THE INFLUENCE OF MOTION TYPE ON MEMORY OF SIMPLE EVENTS

by

Johanna D. Berger

A Thesis Submitted to the Faculty of

The Charles E. Schmidt College of Science

in Partial Fulfillment of the Requirements for the Degree of

Master of Arts

Florida Atlantic University

Boca Raton, Florida

May 2009

THE INFLUENCE OF MOTION TYPE ON MEMORY OF SIMPLE EVENTS

by

Johanna D. Berger

This thesis was prepared under the direction of the candidate's thesis advisor, Dr. Alan W. Kersten, Department of Psychology, and has been approved by the members of her 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 Master of Arts.

SUPERVISORY COMMITTEE

Alan W. Kersten, Ph.D.
Thesis Advisor

Elan Barenholtz, Ph.D.

David F. Bjorklund, 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 14, 2009
Date

ACKNOWLEGEMENTS

The author wishes to express immense appreciation to her parents for their continued encouragement and wisdom. She also wishes to thank her committee members Dr. Alan Kersten, Dr. David Bjorklund, and Dr. Elan Barenholtz for their academic guidance. Furthermore, she is grateful for the participation of this experiment's actors and the help of Shaina Rowell, Simone Chin, Amy Gardiner, Jon Pearl, and Kyle Vick in creating this experiment's stimuli.

ABSTRACT

Author: Johanna D. Berger

Title: The Influence of Motion Type on Memory of Simple Events

Institution: Florida Atlantic University

Thesis Advisor: Dr. Alan Kersten

Degree: Master of Arts

Year: 2009

This experiment investigated an individual's memory of specific motion events' unique actor, intrinsic motion, and extrinsic motion combination. Intrinsic motions involve the movement of an individual's body parts in a specific manner to move around, while extrinsic motions specify a path in reference to an external object. Participants viewed video clips, each depicting an actor performing a unique extrinsic and intrinsic motion combination. One week later, they viewed a different series of retrieval video clips consisting of old (identical to encoding), extrinsic conjunction (extrinsic motion previously performed by different actor), intrinsic conjunction (intrinsic motion previously performed by different actor), and new (novel extrinsic or intrinsic motion) video clips. Participants responded "yes" to viewing the old video clips the most often, followed by conjunction video clips, and then new video clips. Furthermore, there were a greater number of "yes" event memory recognition responses for extrinsic conjunction items than intrinsic conjunction items.

THE INFLUENCE OF MOTION TYPE ON MEMORY OF SIMPLE EVENTS

LIST OF FIGURES

INTRODUCTION

Early one morning, you sit in your silver Saab convertible staring at your local convenience store's entrance. Impatiently you wonder why your friend is taking so long to purchase two waters as you drift into thoughts about all the good sets that you are missing at the beach. Seconds later, you notice a large man wearing a red facemask run out of the convenience store. Incredibly afraid, you duck down in your car emerging minutes later to the sound of police sirens.

You tell the police your most precise memory of the event and hope that somehow the man will be captured. You try to describe the masked-man's unique running form, attempting to distinguish him from countless other people you have seen run before. Just on that occasion alone, you saw at least a dozen people go into and out of the convenience store. Yet, your mental image of him running easily differentiates him from the other convenience-store-exiting individuals you saw that day.

A week goes by and the event's details are starting to fade. You are not confident what time the event happened, what exactly the man was wearing, or his specific whereabouts when exiting the store. You decide to clear your mind by running a few miles at a nearby beach. During your pre-run beach stretch, as any competitive individual would do, you start to check out the other beach-runners' form and strength. Strikingly, you notice that one of the men has a very familiar run; one of the men runs the same as the man in the red facemask. Your sly-self discreetly returns to your car and calls the police, as thoughts that maybe you should have been a detective instead of a beach-running-bum fill your head. With the man quickly captured and hand-cuffed, your bliss-filled thoughts that the case is solved are quickly interrupted by complex criminal proceedings.

During your eye-witness testimony, you confidently state that you remember seeing the suspect, the beach-running-man, also run out of the store the morning of the crime. They drill you endlessly about whether or not you are sure that it was him leaving the store. “Is it possible that he could be just another man that you saw leaving the store that morning?” “No, I am certain that he is not, because I distinctly remember the way the man in the facemask ran, which was the same way that man ran,” you say as you point to him, “when I saw him at the beach.”

There is currently no direct evidence confirming an eyewitness’ ability to identify a criminal based on his or her distinct motion. For example, there is no direct evidence that the eyewitness presented in this paper’s opening scenario can distinctly identify the beach-running-man as the criminal based off his unique run. However, the results of this study provide evidence that eyewitnesses can identify individuals based on their distinct manner of motion.

Research rooted in the language and memory literature on noun meanings, the perception of different types of motion, and event recognition may eventually help in deciphering contradictory and improbable eyewitness testimony. Specifically, greater understanding of eyewitness memory for events may be achieved through comprehending the relationship of two different types of motions, intrinsic motions and extrinsic motions, with person recognition.

The previously described event involved the red facemask man partaking in both an intrinsic motion (*running*) and an extrinsic motion (*out of the convenience store*). Specifically, this event's intrinsic motion is the man moving his body parts in a distinctive manner (i.e., unique arm swing, high leg lift) in order to move around. Within the written English language, intrinsic motions are generally conveyed as verbs (e.g., running) and are constrained by an individual's or object's physical configuration. Prepositions and verb particles (e.g., out of, down), on the other hand, are used to convey extrinsic motions, which specify a path (changing of location) with reference to an external object (e.g., the convenience store) (Jackendoff, 1990, 1992; Kersten, 1998; Slobin, 2003).

Kersten's (1998) division of labor theory proposes that linguistically represented motion events involve differently descriptive nouns and verbs. This theory proposes that the noun conveys information about an object, including which intrinsic motions it is capable of and commonly engages in. Intrinsic motion verbs (e.g., run, spin) typically relate to a more general and non-specific definition. As a result, an intrinsic motion verb's meaning depends on its contextual surroundings, remaining unclear until it is connected with the noun presented within the same context. However, an extrinsic motion (e.g., up, down) is largely semantically independent of its syntactically related noun, with the noun typically providing few pertinent constraints on the extrinsic motion. Although the division of labor theory does not argue against a link between a sentence's noun and extrinsic motion, it emphasizes that there is a far stronger relationship between a sentence's intrinsic motion and noun (Kersten, 1998).

