Structural Differences of Physical and Mental Events and Processes

Xu Xu (XXU@NIU.EDU)
Katja Wiemer-Hastings (KATJA@NIU.EDU)
Department of Psychology, Northern Illinois University, De Kalb, IL 60115 USA

Abstract

Event structure has been intensively studied through different approaches. A recent study by Rips and Estin (1998) applied a property listing approach and documented structural differences between physical and mental events. Physical events were shown to have more distinct parts than mental events, which were described as more homogeneous. The present study replicated this study with one modification. We added a factor that may have been confounded with physicality in their study. This factor further distinguishes events and processes. We examined whether the observed structural differences between physical and mental events was partly due to this factor. The results show that distinctiveness of parts was a function not only of tangibility (physical or mental event), but also of temporal characteristics (event vs. process). Furthermore, the distinction of process and event was the only significant factor when distinctive properties were weighted against common properties.

Event Structure

People perceive everyday activities as discrete events. This ability helps people understand what is happening around them and recollect past experiences. Among all kinds of events people experience, some events are characterized mainly by physical elements such as people, objects, locations, and actions, while others are also associated with mental elements such as goals, beliefs, memory, etc. For example, *having breakfast* requires person(s), food, and an action of eating. In contrast, *making a plan* requires not only physical elements, such as people, but also some mental elements, such as a goal and a thinking process.

Whether physical or mental in nature, all events unfold in time. Previous research on event structure was usually carried out from one of two different perspectives, a temporal perspective (e.g., Barsalou & Sewell, 1985; Bower, Black, & Turner, 1979; Morris & Murphy, 1990; Newtson, 1973; Schank & Abelson, 1977; Zacks, Tversky, & Iyer, 2001) and a situational perspective (e.g., Lancaster & Barsalou, 1997; McRae, Hare, Ferretti, & Elman, 2001; Rifkin, 1985; Stevenson, Crawley, & Kleinman, 1994; Thompson, Gomez, & Schvaneveldt, 2000), respectively. A temporal perspective highlights sequential changes and transitions of a situation across time, while a situational perspective highlights the situational elements within an event, the configuration of these elements, as well as the organization of events in memory based on the common elements shared by the events.

Studies with different approaches have shown that temporal and situational information appear to be interdependent and that people make use of multiple sources of information in thinking about event structures (for a detailed review, see Zacks & Tversky, 2001). One study (Boltz, 1998) about musical event duration and structure provided some evidence. Boltz found that nontemporal information in the form of pitch relations not only mark the beginning and the end of a melody but also unfold at a given rate over the total time span. Temporal information and nontemporal information complement each other in a musical event. Results from his study showed that coherence between temporal and nontemporal information could facilitate both better recall for event duration and better pitch recognition, because even though people may not necessarily attend to both of these two dimensions at the time of encoding, the information would still be represented in memory.

Although music seems unique in its regulated relationship between nontemporal and temporal information for aesthetic purpose, some studies showed that other types of events show similar representational structures. For example, Newtson (1977), in his study about causal events, found that people perceive boundaries of event temporal parts at the points where maximal changes in physical features of object and actor motion occur.

Differences in Physical and Mental Events

Rips and Estin (1998) examined structural differences among object, physical-event, and mental-event categories in the way these categories participate in kind and part-whole relations. They found that people typically regard both part and the whole of a mental event as being elements of the same superordinate. For example, *Using logic* is a part of *reasoning*, and *using logic* and *reasoning* are both a kind of thinking. In contrast, the part and the whole of objects belong to different superordinates, e.g. *Stem* is a part of *an apples*, and *apples* are a kind of fruit, but stem is not. Physical events appear to be an intermediate case.

Rips and Estin explored the sources for this difference in a series of experiments. In the context of this research, we will discuss only the findings regarding physical and mental events. First, parts of physical and mental events were collected. For example, *organizing* may be a part of *planning*, *using logic* a part of *reasoning, getting ID* a part of *checking out books,* and *putting on lotion* a part of *getting a suntan*. The method in the main experiment was a property-listing task on these parts. Participants were presented with a part of a mental or physical event, and instructed to list either common properties that this part shared with other parts of that event, or distinctive properties that are shared by no other parts of that event.

