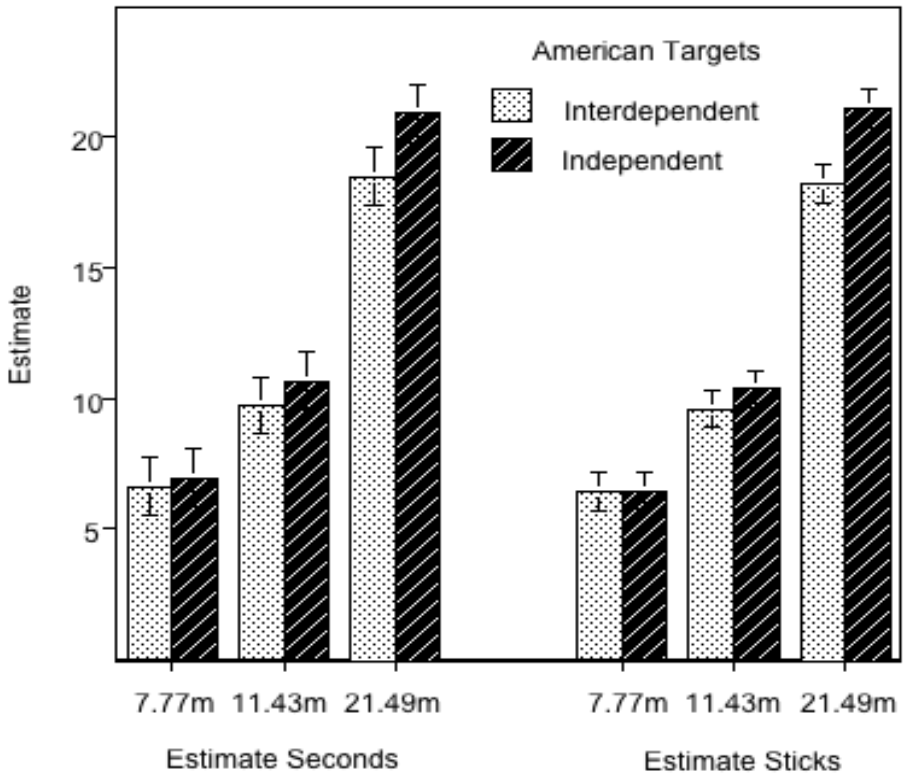

Figure 1. Distance judgments to American-looking targets. Actual distance is indicated on the abscissa. Left: data from Americans estimating distance as time to walk to the target; right: distance estimated as number of hand-held sticks to the target.

Study 2: Distance to Arabs as Perceived by Arabs and Americans

Design and Procedures

Clearly, the novel findings in Study 1 needed to be replicated, and the cultural-effort hypothesis subjected to further test. In Study 2, Arab-looking confederates were used as targets: The confederates were chosen to have dark skin tone, and one of them wore a headscarf, or hijab. Furthermore, both Arab (n=16) and American (n=42) participants were sampled. All other aspects of the design and procedures were identical to those of the first study, except that the participants were asked to report their estimates only in terms of time (i.e., number of seconds) to walk up to the confederates.

It was predicted that the effect of cultural orientation (Int:Ind) on the American participants' estimates would flip in direction relative to the effect in Study 1. That is, since the confederates were Arab-looking, and hence, out-group members, the interdependent Americans would overestimate the distance relative to the independent Americans. Because the interdependents have tuned their motor systems to interact with other Americans, they should expect greater effort in interacting with the Arab-looking confederates than the independent Americans who have a more broadly tuned motor system. In contrast, it was predicted that the Arab participants' estimates to their in-group looking confederates would resemble that of the American participants in Study 1. Interdependent Arabs have a motor system finely tuned for interaction with their in-groups, and thus they should report smaller distance to the targets than the more broadly tuned independent Arabs.

Analysis and Results

The data from three Arab participants were dropped for procedural errors, and the data from one American were dropped for providing an Int:Ind ratio more than 4 sd above the mean. As expected, the mean Int:Ind ratio was significantly higher for Arabs (M=1.1, SD=.17) than for Americans (M=.98, SD=.14), $t(52)=2.61$, $p=.012$.

An MLM model was run to examine the main effects and interactions of Distance, Int:Ind, and National culture (Arab, American). The results are reported in Table 2.