In Kersten's (1998) study, undergraduates viewed a series of events depicting a unique computer-generated character involved in a specific intrinsic motion (e.g., distinct back & forth angled leg movement) and extrinsic motion (e.g., toward other character). During the learning phase, a sentence of the 'The noun is verb' format (e.g., "The zeebee is morping.") always orally accompanied the visual display of the character performing the two motions (Kersten, 1998). Each noun (e.g., zeebee) consistently related to the same unique static computer generated character type (e.g., orange round red-spotted creature), as well as the same unique leg movement (intrinsic motion) and same path (extrinsic motion). Similarly, each verb (e.g., morping) consistently related to the same leg movement and path.

During follow-up testing, participants heard a noun or verb individually and selected which of two motion events best represented it. One event paired the presented noun (e.g., zeebee) or verb (e.g., morping) with both the extrinsic and intrinsic motions it had accompanied previously (e.g., toward other creature & distinct back and forth leg movement). The other event (mismatch event) paired the presented noun or verb with a different extrinsic (e.g., away from other creature) or intrinsic motion (e.g., distinct circular leg movement). The participants' selection tendencies supported Kersten's division of labor theory that nouns generally mapped onto intrinsic motions and not onto extrinsic motions. Specifically, participants typically learned the association between nouns and intrinsic motions but not between nouns and extrinsic motions, selecting the motion events involving the correct noun-leg motion pairings but not the correct noun-path pairings. In contrast to nouns, participants more often correctly related individually presented verbs to their path (extrinsic motion) than to their leg motion (intrinsic motion).

Kersten (1998) proceeded to compare participants' selection tendencies when given verbs or nouns individually to participants' selection tendencies when given sentences involving novel combinations of the nouns and verbs from the learning trials. Therefore, all sentences presented during this mismatch trial had a noun and verb that differed from one another in their association with the intrinsic and extrinsic motions presented during the learning trials. Participants were presented orally with the sentences and selected from two motion events differing from one another either in their intrinsic motion or their extrinsic motion. Participants' ability to correctly associate the extrinsic motion with the verb given in the sentence seemed virtually unaffected by the presence of the incompatible noun, with participants performing the same as when given the verbs individually. However, participants were significantly less likely to choose the intrinsic motion associated with the verb when given in sentences with an incompatible noun, compared to when given verbs individually. These cross-trial comparisons support the theory that nouns are more significantly related to intrinsic motion identification than extrinsic motion identification.

Further support for Kersten's division of labor theory comes from evidence that determining the meaning of an intrinsic motion verb often requires knowledge of the linguistic context in which the verb is presented (Behrend, 1990; Kersten, 1998, 2003; Kersten & Earles, 2004). Consider the simple sentence: The kitty spins. If the verbal or written form of the verb 'spin' was presented in isolation and you directly related it to the noun kitty you may be incorrect. Correct interpretation requires first becoming aware of the context in which spin is presented in order to determine that the verb is actually referring to the adorable spinning motion of a kitty chasing its tail.

English speaking children quickly learn that an intrinsic motion verb (e.g., spin) can refer to a multitude of actions. The child realizes that when Mommy spins her in the air like an airplane it is very different from when Mommy spins her fiber into yarn. Although the child may not understand the process of using the spinning wheel, she understands that the same verb can involve very different motions. Determining the correct intrinsic motion associated with the verb often requires that the child correctly recognizes the object performing the action described by the verb, thereby linking the intrinsic motion verb and noun together to gain clear comprehension.

There is a great deal of evidence (i.e., Gentner, 1982; Kersten, 1998; Kersten & Smith, 2002) that understanding a verb's meaning is typically contingent on first gaining knowledge of its corresponding object's physical make-up. This evidence comes from findings that children pay attention to object structure when learning verbs. For example, Kersten and Smith (2002) presented 3½- to 4-year old children with motion events along with novel verb or noun labels, in which both the object's appearance and its motion were related to the word to be learned.

Kersten and Smith (2002) found that while children typically attended solely to the unfamiliar object's appearance when learning a noun, children typically attended to both the unfamiliar object's appearance and its motion when learning a verb. Specifically, the results revealed that when selecting the motion event which accurately represented the instructed noun, children tended to select motion events presenting an accurate portrayal of the object's appearance, unconcerned with whether or not the motion type displayed was accurate. However, when selecting the motion event which accurately represented the instructed verb, children tended to equally select motion events depicting the verb consistent with the object's appearance or with the motion instructed during the learning trials.

Comparing two experiments in Kersten and Smith (2002) revealed that children had a stronger tendency to relate a novel verb to a novel object when learning intrinsic motion verbs than when learning extrinsic motion verbs (Kersten, Smith, & Yoshida, 2006). Participants in one experiment were taught verbs that consistently related to both the intrinsic motion (e.g., distinct back & forth leg movement) and object (e.g., creature with two orange legs), but not the extrinsic motion (e.g., one creature moving toward or away from another creature) displayed in the motion event clips. Participants in the second experiment were taught verbs that consistently related to both the extrinsic motion and object, but were not related to the intrinsic motions displayed.

As discussed in Kersten et al. (2006), although all participants in the Kersten and Smith (2002) experiments paid attention to novel objects when learning novel verbs, this tendency was stronger when the verbs represented an intrinsic motion than an extrinsic motion. For example, children paid more attention to the object's appearance when learning a novel verb (e.g., morping) which represented an intrinsic motion (e.g., backward arm circles) than when it represented an extrinsic motion (e.g., toward another object).

The tendency of children to pay greater attention to objects when learning intrinsic motions than when learning extrinsic motions adds to the evidence that object structure relates more to intrinsic motions than to extrinsic motions. For example, individuals would be better at remembering the relationship between an object (i.e., red facemask man) and an intrinsic motion (i.e., run) given together at encoding than the relationship between a noun and an extrinsic motion (i.e., out of). Therefore, it is likely that when viewing a simple motion event, the witness is more likely to associate individuals with their intrinsic motion than with their extrinsic motion. For example, the witness likely formed a greater association between the red facemask man and his intrinsic motion (running) than between the red facemask man and his extrinsic motion (out of).