The critical measure was the number of distinctive properties that participants listed. An event with a clear structure was assumed to have parts that can be clearly distinguished, hence, that have distinct properties. Rips and Estin predicted that the parts of physical events would be more distinctive than those for mental events. This is indeed what they found. Temporal parts of mental events appeared to be less distinct than those of physical events. In other words, the temporal parts of mental events, such as planning and reasoning, are more homogeneous than temporal parts of physical events, such as checking out books and getting a suntan.

As a result, people are more likely to think of a mental event as a whole than a physical event. In contrast, they are more likely to think of a physical event as a sequence of steps that lead to the achievement of a goal than of a mental event. It has been attributed to the apparent homogeneity of parts in mental events that people tend to classify both a mental event and a part of that mental event into the same superordinate category.

Motivation of the Present Study

Rips and Estin's findings suggest that the situational characteristics of events affect how people think about the temporal structures of the events. Mental events such as making a plan involve more nonphysical elements than physical events. Similar to physical events, mental events can have different phases. However, due to the intangibility and ambiguity of phases and phase boundaries, these phases are difficult to differentiate from each other. In contrast, physical events, which involve mainly physical elements, are more likely to present clear phases along temporal dimension.

One problem that potentially limits the conclusiveness of these findings regards the materials. It appears that most of the concepts used as physical events were really events, whereas a lot of the mental concepts could more aptly be described as processes. For example, *catching a plane,* and *checking out books,* as examples for physical events, are all actions that take place over a limited time period, and involve some element of accomplishment (see Vendler, 1967). Examples for mental activities used in the experiment are *reading, dreaming,* and *reasoning*, all of which can go on over a longer stretch of time and do not imply a specific action as terminating the event.

This posits a serious challenge to the conclusions. It appears that events have more distinct parts (such as beginning and end) than processes do, which can generally be described as continuous, phaseless activities that are homogeneous throughout (Vendler, 1967). For example, the process of *reading* does not require any differences in action between the first seconds of reading and the last - at any point the process can be called *reading*. In contrast, *checking out books*, for example, begins with entering a library, empty-handed, and ends by leaving it, holding books. In the materials used by Rips and Estin, most physical events were events and most mental "events" were processes. Since both being physical (versus mental) and being an event (versus a process) may lead to more homogeneous parts, the differences observed in the experiment may have been at least in part due to the difference between events and processes.

Physicality and Aspect

Our study aimed and untangling the effects of physicality and aspect characteristics of activities. We adopted Rips and Estin's (1998) property listing approach, but constructed materials that allowed us to estimate structural differences due the distinction of physical versus mental activities, as well as due to the effects of activity aspect. We predicted that each factor would contribute to the observed structural differences, thus that mental activities would overall be more homogeneous than physical activities, and processes more so than events.

To create stimulus sets that were more comparable, we did not use activities described by different numbers of words. Instead, all of our stimuli were individual nouns (e.g., *interview*, *imagination*). We did not expect the noun form to cause differences in the findings from gerundive verbs as used by Rips and Estin, since frequently results for nouns and verbs are equivalent (e.g., Rifkin, 1985). Consistent with previous research (Rifkin, 1985), we counted activities that involved a thought as a central aspect of the activity as mental events or processes (e.g., *imagination, recognition*). Physical events and processes were activities that were not centrally characterized by mental elements (e.g. *robbery*, *interview*).

Furthermore, to differentiate events and processes, stimuli were used that were either homogeneous activities or activities that involved a moment of achievement or accomplishment (Vendler, 1967). A norming study was conducted to select, out of a larger pool of activity nouns, items that were consistently classified as events or processes. As a result, we constructed four groups of stimuli: physical events, mental events, physical processes, and mental processes.