Table 2
Parameter estimates (in seconds) to walk to Arab-looking confederates

Factor	Parameter	Denominator df	*t*	*p*
Int:Ind	0.688	53.99	0.19	.74
Culture	-0.43	53.99	-0.33	.85
Distance	0.813	1884.99	74.18	.001

Culture*Int:Ind	18.6	53.98	2.42	.02
Culture*Distance	-0.068	1884.99	-2.55	.01
Int:Ind*Distance	-0.018	1884.99	-0.25	.80
Culture*Int:Ind*Distance	1.236	1884.99	7.87	.001

Figure 2 plots the regression-estimated marginal means of the participants' walking-time estimates as a function of the real distance. The predicted pattern of results was successfully obtained in the form of two interactions. First, there was an interaction of Culture (Arab vs. American) and Int:Ind on distance estimates. For the Arabs (bars on the left), the in-group (i.e., Arab-looking) confederates were perceived as closer by the interdependent than by the independent participants (distance in seconds estimated, respectively, at 1 sd above and below the mean Arab Int:Ind ratio). For the American participants, the pattern flips: The out-group (i.e., Arab-looking) confederates were perceived as farther by the interdependent than the independent subgroups (estimated at 1 sd above and below the mean American Int:Ind ratio). Second, this interaction was modified by actual distance to the confederate such that increasing the distance increased the size of the two-factor interaction.

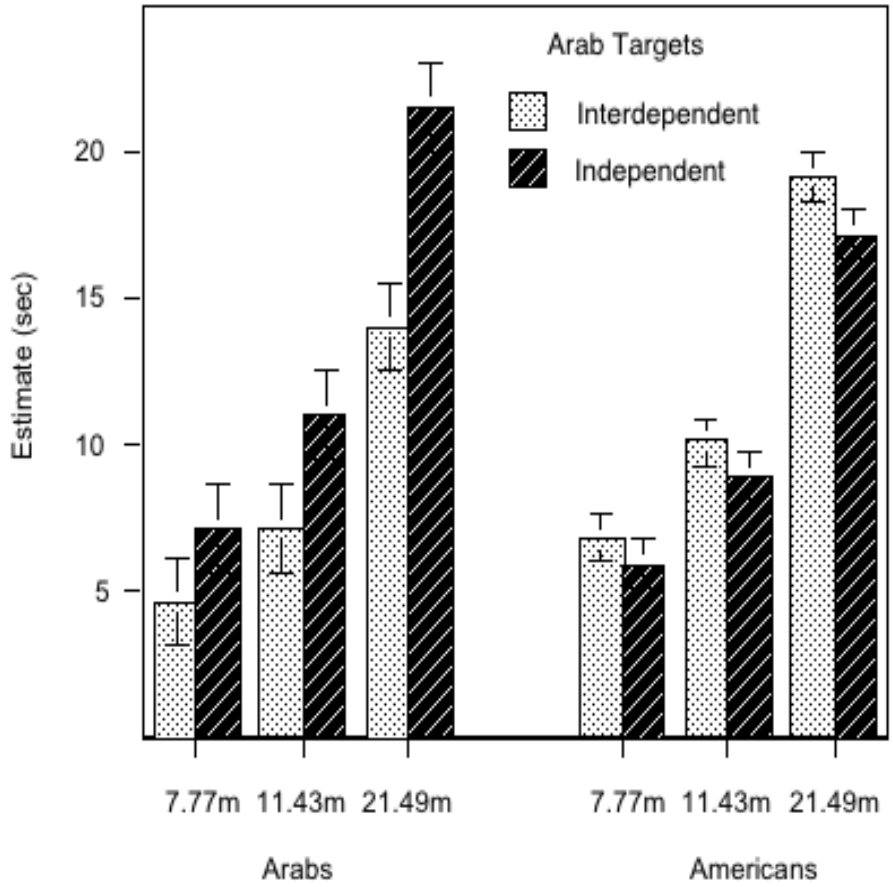

Figure 2. Distance judgments (in estimated time to walk to target) to Arab-looking targets. Actual distance is indicated on the abscissa. Left: data from Arabs judging distance; right: data from Americans judging distance.

Study 3: Distance as Perceived after Easy/Hard Interactions

Design and Procedures

This study moved from documenting correlations between cultural orientation and visual distance to the direct manipulation of the mechanism hypothesized to underlie these correlations: anticipated motor effort of interaction. Americans participated in same-gender pairs (n=64, women=30). Each participant was asked to fill out the SCS survey before reporting to the laboratory. Then, each member of the pair estimated distance to the partner both before and after working with the partner on either an easy or a hard version of a joint sensorimotor task. It was predicted that participants

randomly assigned to the difficult version of the task will report inflated post-task distance estimates to their partners.