Further supporting the significant relationship between an object and its intrinsic motion, researchers found that an intrinsic motion (the motion of the object's unique physical parts) may also aid in an object's identification (Johansson, 1973; Loula, Prasad, Harber, & Shiffrar, 2005; Norman, Payton, Long, & Hawkes, 2004; Tversky & Hemenway, 1984). This is evident in Johansson's (1973) work illuminating the human structure walking via thirteen key lights located at the human's head and important joints. Participants required dynamical stimuli (continuous moving frames as opposed to discontinuous frames) to recognize that the light points depicted human beings. Furthermore, other studies found that after viewing similar dynamical stimuli, individuals were often capable of labeling the displayed activity (e.g., walking, skipping) (Norman et al., 2004) and identifying the event's specific actor (Loula et al., 2005). Evidently, not only the visual image of a human's structure matters in human recognition, but also their dynamical movement (their intrinsic motion) (Loula et al., 2005).

This point-light walker research provides evidence that individuals are strongly associated with their particular intrinsic motions, which has important implications for recognition memory. Similar to individuals' ability to identify actors based on their intrinsic motion (Johansson, 1973; Loula et al., 2005), eyewitnesses should be capable of recognizing a criminal when they later see him or her perform the same intrinsic motion. For example, these studies provide evidence that the witness described in this paper's opening scenario is capable of identifying the red facemask man based off his running form (intrinsic motion); the witness is capable of recognizing that the beach-running-man is the same man that she saw running on the day of the crime.

The present study demonstrated that when viewing an event involving a person performing both an intrinsic motion and an extrinsic motion, individuals tend to associate the person more strongly with the intrinsic motion than with the extrinsic motion. The results support the hypothesis that the linguistic properties discussed (i.e., stronger relationship between intrinsic motions and nouns than between extrinsic motions and nouns) are reflected in participants' conceptual representations of an event. Specifically, participants' memory for an event reflected an easier time remembering an actor's specific intrinsic motions than her specific extrinsic motions.

Language is also thought to influence a participant's memory for motion events by directing their attention at encoding to the event components of linguistic importance to them (Slobin, 2003). Slobin (2003) presents numerous findings supporting the high saliency of intrinsic motions in the English language. For example, the English language contains a multitude of intrinsic motion varieties (e.g., twirling, spinning, dancing). The intrinsic motion verbs occur frequently and may be used metaphorically, demanding English speakers' careful attention. Therefore, English speakers are easily able to list and regularly use (i.e., in conversational dialogue, in oral and written narrative) an extensive and diverse assortment of intrinsic motion verbs.

Slobin (2003) argues that along with intrinsic motions, extrinsic motions are also easily accessible within the English language structure. The English language is a "path-satellite language" (S-language) in which path is specified in an optional prepositional phrase, while the verb encodes the manner (Slobin, 2003; Talmy, 2000). Although speakers of S-languages have a large verb lexicon of intrinsic motions and a much smaller lexicon of extrinsic motions, both are considered highly accessible linguistic components.

Since both intrinsic and extrinsic motion types are highly codable within the English language (Slobin, 2003), English speakers may automatically process both when viewing motion events. Slobin (2003) argues that when tested on their memory of these events, participants will likely rely on their linguistically directed encoding of the event. Therefore, with both motion types highly codable for English speakers, participants were expected to pay attention equally to both motion types and thereby be equally likely to recognize an event's intrinsic and extrinsic motions.

To test the influence of motion type on event memory, this study utilized a methodology similar to prior studies by Billman and Krych (1998), Finkbeiner, Nicol, Greth, and Nakamura (2002), and Gennari, Sloman, Malt, and Fitch (2002). Similar to these previous studies, at encoding participants viewed a series of brief video clips depicting unique motion events. Also similar to these previous studies, at retrieval participants viewed events identical to their encoding counterpart except that they portrayed either a different path (new extrinsic motion item) or a different manner (new intrinsic motion item**).**

Unlike these prior studies, this study was designed to test participants' ability not only to remember actions but also to correctly associate an actor with their unique motions. This was tested by using a method most similar to Kersten, Earles, Curtayne, and Lane (2008). In Kersten et al.'s (2008) study, young and older adults viewed a series of video clips depicting actors performing simple actions (e.g., hand clapping). At retrieval testing, participants often incorrectly remembered having viewed events depicting an old action actually performed by an actor viewed in a different encoding video clip. Despite their ability to correctly recall each feature of an event independently, participants often made conjunction errors (incorrectly transferred their memory of the old action to another previously viewed actor).

All individuals' memories are susceptible to unconscious transference (Kersten et al., 2008) and the possibility of memory conjunction errors. Studies such as Kersten et al. (2008) provide evidence that despite a witness' ability to correctly recall each independent component of an event he or she may often incorrectly associate his or her memory of the criminal's actions with that of an innocent individual. Therefore, an individual's testimony may be false due to incorrectly attributing the crime he or she witnessed to another individual previously encountered in a non-criminally related setting (Loftus, 1980).

These binding errors (i.e., the incorrect association of an innocent man to the criminal's actions) typically occur when two independent memory items are wrongfully linked in memory (Kersten et al., 2008). As discussed previously, an intrinsic motion's meaning depends significantly on the noun (i.e., object, individual) it syntactically relates to, while the meaning of an extrinsic motion typically does not. Therefore, since extrinsic motions and actors are generally independent event features, while intrinsic motions and actors are generally interrelated event features, extrinsic motion-actor combinations should be more susceptible to binding errors. This was in fact what was found.

To the best of my knowledge, prior to this study, there was no research investigating how varying relationships between objects and the two motion types influence an individual's memory of the actor performing the motions. Previous studies provide evidence that compared to extrinsic motions, intrinsic motions have a stronger relationship with their corresponding objects (e.g., Kersten, 1998; Kersten & Smith, 2002). However, unlike previous studies, this study included intrinsic conjunction and extrinsic conjunction items in order to examine how differences between actor-intrinsic and actor-extrinsic relationships influence memory of events.

This study investigated whether or not there is a stronger relationship and decreased susceptibility for binding errors between an event's individual and intrinsic motion (versus event's individual and extrinsic motion). Specifically, participants in this study initially viewed motion event video clips depicting a unique extrinsic motion and intrinsic motion. For example, they viewed an actor walking backwards (intrinsic motion) up a ramp (extrinsic motion). At retrieval testing, they viewed a series of various types of video clips and selected whether or not they had also viewed this clip at encoding.