It was predicted that the parts of mental activities would be less distinctive, i.e., have less distinctive properties and share more common properties with other parts of that activity. Physical activities were expected to contain parts that are more distinctive, i.e. that have more distinctive properties and share less common properties with other parts of that activity. Rips and Estin did not find significant differences in the number of common properties for parts of mental versus physical activities. Since we are introducing a second factor, the number of common properties was included in the analysis to detect possible effects of the aspect manipulation.

In line with the arguments described above, we predicted, with respect to aspect, that participants would describe parts of events with more distinctive properties and fewer common properties than parts of processes.

Method

Participants. 120 participants were recruited from undergraduate introductory Psychology classes at NIU. Most of these students were freshmen and sophomores.

Students obtained course extra credit for their full participation in this experiment.

Materials. Seventy activity words were sampled from a database. Four independent judges who were either faculty or graduate students at Northern Illinois University and can be considered able to discriminate activities with respect to aspect were asked to classify these 70 words as events, processes, or states, respectively. From the initial 70 words, only those words were retained that were classified consistently by at least 3 of the four raters as either a process or an event. From this word pool, 12 event and 12 process concepts were selected for use in the study so that half of them were mental and half of them were physical. Table 1 presents an example for each group.

Table 1: Example items for the four conditions of the experiment

	Physical	Mental
Event	Robbery Concert	Judgment Realization
Process	Acceleration Decomposition	Contemplation Imagination

Part Generation

Parts of events were collected empirically. Ten participants, who did not participate the main study, were recruited for a preliminary study and instructed to list parts of each of the 24 common activities. The instructions included two example words, *exam* and *evaluation*, with parts to help participants understand the task.

Participants were told that they would read terms that "refer to some common activities which can be divided into different parts along the temporal dimension". Participants were asked to write down as many parts as they could think of, but only parts that necessarily are contained by all instances of that activity. For example, participants read: "Here's an activity – *interview*. An interview contains different parts taking place in a certain order and covering a certain period of time. Please think of as many parts as you can, which are typical to any interview and write down your responses in order." The 24 items described above were presented to participants in random order one at each page in a booklet. One part of each concept was chosen from among the most frequently listed responses by participants. Synonyms of an item were counted as instances of the same part. Non-responses such as "this is a hard word" were not counted.

Main Experiment Instruction

In the main experiment, participants were presented with questions about the parts of some activities generated from the part generation study. Each question mentioned an activity and one of its parts. Participants were randomly assigned to perform one of two tasks: common property listing, or distinctive property listing.

Participants in the common property group were asked to list properties of a part, which were true of all other parts of the activity. Taking *interview* as an instance, participants will be asked to "list the properties of *answering questions* that are true of *all* other parts of an *interview*".

The other half of participants was assigned to the distinctive property group. The instructions asked participants to list properties of a part, which were true of *no* other parts of the activity. Taking *interview* as an instance, participants will be asked to "list the properties of *answering questions* that are true of *no* other parts of an *interview*".

Main Experiment Design

The 24 event concepts and their parts were divided into three sets. Each contained the parts generated for 2 pairs of mental events, 2 pairs of physical events, 2 pairs of mental processes, and 2 pairs of physical processes. By crossing two types of instructions (common property listing or distinctive property listing) with these three concept sets, there were altogether six different conditions. The 120 participants were randomly assigned to receive one of the six different types of property listing materials. All materials were presented in booklets, and participants recorded their responses using a paper and pencil procedure.

Results

Evaluation of Responses

The properties listed in the main experiment were analyzed as follows. For each part in each condition, it was counted how many participants had mentioned each particular property. Synonymous expressions within the responses to a same item were counted as the same property for that item. Only properties listed by at least two participants for an item were included in the analyses. In doing so, we expected to eliminate idiosyncratic responses and increase the reliability of the analysis. The mean number of distinct and common properties was then computed for each type of activity.