The joint Simon task was used to manipulate the ease of interaction (Sebanz et al., 2005). The pair members sat on either side of a keyboard and a monitor. Each member of the pair was assigned a response key on the closest side of the keyboard, as well as a stimulus to respond to. Thus, the left-side participant used the "a" key to respond to red squares and the right-side participant used the ";" key to respond to green squares. Due to the inevitable encoding of the spatial features of the stimuli, participants in this task setting are typically slowed down and less accurate when their own stimulus is presented on the side of the monitor spatially opposite of the assigned response key. Importantly, however, this spatial interference only occurs if an active partner sits on that side. For example, trials in which the red square is presented on the right side of the screen are harder for the left-side participant, but only if she shares the task with a right-side collaborator. Both of these features were used to manipulate the perceived difficulty of interaction as follows.

Each participant first performed individually on one 10-trial training block and four 50-trial main blocks of the Simon task. In this individual phase of the experiment, using two different computers in two rooms, the participant used either the right or left hand to respond to just one stimulus type. Also, 35% of the trials in each of the main blocks were spatially incongruent and the participant had to respond within 500 ms for the response to be counted as correct. A score dependent on correct and fast responding was presented on the screen. Correct and fast responding resulted in the score increasing; incorrect or delayed responding resulted in the score decreasing. Thus,

each participant obtained an individual score based on the speed and accuracy of responding.

In the joint phase of the experiment, the two participants were brought together to use a single computer while maintaining their respective hands and imperative stimuli. The average of the individual scores for the two members of a pair was used to set an initial joint score for the joint Simon phase. For the pairs randomly assigned to the Easy version of the joint task, only 20% of the trials in each of the eight 50-trial blocks were spatially incongruent and participants had 550 ms to respond. In the Hard version of the joint task, 50% of the trials in each of the eight 50-trial blocks were incongruent and the participants had 450 ms to respond. The joint score was displayed throughout this joint phase, and as with the individual task, correct and fast responding resulted in the score increasing whereas incorrect or delayed responding resulted in the score decreasing. In addition, participants were informed that they would get a bonus of $4 if their joint score exceeded an unnamed cutoff. At the end of the joint task, participants in the Easy condition were told that their score exceeded the cutoff, whereas participants in the difficult condition were told that their joint performance was "not good enough to qualify them for the reward." (In fact, all participants were given the bonus at the very end of the experiment.)

Distance estimates were obtained both before and after the Simon task. Blind walking (Phelbeck & Loomis, 1997) was used as the measure of perceived distance in addition to the verbal report of distance in terms of time to walk up to the partner. The procedure in the distance estimation phases was as follows: a) the participant was blind-folded, b) the partner's distance to the blindfolded participant was adjusted, c) the

participant was allowed to lift the blindfold for five seconds to ascertain the distance, d) the blindfold was replaced and the participant estimated the time to walk to the partner (on a random half of the trials), or actually walked to a point halfway to the partner (to rule out any concerns about bumping into each other). Finally, the participants' roles were switched; the partner was blind-folded and the first participant served as the target.

To review, participants were asked to fill out the SCS survey before coming to the lab. Upon arrival at the lab, members of same-gender pairs first blind-walked to each other and provided verbal time estimates of distances. Then, members of the pair performed the Simon task individually. Next, members were brought back together and performed the Easy or Hard version of the joint Simon task. Finally, pair members both blind-walked and provided verbal estimates of distances to each other.

Analysis and Results

Table 3 lists the full results of the MLMs for the Blind walk and Time estimates. For the Blind walk analyses, the data used were double the distances actually walked because participants were instructed to walk half of the perceived distance. In both the Blind walk and Time MLMs, four participants were dropped for providing Int:Ind ratios greater than 2 sd above or below the mean of .97 (sd=.16). Two other participants (a pair who worked jointly) were also dropped for obtaining a joint-Simon score more than 2 sd below the mean of 281.5 (sd=16). Two more participants were dropped each for scoring 2 sd below the mean individual Simon score of 96 (sd=7.5). In the Time MLM only, four additional participants were dropped for providing estimates more than 2 sd above or below the mean of 6.54 (sd=4.12).