This experiment's main hypothesis was that old (identical to encoding) video clips would yield the most "yes" (correct) recognition responses, followed by less frequent "yes" (incorrect) recognition responses for extrinsic conjunction (an extrinsic motion that had previously been performed by a different actor), then intrinsic conjunction (an intrinsic motion that had previously been performed by a different actor), and lastly new (a novel intrinsic or extrinsic motion) video clips. Such a finding would provide evidence that although intrinsic and extrinsic motions are both highly codable within the English language, individuals form stronger associations between actors and their intrinsic motions than between actors and their extrinsic motions. In other words, support for the main hypothesis would suggest that individuals better remembered the actor's intrinsic motion than the actor's extrinsic motion.

METHODS

Participants

50 undergraduates from Florida Atlantic University participated in this experiment for course credit.

Materials

The stimuli for this experiment consisted of one hundred and eighty color video clips displayed on a 17-inch color computer monitor, without any accompanying audio. The duration of the video clips ranged from approximately 1s to 23s (M = 6s).

The actors in the video clips were ten female undergraduates. Each video clip depicted a unique motion event, involving an actor performing a unique combination of an extrinsic and an intrinsic motion (XINMO). The XINMOs were compiled from a list of 50 different extrinsic motions and 50 different intrinsic motions. One example of an XINMO is *Actor three spins out of a building*. Figure 1 displays the complete list of 50 intrinsic motions and 50 extrinsic motions.

Extrinsic motions list

The 50 different extrinsic motions consisted of six examples each for six different general directions (down, up, into, out of, past, around) and seven examples each for two different general directions (away from, to). Furthermore, each of the 50 extrinsic motions involved a unique landmark (i.e., statue, pay-phone, building). One example of an extrinsic motion is *away from the statue*.

Intrinsic motions list

Intrinsic motions involved the movement of an individual's body parts in a specific manner to move around. None of the intrinsic motions required the use of an external object. For example, the intrinsic motions involved in skateboarding or manipulating a wheelchair were not included because they also involve the use of an external object to perform the intrinsic motion. One example of an intrinsic motion is *walk backwards.*

Encoding lists

There were five different encoding lists, each consisting of a unique set of 40 XINMOs. The XINMOs were equally divided amongst the 10 actors. Thereby, each encoding list consisted of 4 video clips of each actor performing 4 unique XINMOs.

Retrieval lists

There were five different retrieval lists, each corresponding to one of the encoding lists. Each retrieval list was made up of 50 XINMOs, equally divided amongst the 10 actors and consisting of 10 old, 20 conjunction, and 20 new items. The XINMOs were counterbalanced across the retrieval lists, with each appearing equally often as an old item, conjunction item, and new item type across the five retrieval lists.

Old items replicated an item in the corresponding encoding list. For example, one old item, *actor five jumping out the door of the tennis courts*, was listed on both encoding and retrieval list 1.

The 20 conjunction retrieval items consisted of ten extrinsic conjunction items and ten intrinsic conjunction items. Extrinsic conjunction retrieval items involved an actor-intrinsic motion combination given at encoding. However, the extrinsic motion was performed by a different actor at encoding. For example, the retrieval list 1 item, *actor seven walking away from the silver statue*, was an extrinsic conjunction item because the actor-intrinsic motion combination (*actor seven walking*) is given in an encoding list 1 item, *actor seven walking up stairs*. However, the extrinsic motion (*away from the silver statue*) was only performed by another actor (*actor eight*) in an encoding list 1 item, *actor eight running away from the silver statue while punching the air.*

Intrinsic conjunction retrieval items involved an actor-extrinsic motion combination seen at encoding. However, the intrinsic motion was performed by a different actor at encoding. For example, a retrieval list 4 item, *actor eight rolling to large tree,* was an intrinsic conjunction item because the actor-extrinsic motion combination (*actor eight to large tree*) was given in an encoding list 4 item, *actor eight scooting to large tree.* However, the intrinsic motion *(rolling)* was only performed by another actor *(actor seven)* in an encoding list 4 item, *actor seven rolling down hill*.

The retrieval list also included 20 new items. New extrinsic motion retrieval items were XINMOs that had the same actor-intrinsic motion combination as a XINMO listed at encoding. However, they involved an extrinsic motion that was not part of any encoding XINMO. New intrinsic motion retrieval items were XINMOs that had the same actor-extrinsic motion combination as a XINMO listed at encoding. However, they involved an intrinsic motion not given at encoding. For example, a retrieval list 3 item, *actor nine tiptoeing into a gazebo*, was a new intrinsic motion because, although the actor-extrinsic motion combination (*actor nine into a gazebo*) occurred in a encoding list 3 item, *actor nine walking bowlegged into gazebo*, no encoding list 3 item involved this specific intrinsic motion (tiptoeing).

Procedure

During both testing sessions, encoding (testing session 1) and retrieval (testing session 2), participants were tested individually via a color computer program. Throughout both testing sessions, an experimenter was available to answer participants' questions.

Encoding

Testing session 1 took approximately twenty-five minutes. First, participants were instructed to view the upcoming series of video clips and try to remember their specifics (actor, path, and motion). All experimental instructions were derived from those used by Kersten, Earles, Curtayne, and Lane (2008).

They received the following instructions: "This is a memory test for observed events. In this study, you will see a series of brief video clips. Each clip involves a person moving in a particular way to get somewhere. Please try to remember as much as possible about each of these video clips, including the person involved, where she is going, and the movements she uses to get there. At the end of each video clip, press the button labeled "Continue" to view the next video clip. If you have any questions please ask the experimenter now. Otherwise, please begin by clicking on the button labeled "Begin" in the screen's lower right-hand corner."

Following instructions, a series of 40 video clips were presented individually and sequentially to each participant. The video clips came from one of the five encoding lists and each participant received a different random order of the video clips. Participants pressed the "Continue" button to transition through the video clips. After the last video clip, participants filled out a demographic questionnaire (i.e., assessing age, ethnicity, general health status, gender) and completed a test of their vocabulary knowledge (Shipley, 1986). Then they were instructed that during the next week's testing session they would view another set of video clips and rate each clip as previously viewed or not viewed during testing session 1.

After viewing the video clips, participants received the following instructions: "Next week, you will be shown an additional set of video clips with actors performing actions. Some of these video clips will be identical to the ones observed today. You will be asked whether or not the video clips were viewed previously. Thank you for your time. See you next week!"