Differences in the Number of Parts

A one-way ANOVA was performed on the mean number of parts generated for each concept of the four groups: physical events, mental events, physical processes and mental processes. The overall test indicated a significant difference between groups, $F = 14.85$, $MSE = .54$, $p < 0.001$. A post hoc analysis revealed that people listed more parts for physical events than for the concepts of the other three groups (see Table 2), while there are no significant differences between the mean numbers of parts listed for mental events, physical processes, and mental processes.

Table 2: The mean number of parts for physical events, physical processes, mental events and mental processes.

Activity Type	Mean	Std
Physical Event	5.18	1.04
Physical Process	3.12	0.76

Mental Event	3.17	0.51
Mental Process	2.52	0.50

Distinctive Properties

A 2 (physical/mental) X 2 (event/process) ANOVA was carried out to examine the difference in the mean number of distinctive properties listed for each concept. As predicted, two main effects were found. The first effect replicated the effect found by Rips and Estin (1998). There was a significant difference in the distinctness of parts for physical versus mental activities, F (1, 20) = 22.910, MSE = 0.149, $p < 0.001$. Consistent with the previous findings, more distinctive properties were listed for parts of physical activities (M = 2.75) than for the parts of mental activities (M = 2.00). Second, we also observed a significant effect of the aspect groups, processes versus events, on the distinctness of parts, F (1, 20) = 12.875, MSE = .149, $p <$ 0.01. More distinctive properties were generated for the parts of events (M = 2.66) than were generated for the parts of processes (M = 2.09). There was no interaction of these two factors.

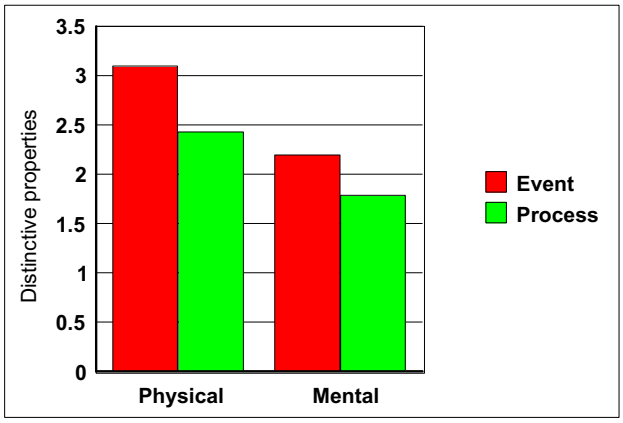

Figure 1: The mean number of distinctive properties listed for the four activity types.

Common Properties

A second ANOVA with the same factors was carried out on the mean number of common properties listed for the parts of the activities. Consistent with the findings by Rips and Estin, we found no significant effects of physicality on this measure, neither did the event / process distinction affect the number of common properties.

Distinctive and Common Properties

From the analysis of distinctive properties, it seems that both physicality and aspect contribute to differences in the homogeneity of activity concepts, as measured by the distinctness of the properties of their parts. To further explore their effects on part properties, an additional 2 (physical / mental activity) X 2 (event / process) ANOVA was performed on the difference score of distinctive properties, minus the number of common properties for each item. Intuitively, one would expect that people list more properties, both distinctive and common, for physical than for mental activities because it may be easier to describe observable activities. If this is true, then the number of distinctive properties may be higher simply because more properties are listed overall, rather than because the parts are more distinctive.

To build the difference score, the number of common properties was subtracted from that of distinctive properties. This score can discriminate among parts that have many distinctive properties but also many common properties, and parts that have many distinctive properties but few common properties. The latter should receive a higher difference score, reflecting higher distinctness. This presents a more accurate measure of distinctness by taking both commonalities and differences into account (Tversky, 1977). A main effect was observed for events versus processes, F (1, 20) = 7.16 MSE = 0.45 $p < .02$. Event parts had higher numbers of distinctive properties (M = 0.94) than process parts (M = 0.21), as one would expect. The surprising result was that the physicality factor was not significant in this analysis. This suggests that in fact the distinction of events and processes may have a bigger impact on homogeneity of activities than the distinction of mental versus physical events.