For both of the Time and Blind walk MLMs, the Int:Ind ratio, the Joint-Simon score, and the relevant pre-interaction Distance estimates (time for the former and blind walk distance for the latter) were entered as covariates. The MLMs were full factorial, testing for the main effects and interactions of Gender (male, female), Ease of interaction (Easy vs. Hard Simon condition), and Distance (as a continuous variable) on either the post-interaction time estimates or Blind walk estimates. All IVs and covariates were centered around their respective means. In both analyses, there were large effects of the pre-interaction distance estimates (Pre-Simon Blind walk and Pre-Simon Time) and actual Distance. The discussion here is focused primarily on significant interactions between Gender and Difficulty and between Gender, Difficulty, and Distance. Note that the effects are numerically very similar for both the Blind Walk and Time estimates, however, for the Time estimates, the *p*-levels (.07) are just shy of standard levels of significance. Apparently this came about because unlike in Studies 1 and 2, calibration training in making time estimates was not given to participants. Consequently, the measure is less accurate than in the previous studies. It was predicted that the difficult Simon task would lead to greater distance estimates. Although that was true for men (significantly for Blind walk and numerically for Time estimates), it was not the case for women (see Figures 3 and 4). Similarly, on the basis of theory and Studies 1 and 2, it was predicted that the effect of difficulty would be greater at the longer distances. Again, this was true for the men (significantly for Blind walk and numerically for Time estimates) but not for women.

Table 3
Parameter estimates for the post-interaction Blindwalk (upper panel) or time (lower) distance estimates to a partner

Blindwalk				
Factor	Parameter	df	t	p
Pre-Simon Blindwalk	0.64	145	9.28	.001
Int:Ind	-0.034	145	0	.97
Joint Score	0.0009	145	0.10	.93
Gender	0.993	145	1.50	.14
Simon Difficulty	0.574	145	0.14	.89
Distance	0.995	145	37.15	.001
Gender*Difficulty	-1.224	145	-2.46	.02
Gender*Distance	0.156	145	0.32	.75
Difficulty*Distance	0.116	145	0.39	.70
Gender*Difficulty*Distance	-0.275	145	-2.41	.02
Time Estimate				
Pre-Simon Time	0.761	128	10.48	.001
Int:Ind	0.107	128	0.32	.92
Joint Score	0.013	128	0.96	.34
Gender	0.951	128	1.06	.29
Simon Dificulty	0.281	128	0.72	.47
Distance	0.602	128	19.92	.001
Gender*Difficulty	-1.23	128	-1.85	.07
Gender*Distance	0.115	128	0.90	.37
Difficulty*Distance	0.189	128	0.17	.87
Gender*Difficulty*Distance	-0.253	128	-1.82	.07