Retrieval

Participants were tested one week later. Testing session 2 took approximately fifteen minutes. They were instructed that they would view a new set of video clips, including some viewed and some not viewed during testing session 1. Furthermore, they were instructed to answer whether or not they had previously watched the video clip and how confident they were of their answer (just guessing, pretty sure, or absolutely sure).

They received the following instructions: "You will now see a number of video clips, some of which you saw in the first part of the experiment and some of which are new. After you see each video clip, you will be asked "Did you see this video clip in the first part of the experiment?" If you saw during the first part of the experiment a video clip involving this same person going to the same place using the same body movements, you should click on the "Yes" button. If any of these three aspects of the video clip changed (actor, where she is going, body movement), click on the "No" button. After selecting either the "Yes" or "No" button, you will be asked to select whether you are just guessing, pretty sure of, or absolutely sure of your "Yes"/ "No" response."

Following the instructions, each participant viewed a series of 50 video clips from the retrieval list corresponding to the participant's encoding video clip series. Each participant received a different random order of the video clips. After viewing each video clip they answered whether or not they viewed the video clip during testing session 1. Next, they answered how confident they were of their response (1 = *just guessing*, 2 = *pretty sure*, or 3 = *absolutely sure*). During this testing, transition to the subsequent videos and questions occurred automatically following each confidence rating.

Design

The primary analysis in this experiment involved a one-way Analysis of Variance (ANOVA), in which the independent variable was item type (old vs. new vs. conjunction). A secondary analysis looked specifically at recognition foils (false alarms). The independent variables in this secondary analysis were the type of item (new vs. conjunction) and type of motion (extrinsic vs. intrinsic) participants viewed at retrieval. All independent variables (retrieval item type & motion type) varied within-subjects.

The primary dependent variable in this experiment was the proportion of "Yes" responses to each item type. A second dependent variable was the average confidence rating (1 = *just guessing*, 2 = *pretty sure*, 3 = *absolutely sure*) following "Yes" responses to each item type.

RESULTS

Old vs. Conjunction vs. New items – Proportion of "yes" responses

A primary analysis of variance (ANOVA) for item type was conducted comparing old, conjunction, and new item types. This analysis revealed a significant main effect of item type, $F(2, 98) = 228.674$, $MSE = .017$, $p < .001$, $\eta^2 = .824$. Old items had the highest proportion of "Yes" responses ($M = .82$, $SD = .16$), followed by conjunction items ($M = .48$, $SD = .14$), and new items ($M = .28$, $SD = .16$). A pairwise comparison using a Bonferroni adjustment revealed significant differences ($p < .001$) between old and conjunction motion items (mean difference = .345, $SE = .026$), old and new motion items (mean difference = .547, $SE = .029$), and conjunction and new motion items (mean difference = .202, $SE = .022$). Figure 2 displays this main effect of item type.

New vs. Conjunction items- Recognition foils

A repeated measures 2 x 2 ANOVA on "yes" responses to new intrinsic, new extrinsic, intrinsic conjunction, and extrinsic conjunction items revealed a significant interaction between motion type (intrinsic/extrinsic) and item type (new/conjunction), $F(1, 49) = 18.348$, $MSE = .019$, $p < .001$, $\eta^2 = .272$. The ANOVA also revealed a main effect for item type, $F(1, 49) = 88.095$, $MSE = .023$, $p < .001$, $\eta^2 = .643$, but no main effect for motion type, $F(1, 49) = .176$, $MSE = .028$, $p > .05$, $\eta^2 = .004$. Figure 3 displays the "yes" responses to recognition foils.

Intrinsic Conjunction vs. Extrinsic Conjunction motion types

To better understand the significant interaction between motion type and item type, the effects of motion type were analyzed separately for the new items and conjunction items. A repeated measures ANOVA on "yes" responses to conjunction items revealed that participants were significantly more likely to falsely recognize an extrinsic conjunction item as previously viewed than an intrinsic conjunction item, $F(1, 49) = 7.935$, $MSE = .028$, $p < .01$, $\eta^2 = .139$. Specifically, extrinsic conjunction items yielded a higher proportion of "yes" responses ($M = .526$, $SD = .189$) than intrinsic conjunction items ($M = .432$, $SD = .175$).

New Intrinsic vs. New Extrinsic items

Participants did not, as hypothesized, respond similarly to intrinsic motions and extrinsic motions. Rather, a repeated measures ANOVA on "yes" responses to new items revealed a main effect of motion type, with the likelihood of positive ("yes") responses significantly different for intrinsic and extrinsic motion items, $F(1, 49) = 6.929$, $MSE = .020$, $p < .05$, $\eta^2 = .124$. Specifically, participants were significantly more likely to incorrectly identify new intrinsic motion item types as previously viewed ($M = .314$, $SD = .193$) than new extrinsic motion types ($M = .24$, $SD = .18$). The direction of this inequality strengthens the experiment's main finding that individuals are more strongly associated with their intrinsic motions than with their extrinsic motion. Specifically, the finding that participants more accurately remembered actors' intrinsic motions than actors' extrinsic motions is further strengthened by the persistence of the stronger actor-intrinsic motion relationship despite participants' less accurate memory for specific intrinsic motions than specific extrinsic motions.

Mean differences

Next, the effects of item type on intrinsic motions and on extrinsic motions were separately analyzed to better understand the interaction of item type and motion type in the overall analysis of recognition foils. The difference between "yes" responses to extrinsic conjunction items (*M* = .53) and new extrinsic items (*M* = .24) was much larger (mean difference = .29) than the difference between intrinsic conjunction items (*M* = .43) and new intrinsic items (*M* = .31) (mean difference = .12). This will be discussed in detail in the general discussion section of this article.

Average confidence ratings to "yes" responses

Analyses of confidence ratings revealed that participants were more confident in their "yes" responses to old items than to conjunction or new items, $F(2, 98) = 52.674$, $MSE = .073$, $p<.001$, $\eta^2 = .518$. Specifically, an analysis of variance (ANOVA) for confidence ratings was conducted looking at participants' average confidence rating (1 = *just guessing*, 2 = *pretty sure*, 3 = *absolutely sure*) following "yes" responses to each item type. Participants were significantly more confident of their "yes" responses to old items (*M* = 2.6), with negligible differences between participants' confidence ratings for conjunction (*M* = 2.1) and new items (*M* = 2.1). Figure 4 displays each mean confidence rating following "yes" responses according to motion type.