Discussion

The purpose of this study was to investigate the structural differences in temporal parts between physical and mental events and processes. Previous research had shown that mental activities tend to be more homogeneous than physical activities. We were concerned that part of this difference may be due to the temporal characteristics of the materials used, in which the mental / physical distinction appeared to be confounded to some extent with the distinction of events and processes. To examine the differential effects of these two important factors, we constructed materials that allowed to compare the effects of physical versus mental nature of an activity and the effects of its temporal characteristics as an event versus a process on the homogeneity of activity parts. The results from our study show that there are differences in temporal structures between different event concepts, physical and mental. Also, there are basic structural difference between events and processes.

In the part generation task, participants listed more parts for physical events than for mental events. This finding is not surprising. Intuitively, physical events are more tangible and easier to identify and describe their parts, while mental events are more elusive to catch the details of their characteristics. Vendler (1967) described processes as successive phases following one another in time and any part of a process is of the same nature as the whole. According to this description, neither a physical nor a mental process should contain more than one temporal part, explaining our finding that the numbers of parts listed for physical and mental processes are significantly smaller than those for physical events. Furthermore, there is no difference in the numbers of parts listed for mental events and for both types of processes, suggesting that people tend

to judge any mental event as a whole instead of as a series of detectable temporal parts. In other words, it may be due to intangibility and uncertainty of phases and phase boundaries within mental events, that people tend to treat mental events as processes.

Homogeneity

In the property listing task, participants listed more distinctive properties for parts of physical events than for parts of mental events. This is consistent with Rips and Estin's findings. However, the further distinction of events and processes allowed us to examine the effect in more detail. We found that people describe the parts of events as more distinctive than parts of processes, indicating that not only tangibility (physical versus mental) but also aspect (event versus process) affects how people perceive the temporal structures of activities. These two factors were confounded in some of the materials used previously (Rips & Estin), which had actual physical *events* as physical events, but mental *processes* as mental events. This may have inflated the structural differences observed between physical and mental activities. That is, the difference between physical and mental events they found in their study was not only due to tangibility but also due to the effect of aspect.

To test this argument empirically, we examined the difference scores between distinctive and common properties for each concept. We found that participants still described the parts of events as more distinctive than parts of processes using this measure, but there was no difference in distinctiveness between physical and mental activities. Thus, overall, physical activities lead to more listed properties, leading to higher numbers of distinctive properties. The difference between distinctive and common properties provides a more accurate measure of distinctness of parts, since both the number of common and of distinct properties should have an effect on it (Tversky, 1977). Using this corrected measure, our data suggest that the observed structural differences reported previously may in fact be due to aspect as opposed to the distinction of mental and physical events. This is a surprising result, considering that there are obvious differences in our perception of mental and physical activities.

Considering that crisp definitions of mental versus physical and process and event are not really possible, however, the finding reported here needs to be interpreted with caution. We could imagine quite easily a continuum on which activities gradually vary in both characteristics. Accordingly, it may be possible that the stimuli in Rips and Estin's study were selected from the extreme ends of both, whereas our stimuli may have been less distinct. This can and should be followed up upon in future experiments.

It did not appear that there were substantial differences in the numbers of common properties between activity types. This is probably due to the limited number of common properties listed for each item. Compared to the listed numbers of distinctive properties, the numbers of common properties were much smaller, F (1, 23) = 13.07, MSE = .30, p < .001. The reason that participants listed more distinctive properties than common properties in the same amount of time might be the use of a different properties listing strategies for these two different tasks. Participants who were instructed to list distinctive properties produced both sub-phases of a part of an activity, as well as abstract properties of the part as properties that could distinguish the part from other parts of the activity. In contrast, participants in the common property listing group could not apply this strategy in their tasks. Thus, the listing of common properties may have been a more difficult task than the listing of distinctive properties, especially when constrained by the same time limit. Some adjustment could be made in future studies employing this method.