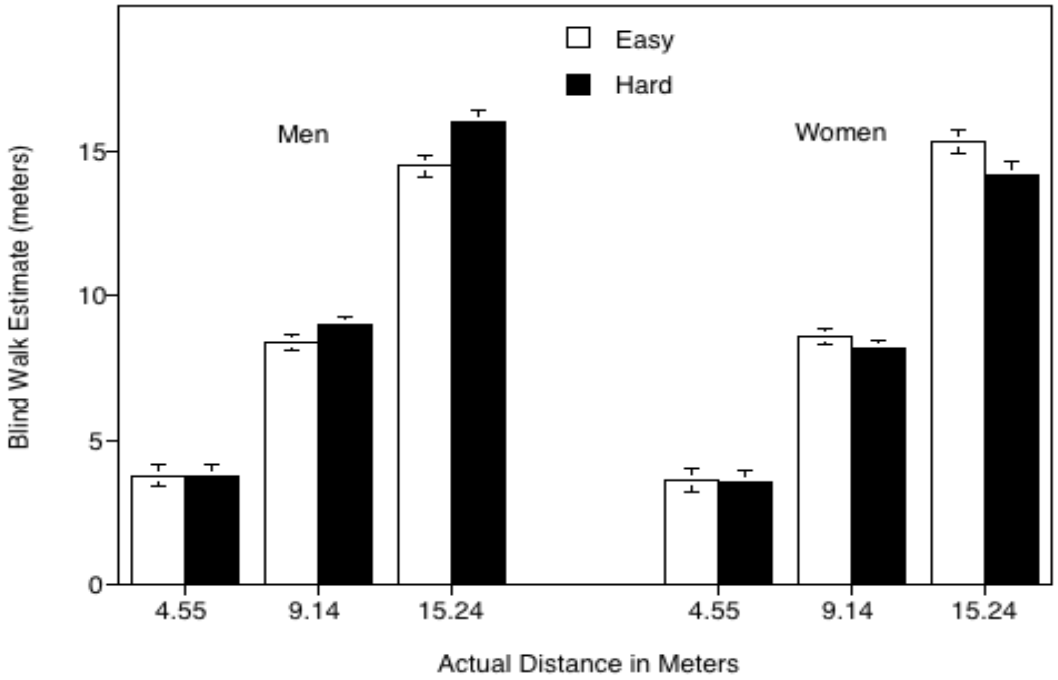

Figure 3. Blindwalk distance estimates after easy (light bars) vs. hard (black) interaction. Left: Men's blind-walked estimates to same-gender partners (significant at p=.039). Right: Women's blind-walked estimates to same-gender partners (unreliable, p=0.14).

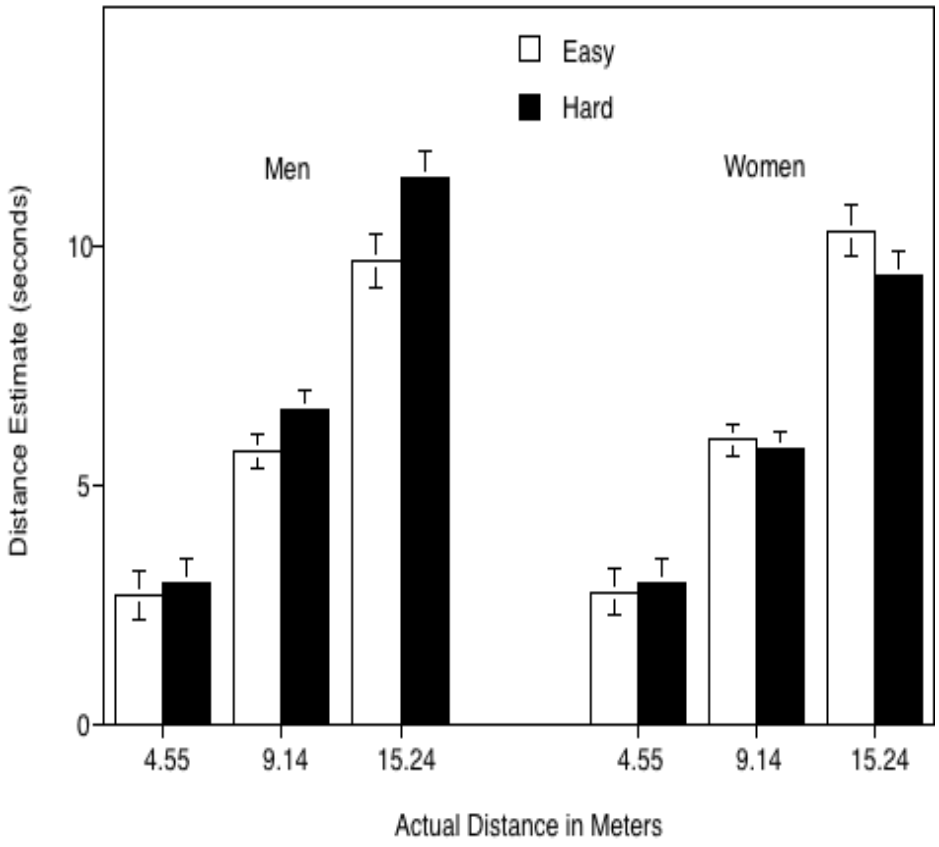

Figure 4. Walk time estimates after easy (light bars) vs. hard (black) interaction. Left: Men's walk time estimates to same-gender partners (p=.06). Right: Women's walk time estimates to same-gender partners (p=.6).

Why did women fail to show the predicted effect of the Simon manipulation? One hypothesis is that the Simon task was less effective in generating differentially hard interactions for women than it was for men. In fact, the Simon manipulation affected the men's coordinative performance (the mean difference between the Easy and Hard conditions was 28 points, d=2.47) much more so than for women (mean difference=14 points, d=1.24). Also, women outperformed men selectively in the Hard condition ($t(46)$=2.1, p<.04, d=.64). That is, women were selectively better at counteracting the Hard-Simon manipulation and managed to maintain relatively smoother interaction in comparison to men assigned to this same Hard condition. This difference does not

reflect gender-specific competency in computer games; when working individually, women did not obtain a significantly higher individual score relative to men ($t(56)=-.28$, $p=.78$).