DISCUSSION

Participants were significantly more likely to remember an actor's specific intrinsic motion than her specific extrinsic motion. This was evident in participants' greater tendency to falsely recognize extrinsic conjunction items as old (M = .526) compared to intrinsic conjunction items (M = .432). Such an interaction of item type and motion type may have important implications for eye-witness testimony.

This experiment's results suggest that participants are substantially more accurate at remembering an actor's specific intrinsic motion than an actor's specific extrinsic motion. The stronger actor-intrinsic motion relationship likely derives from the strong tie between an individual's intrinsic motion and her frame, with the individual's unique structural features directly influencing her distinct intrinsic motion. For example, a 6 feet tall 260 pound European man most likely runs (intrinsic motion) very differently from a petite 5 feet tall 105 pound Iranian woman.

Extrinsic motions, unlike intrinsic motions, relate very little to an individual's frame. Regardless of whether you are a hefty European man or petite Iranian woman, each individual similarly performs an extrinsic motion. For example, both the man and woman perform the extrinsic motion *go into the store* similarly. The path followed when entering the store has minimal or no constraints placed upon it by the individual performing the extrinsic motion. This lack of a direct relationship between an extrinsic motion and an individual is consistent with this experiment's finding that participants performed poorly at remembering an actor's specific extrinsic motion.

The stronger relationship between an actor-intrinsic motion pair over an actor-extrinsic motion pair is further supported by the persistence of such a relationship despite participants' greater accuracy remembering extrinsic motions than intrinsic motions. As discussed in the results section, participants were significantly better at remembering specific extrinsic motions than specific intrinsic motions as indicated by a significantly smaller proportion of false recognition responses for new extrinsic motions (24%) than new intrinsic motions (31%). However, despite being better at remembering extrinsic motions, participants were significantly worse at identifying an actor's extrinsic motion than an actor's intrinsic motion.

Further analysis into the difference between new and conjunction items also revealed a substantially smaller gap between new intrinsic and intrinsic conjunction items than between new extrinsic and extrinsic conjunction items. For intrinsic motions, participants falsely identified new intrinsic items approximately 31% of the time, while their mean recognition false alarms only increased 12% for intrinsic conjunction items. However, for extrinsic motions, participants falsely identified new extrinsic items approximately 24% of the time, but their mean recognition false alarms increased approximately 29% for extrinsic conjunction items. Clearly, participants' deficit in identifying actors' extrinsic motions is not due to an inability to remember the extrinsic motions viewed at encoding, but rather due to an inability to remember the relationship between actors and their extrinsic motions.

The weaker link between individuals and their extrinsic motions has important implications for eyewitness testimony. For example, law-enforcement personnel should be hesitant to convict an individual based solely on a witness' recollection of him exiting the crime-scene-store. It is possible that the witness saw this person before, maybe even exiting the crime-scene-store the same day of the crime. However, as suggested by this experiment's results, it is possible that the witness incorrectly bound the image of an innocent individual to the actual criminal he saw exit the crime-scene-store.

Regarding this paper's opening scenario, evidence that individuals more accurately remember an actor's intrinsic motion than an actor's extrinsic motion supports giving less weight to allegations based on a witness' memory of the event's criminal and extrinsic motion ("That's the man I saw exit the store!"), since the witness possibly bound her memory of the criminal exiting the store with the memory of another previously seen innocent man. Rather, the results support giving greater weight to allegations from the woman who witnessed the criminal (red facemask man) running and then later recognized the beach-running-man's similar running style.

Confidence Ratings for "Yes" Responses

Participants were most confident in their "yes" responses to old items, with negligible differences between confidence ratings for conjunction and new item types. For old item types, participants were generally very confident (absolutely sure) when they selected that the item was also seen at encoding. However, while participants' average confidence rating for old items was 2.6 (1 = *just guessing*, 2 = *pretty sure*, 3 = *absolutely sure*), it was approximately only 2.1 for all other item types.

The positive relationship between higher confidence ratings and accurate memory responses may relate to the tendency for recollection-based memory responses when responding to old items (Yonelinas, 2001; Tulving, 1985). Specifically, higher confidence ratings for old items (*M* = 2.6) may be due to old item recognition responses being based off specific recollection memory, while significantly less confident ratings (*M* = 2.1) following "yes" responses to conjunction and new items may be due to responses being based off familiarity-based memory (Yonelinas, 2001). Future investigation is needed to directly test whether confidence ratings in fact varied due to differences in familiarity- versus recollection-based memory responses.

Future Studies

The results of this experiment support a stronger relationship between an actor-intrinsic motion pair than an actor-extrinsic motion pair. In attempt to further strengthen this argument, future studies will investigate the relationship between an actor and her intrinsic motions and extrinsic motions through analyzing the effect that manipulating a participant's attention has on accurate memory responses. Specifically, these future studies will use simple motion events, such as those used in this experiment, and direct participants to pay attention to either solely the intrinsic motion displayed (IM condition), extrinsic motion displayed (EM condition), or actor displayed (ACTOR condition), or to the actor, intrinsic motion, and extrinsic motion combination (COMBO condition).

As a result of the stronger relationship between an actor and her intrinsic motion (versus extrinsic motion), participants in the IM condition are hypothesized to be significantly better at remembering the actor originally displayed than those in the EM condition. Furthermore, participants in the ACTOR condition are hypothesized to be significantly better at remembering the intrinsic motion originally displayed than the extrinsic motion originally displayed.

However, while such future studies would support superior memory for an actor's intrinsic motion than her extrinsic motion, future studies should also be conducted using more naturalistic stimuli to more directly investigate the accuracy of an eye-witness' testimony. Specifically, future studies should use video clips that depict realistic criminal event reenactments. For example, one video clip could depict a man wearing a facemask running out of a convenience store.

Evidently English speaking individuals are better at remembering an actor's specific intrinsic motion than an actor's specific extrinsic motion; however it is unclear whether or not language differences in the codibility of motion types relate to event memory differences. Languages differ in the codibility of intrinsic and extrinsic motions (Slobin, 2003). While in the English language and other S-languages both extrinsic and intrinsic motions are considered highly accessible linguistic components, V-languages (i.e., Spanish, French) do not readily code intrinsic motions. For example, in French intrinsic motions are optional aspects of the sentence structure and therefore not as readily accessible as they are within the English language (Slobin, 2003). Future research projects should investigate whether or not differences in linguistic codibility influence individuals' event memory accuracy.