To sum up, our findings support the hypothesis that mental and physical activities, distinguished in this study as activities that do or do not have a thought as a central element, differ in homogeneity. This is consistent with the findings by Rips and Estin. Our study provides stronger support for their argument because we replicated their finding after taking an important confound into account. We obtained this effect only in the mean number of distinctive properties listed by participants, however. When the number of common properties is also considered in the dependent measure, the effect of physical versus mental activity on homogeneity disappears, while the difference between events and processes is still significant.

A limitation of the current study is the small number of stimuli. Since listing properties for abstract concepts such as mental events is a relatively difficult task to accomplish in a limited amount of time, fewer words might have ensured the quality of responses but lowered the effect size of the results. More words should be included in future studies.

Acknowledgments

We gratefully acknowledge the thoughtful and very helpful contributions of Dr. Betty Birner and Dr. Joseph Magliano to this study. We also thank our four raters for the classification of seventy activities into events, processes and states for norming purposes, which was a critical component in the aspect manipulation of the materials.

References

Barsalou, L. W., & Sewell, D. R. (1985). Contrasting the representation of scripts and categories. *Journal of Memory & Language, 24,* 646-665.

Boltz, M. G. (1998). The processing of temporal and nontemporal information in the remembering of event durations and musical structure. *Journal of Experimental Psychology: Human perception and performance, 24,* 1087-1104.

Bower, G. H., Black, J. B., & Turner, T. J. (1979). Scripts in memory for text. *Cognitive Psychology, 11,* 177-220.

Graesser, A. C. & Clark, L. F. (1985). *Structures and procedures of implicit knowledge*. Norwood, NJ: Ablex.

Hampton, J. A. (1981). An investigation of the nature of abstract concepts. *Memory & cognition, 9,* 149-156.

Lancaster, J. S., & Barsalou, L. W. (1997). Multiple organisations of events in memory. *Memory, 5(5),* 569-599.

McRae, K., Hare, M., Ferretti, T. R., & Elman, J. L. (2001). Activating verbs from typical agents, patients, instruments, and locations via event schemas. *In Proceedings of the Twenty-Third Annual Conference of the Cognitive Science Society* (pp. 617-622). Mahwah, NJ: Erlbaum.

Morris, M. W., & Murphy, G. L. (1990). Converging operations on a basic level in event taxonomies. *Memory & Cognition, 18(4),* 407-418.

Newtson, D. (1973). Attribution and the unit of perception of ongoing behavior. *Journal of Personality and Social Psychology, 28,* 28-38.

Newtson, D., Engquist, G., & Bois, J. (1977). The objective basis of behavior units. *Journal of Personality and Social Psychology, 35,* 847-862.

Rifkin, A. (1985). Evidence for a basic level in event taxonomies. *Memory & Cognition, 13(6),* 538-556.

Rips**,** L. J., & Estin, P. A. (1998). Components of objects and events. *Journal of Memory & Language, 39,* 309-330.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding: An inquiry into human knowledge structures.* Hillsdale, NJ: Erlbaum.

Stevenson, R. J., Crawley, R. A., & Kleinman, D. (1994). Thematic roles, focus and the representation of events. *Language and Cognitive Processes, 9,* 519-548.

Thompson, L. A., Gomez, R. L., & Schvaneveldt, R. W. (2000). The salience of temporal cues in the developing structure of event knowledge. *American Journal of Psychology, 113(4),* 591-620.

Tversky, A. (1977). Features of similarity. *Psychological Review, 84,* 327-352.

Vendler, Z. (1967). *Linguistics in philosophy.* Ithaca, NY: Cornell Univ. Press.

Zacks, J. M., & Tversky, B. (2001). Event structure in perception and conception. *Psychological Bulletin, 127(1),* 3-21.

Zacks, J. M., Tversky, B., & Iyer, G. (2001). Perceiving, remembering, and communicating structure in events. *Journal of Experimental Psychology: General, 130(1),* 29-58.