It is suspected that the gender effects in this study were driven by a simple, although unfortunate, reason, namely, failure of random assignment to equate the groups. Women are generally known to be more interdependent than men (e.g., Cross & Madson, 1997), and the current sample conformed to this typical effect (t (48) =-2.02, $p=.049$, $d=.59$). But had women assigned to the Easy condition and those assigned to the hard condition been equally interdependent, this gender difference in cultural orientation would not have posed a problem. Unfortunately, my random assignment procedure may not have balanced the Int:Ind ratio for women.

Men randomly assigned to the Easy and to the Hard Simon conditions had comparable Int:Ind scores ($t(48)=-1.61$, $p=.11$). As such, the Simon manipulation worked effectively in affecting the ease of coordinative interaction among men, which was in turn reflected in the significant effect of the manipulation on their post-interaction distance estimates. Women assigned to the Hard condition, on the other hand, were significantly more interdependent than women assigned to the easy condition ($t(48)=2.09$, $p=.04$), with a mean Int:Ind difference of .13 ($d=.81$). In terms of the proposed hypothesis, women in the Hard condition were especially competent in the in-group patterns of sensorimotor interactions, hence were less impacted by the Hard manipulation and managed to maintain relatively smooth interaction with their (in-group, same gender) partners. This, in turn, rendered their post-interaction estimates comparable to the women in the easy condition. In fact, this result ties the findings of

the first two studies (i.e., that the more interdependent the cultural orientation of the participant, the closer an in-group is perceived) with the findings of the present study.

In summary, difficult interactions (in the Hard joint Simon condition) increased perceived distance to the partner both when distance was measured by literal (blindfolded) walking, and numerically when distance was measured by a verbal estimate of the number of seconds needed to walk to the partner. However, this effect was only found for men, apparently because interpersonal coordination in the Hard joint Simon task was not all that hard for the interdependent women.

Chapter 3

DISCUSSION

Contemporary psychology continues to be composed of diverse discourse communities that do not make substantial connection with the discipline as a whole. These diverse communities of psychologists, which have proliferated in rapid succession, increasingly work under different, often conflicting, conceptions of science (Hoshmand & Martin, 1994)… In some cases, psychologists appear to be more interested in contributing to a subdiscipline or specialty than to psychology as a whole (Maclntyre, 1985; Staats, 1983). In this way, fragmentation has been, and continues to be, as much a part of psychology as any of its pragmatic definitional characteristics such as "the study of behavior" or "the study of cognition." Indeed, there seems to be no evidence that psychology is united by any explicit conception or theoretical framework. (Yanchar & Slife, 1997, pp. 236).

What is psychology? Is it a single, coherent scientific discipline awaiting transformation from the current preparadigmatic state into a more mature unified one? Or, is it a heterogeneous federation of subdisciplines that will ultimately fragment into a multitude of smaller, more specialized fields? This is, in essence, the "to be or not to be" question of the field. (Henriques, 2004, pp. 1207).

Psychology is what I call a modern disunified science, with a plethora of diverse and unrelated scientific products but with little investment in unifying those products. The resulting disorganization of knowledge leads people such as Toulmin (1972) to consider psychology a "would-be science." A science in the early stage of disunity does not have the full power of science, and it is not considered to be a full science. That power and that recognition await the beginning of the science's advancement to unification. Psychology has not begun that arduous journey. That will happen inevitably, in my opinion. (Staats, 2004, p. 273).

These critical citations articulate a meta-theoretical controversy that has been reverberating since the latter decades of the past century (Driver-Linn, 2003; Goertzen, 2008; Kimble, 1989; Staats, 1983, 1991, 1999; Sternberg & Grigorenko, 2001). Psychology is perceived by many as a "house divided," a fragmented collection of sub-disciplines locked into pigeonholes of disparate theoretical paradigms and levels of construct specification, making an integrative understanding of behavior difficult. This apparent lack of common theoretical principles that can (nontrivially) span the array of psychological sub-disciplines has led, in some extreme cases, to the reserved use of the label "scientific" in characterizing the psychological inquiry (e.g., Koch, 1993).