Conclusion

This study's results suggest that under certain conditions participants are more likely to remember an actor's intrinsic motion than an actor's extrinsic motion. The greater bind between an actor and her intrinsic motion has important implications for eyewitness testimony and criminal allegations. The findings support giving greater weight to allegations from the woman depicted in the introduction who witnessed the criminal (red facemask man) running and then later recognized the beach-running-man's similar running style than to allegations from a witness who identifies an individual based on remembering the individual exiting the convenience store after committing the crime.

	50 INTRINSIC MOTIONS		50 EXTRINSIC MOTIONS
1	high-knees run	1	into shed
2	touch ground, jump arms up	2	away from soda machine
3	walk while doing jumping jacks	3	out of dorm room
4	crawl on stomach	4	into sandpit
5	skip	5	past map sign
6	walk on heels	6	away from fountain
7	march	7	to water pipe
8	leapfrog	8	around foosball table
9	walk like a monkey	9	down Ramp 1
10	pretend to be on tightrope	10	up Staircase 1
11	walk while doing pat-a-cake	11	into Building 1
12	spin	12	out of Building 2
13	somersaults	13	away from fire hydrant
14	carioca	14	past emergency phone
15	race-walk	15	to bike rack
16	walk like a robot	16	out of restroom
17	shuffle	17	around stop sign
18	run while kicking buttock	18	up Ramp 2
19	pretend to swim	19	away from dumpster
20	limp	20	down Staircase 2
21	jump	21	out of tennis court
22	walk with arms stretched forward	22	into soccer net
23	running-long-jump	23	to volleyball net
24	lunges	24	past Statue 1
25	run legs straight ahead	25	past Statue 2
26	crab walk	26	around Statue 3
27	hop	27	up Staircase 3
28	dance	28	down Staircase 4
29	cartwheel	29	away from electrical box
30	walk like an Egyptian	30	to Statue 4
31	flap like a bird	31	out of elevator
32	waltz	32	into pool
33	walk backwards	33	past TV
34	crawl on knees	34	around picnic table
35	walk	35	away from Statue 5
36	run while punching air	36	up Staircase 5
37	ballet dance	37	around palm tree
38	walk on all fours	38	to Statue 6
39	scoot	39	down the hill
40	roll	40	to large tree
41	walk bowlegged	41	away from bush
42	tiptoe	42	into gazebo
43	stomp	43	past Statue 7
44	right-legged hop	44	around bench
45	run	45	to water fountain
46	walk very slowly	46	down Playground equipment steps 1
47	walk while doing large arm circles	47	down bleachers
48	chicken dance	48	up Playground equipment steps 2
49	walk in very big steps	49	up Ramp 3
50	walk sideways	50	out of parking garage

Figure 1. List of the intrinsic and extrinsic motions used. All landmarks (e.g., staircases, buildings, ramps, playground equipment steps) were distinctly different in appearance.

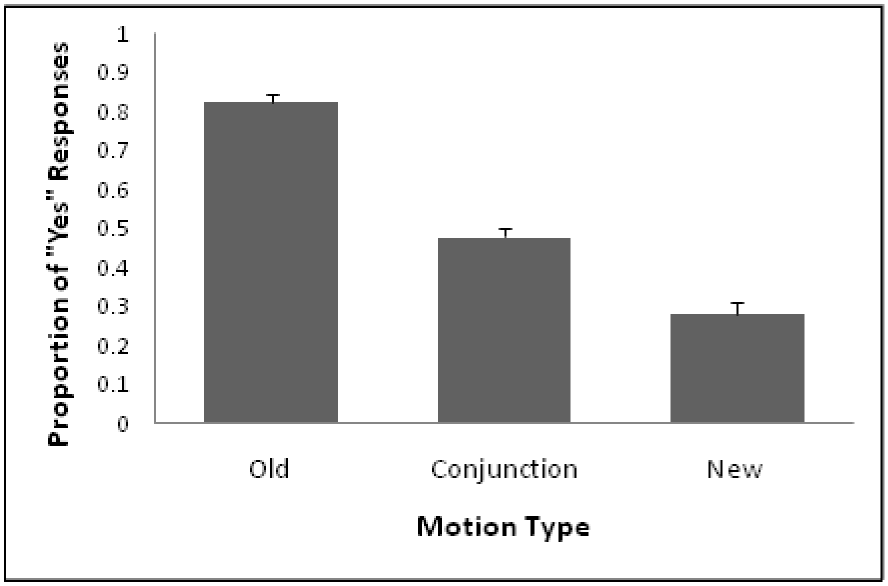

Figure 2. Proportion of “yes” responses (and standard errors) for old, conjunction, and new motion types.

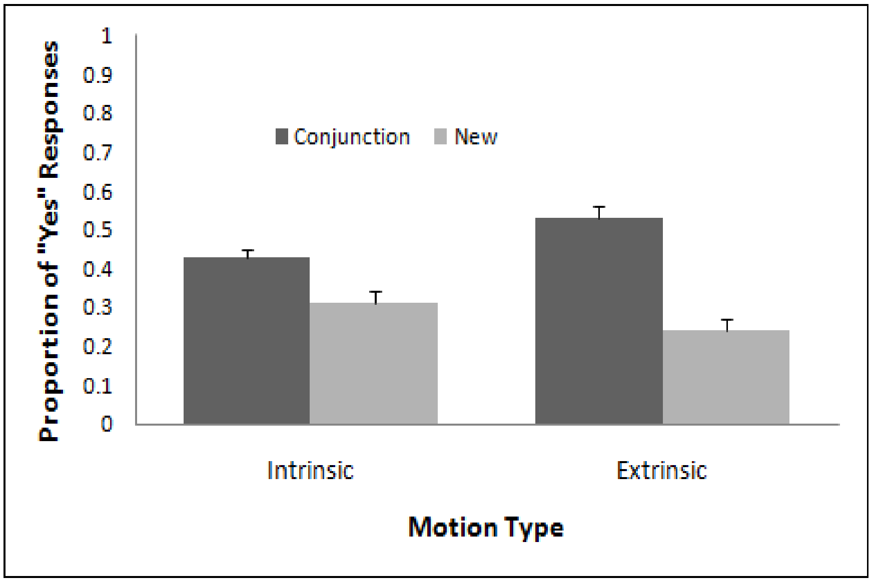

Figure 3. Proportion of "yes" responses (and standard errors) for each new and conjunction item type. The proportions shown here are based off recognition foils to item type.