In light of this last and serious implication, this thesis presents here among the first and most explicit empirical attempts to counteract the disunity problem. A unification approach was developed and experimentally illustrated: Sensorimotor mechanisms can be exploited to traverse the cognitive, social, and cultural domains of behavior while sidestepping the incommensurable theoretical metaphors dominant in each of these territories. Consistent with this approach, the three studies reported here strongly point to the involvement of the motor system even in one of the most abstractly-framed area of human behavior: culture.

By bringing together findings from the cultural and motor-simulation literatures, it was predicted that people with interdependent self construals would anticipate needing less motor effort to interact with in-groups than with out-groups. In contrast, people with independent self construals would anticipate more similar motor effort to interact with in-group and out-group members. The visual signature of motor effort (Proffitt, 2006) was exploited to examine this cultural motor-effort hypothesis. Based on Proffitt's work, inflated reports of visual distance were expected to be associated with greater anticipated effort.

Study 1 confirmed the prediction using two different means of distance estimation, estimated time to walk to a target and estimated number of sticks to the target. Relative to American independents, interdependent Americans reported a shorter expected time to walk to, and a fewer sticks to touch, the American in-group confederates. Study 2 replicated and extended the effects by demonstrating that the interdependent Arab participants perceived their in-group Arab confederates as closer than did the independent Arabs, whereas the same Arab confederates were perceived as

farther by the interdependent than by the independent American participants. In Study 3, the mechanism assumed to underlie these correlations was directly examined. That is, the difficulty of interaction between two participants was manipulated, with the expectation that an easy interaction will lead to a shorter estimate of distance than a more difficult interaction. This expectation was confirmed for men. Importantly, the effect was obtained using yet a third means of distance estimation, blind walking. It is suspected that the effect would hold for women, too, except for the failure of random assignment to equate the women for self-construal.

Thus, this thesis has demonstrated that several of the basic characteristics of the motor system (i.e., it scaffolds action recognition and intention-grasping through simulation; it functions predictively by projecting its future states; and it is sensitive to the cost of looming interactions) extend from the basic cognitive (i.e., visual distance perception, Proffitt, 2006), the interpersonal (i.e., social support, Schnall et al., 2008) into the domain of self-construal and inter-cultural contact. One and the same bodily mechanism can explain these otherwise diverse human behaviors.

The current findings are not the only demonstration of the principle of embodied psychological unity that the current thesis tries to promote. In retrospect, many of the embodied-cognition findings may indirectly support the unifying potential of the bodily mechanisms. For example, the neural circuits responsible for the perception of somatic, visceral pain are a) implicated in one's own experience of social emotions of seclusion (Eisenberger & Lieberman, 2004), b) resonate with the perceived pain of others (Immordino-Yang et al., 2009), and c) this resonance is moderated by personality and cultural factors (Avenanti et al., 2010). As another example, the primary

somatosensory cortex (that had long been considered to have a purely epistemic function) was recently found to a) resonate vicariously with the perceived touch of others (Bolognini et al., 2011), b) show moderated activity based on the assumed gender of who applies the touch (Gazzola et al., 2012), and c) shows higher resonance levels when the observed touch is at a cultural in-group's body (Xu et al., 2009). And third, circuits that represent comparative magnitude, intensity, and extent (i.e., spatial-cognitive functions; Dehaene et al., 2003) were found to serve the homologous social function of status and rank recognition and discrimination (Chiao et al., 2009). Yamakawa and colleagues (2009), using FMRI, showed that a common neural substrate located in the parietal lobe is implicated when participants judge the proximity of objects in the physical space as well as when they judged relationships of kinship of family members and closeness of friends.

The above results may, in fact, take the argument for embodied psychological unity (as exemplified in the current research) to a neurophysiological level. Rather than being a mere metatheoretical necessity, the contention that bodily mechanisms can serve multiple cognitive, social, and cultural functions may be reflective of a foundational principle for the functional and structural organization of the brain. Anderson (2010) presented extensive evidence that over both the phylogenic and ontogenic brain lifetimes, "neural reuse" is commonplace. That is, the same neural structures are re-used for progressively more advanced functions. Thus, much as is argued here that sensorimotor systems may underlie individual, social, and cultural behaviors, neural reuse may be a viable outlook for how the brain responds efficiently

to the cognitive, social, and cultural adaptive demands, and thereby underlie the re-use of mechanisms demonstrated here (see also Immordino-Yang et al., 2010).

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