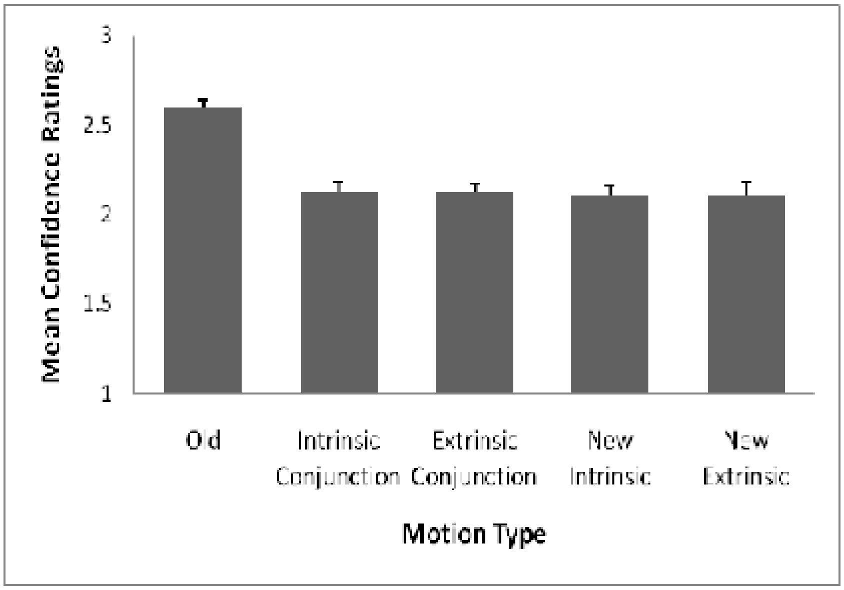

Figure 4. Mean confidence ratings (and standard errors) following "yes" responses for each motion type. n = 50 for old, intrinsic conjunction, and extrinsic conjunction motion types. A few participants did not give any "yes" responses to new motion types, making n = 47 for new intrinsic motion types and n = 44 for new extrinsic motion types. Confidence ratings were made on a 3 point scale (1 = *just guessing*, 2 = *pretty sure*, 3 = *absolutely sure*).

REFERENCES

Behrend, D.A. (1990). The development of verb concepts: Children's use of verbs to label familiar and novel events. *Child Development, 61,* 681-696.

Billman, D., & Krych, M. (1998). Path & manner verbs in action: Effects of "skipping" or "exiting" on event memory. *Proceeding of the Twentieth Annual Conference of the Cognitive Science Society*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Finkbeiner, M., Nicol, J., Greth, D., Nakamura, K. (2002). The role of language in memory for actions. *Journal of Psycholinguistic Research, 31*, 447-457.

Gennari, S.P., Sloman, S.A., Malt, B.C., & Fitch, W.T. (2002). Motion events in language and cognition. *Cognition, 83,* 49-79.

Gentner, D. (1982). Why nouns are learned before verbs: linguistic relativity versus natural partitioning. In S. Kuczaj II (Ed.). *Language Development, Vol. 2: Language, Thought, and Culture* (pp. 301-334). Hillsdale, NJ: Erlbaum.

Jackendoff, R. (1990). *Semantic Structures*. Cambridge, MA: MIT Press.

Jackendoff, R. (1992). *Languages of the Mind*. Cambridge, MA: MIT Press.

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception and Psychophysics, 14*, 201-211.

Kersten, A.W. (1998). A division of labor between nouns and verbs in the representation of motion. *Journal of Experimental Psychology: General, 1,* 34-54.

Kersten, A.W. (2003). Verbs and nouns convey different types of motion in event descriptions. *Linguistics, 41,* 917-945.

Kersten, A.W. & Earles, J.L. (2004). Semantic context influences memory for verbs more than memory for nouns. *Memory & Cognition, 32,* 198-211.

Kersten, A.W., Earles, J.L., Curtayne, E.S., & Lane, J.C. (2008). Adult age differences in binding actors and actions in memory for events. *Memory & Cognition, 36,* 119-131.

Kersten, A.W. & Smith, L.B. (2002). Attention to novel objects during verb learning. *Child Development, 73,* 93-109.

Kersten, A.W., Smith, L.B., & Yoshida, H. (2006). Influences of object knowledge on the acquisition of verbs in English and Japanese. In K. Hirsh-Pasek & R.M. Golinkoff (Eds.). *Action Meets Word: How Children Learn Verbs* (pp. 499-524). Oxford University Press.

Loftus, E.F. (1980). *Memory: Surprising new insights into how we remember and why we forget.* Reading, MA: Addison-Wesley Pub. Co.

Loula, F., Prasad, S., Harber, K., & Shiffrar, M. (2005). Recognizing people from their movement. *Journal of Experimental Psychology*, *31,* 210-220.

Norman, J.F., Payton, S.M., Long, J.R., & Hawkes, L.M. (2004). Aging and perception of biological motion. *Psychology and Aging, 19,* 219-225.

Shipley, W.C. (1986). *Shipley Institute of Living Scale.* Los Angeles: Western Psychological Services.

Slobin, D.I. (2003). Language and thought online: Cognitive consequences of linguistic relativity. In D. Gentner & S. Goldin-Meadow (Eds.). *Language in mind: Advances in the investigation of language and thought* (pp. 157-191). Cambridge, MA: MIT Press.

Talmy, L. (2000). *Toward a cognitive semantics, Vol. II: Typology and process in concept structuring*. Cambridge, MA: The MIT Press.

Tulving, E. (1985). Memory and consciousness. *The Canadian Psychologist, 26*, 1-12.

Tversky, B., & Hemenway, K. (1984). Objects, parts, and categories. *Journal of Experimental Psychology: General, 113*, 169-193.

Yonelinas, A. P. (2001). Consciousness, control and confidence. The three Cs of recognition memory. *Journal of Experimental Psychology: General, 130*, 361-379.