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EFFECT OF ACT TYPICALITY AND HOMOGENEITY ON SCRIPT PREFERENCES: BIASES AND IMPLICATIONS

by

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ABSTRACT OF THE DISSERTATION

Effect of Act Typicality and Homogeneity on Script Preferences: Biases and Implications

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Social commerce involves a combination of visual and verbal behaviors whose interpretations are subject to the ambiguity inherent in any given act, which, to varying degrees, may be consistent with multiple scripts. While a single act might lead to a particular inference, preceding acts in a sequence might be expected to bias subjective representations of subsequent behaviors and resulting agent related inferences. The present set of studies examined the notion of act typicality in scripts that share a context, the combined impact of the typicalities of an act *sequence* on script inferences and the interaction between the typicality of acts and their hierarchy within these scripts. Typicalities were found to be graded analogous to objects categories, suggesting a rich "shared" structure of scripts containing actions strongly supportive of only one of the two scripts and others highly equivocal with respect to the two scripts. Typicalities of four act sequences were found to be strongly correlated with ratings assigned to competing explanatory scripts, obtained at the end of the sequence but independent of the number of different *scenes* represented

by the acts in a sequence. Next, sequential ratings to competing scripts in response to an unfolding act triple of non uniform typicality were found to be strongly biased towards the script suggested by the high typicality act and unaffected by the greater number of acts of medium/low typicality preceding the former. Changes in script ratings were found to be asymmetric going from high to low/medium acts and vice versa. These findings have implications for the manner in which *covert* scripts might be implemented via the exploitation of typicality biases.

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Chapter 1

Introduction

1.1 Scripts as Social Knowledge Structures

Understanding behavior is a highly complex activity that people engage in routinely. It requires the use of knowledge of the physical world as well as social knowledge. The later may be represented as scripts (Schank and Abelson, 1977) which consist of information about events that are believed to typically occur in a particular scenario. For example, people might have a script for the events and behaviors associated with a visit to a restaurant. A study by Bower, Black and Turner (1979) showed that people's scripts for everyday scenarios overlap significantly. Further these scripts were shown to exhibit a particular kind of internal arrangement in which certain actions were linked to others so that one set of actions tended to be falsely remembered when shown the other. This linking was also observed when people were asked to list the events that typically occurred in a given situation. Events in a script are also found to reflect a partial temporal ordering so that certain actions are expected to occur before others. For instance, in a restaurant script, the step of ordering food would occur prior to the step of paying for it. This linking of certain events combined with their temporal ordering allows people to infer certain events not explicitly stated given only a subset of the script. A script might

also have the added effect of causing people to expect future events in the light of those explicitly stated. A statement such as "John picked up the menu" might lead to the expectation that John might, at some point, place an order for food.

Scenarios and situations do not, in practice, unfold in strict accordance with a script. A visit to a restaurant could proceed in an infinite variety of ways. However, each of these variations would have certain common features. These similarities are what a "restaurant" script captures providing a schematic representation of the events/actions that occur during a visit to a restaurant. The schematic nature of a script allows the observer to recognize two different situations corresponding to the same script much like classifying two objects as members of the same category. Categorization of actions using a script provides the observer with information about the actor's goals leading to a characterization of the observed actions as the implementation of a plan to achieve these goals. Thus, explaining actions amounts to recognizing the actor's plan. A script even guides the actor's own planning process. For example, if one has the goal of "visiting a restaurant" then, an existing "restaurant" script would provide the planner with the various "scenes" (Schank and Abelson, 1977) in the script such as "placing an order" and "paying for the meal". These scenes would inform the planner of the various sub-goals that must be achieved before the main goal of "visiting the restaurant" is completed. For instance, the "paying for the meal" scene would inform the actor of the necessity of achieving the prior sub goal of "obtaining money". However, if the actor has already completed this sub goal at the time of planning a visit to the restaurant, then this particular sub goal would be omitted from the actor's plan. While a restaurant script tells one how to implement a plan to visit a restaurant it doesn't tell you what to do if your wallet is stolen on the way to the restaurant. This situation would correspond to an alternative script of dealing with the loss of a wallet which might involve visiting the police station, borrowing money and

so on. Thus a script is sufficiently abstract that it can function as a category definition but at the same time contains enough detail to usefully guide one's behavior. Hudson, Shapiro and Sosa, (1995) have found that even preschoolers make use of scripts to both recognize the actions of others as well as plan their own actions.

Inferences derived on the combined basis of observed behavior and an existing script could be of three kinds. These inferences could refer to actions that were carried out between a pair of observed actions, to actions that are expected to occur in the immediate future and those actions that are expected to occur in the distant future. For example consider the following sequence of actions: *(a) John picked up the menu, (b) John sat back and waited for the food to arrive (c) John calculated the tip.* This sequence may activate the "restaurant" script leading to the inference that John must have placed an order for food at some point of time between acts a) and b). However observation of act (a) alone, would initially have led to the expectation that John was about to place an order for food. Act (a) would also have led to the more distant expectation that John would pay for his meal and leave. In addition to these expectations an inference can sometimes take the form of a summary of the observed actions such as "John had a meal at a restaurant". Schank and Abelson, 1977) suggested that these summaries or "script headers' lie at the top of the script hierarchy which is made up of "scene headers' at the next lower level followed by scene actions at the very lowest level. These scene headers refer to sets of actions corresponding to scenes. Bower et al (1979) found that when asked to group act statements, corresponding to a given script, that appeared to be linked to each other, people gathered these acts into scenes. Further, the boundaries of these scenes were found to be consistent across subjects. Abbott, Black and Smith (1985) have shown that this kind of a hierarchical structure has an impact on the type of inferences drawn from stories constructed around a single script. They found that people falsely recognized

scene headers after reading scene actions but not scene actions after reading scene headers. They also found that people gave higher confidence ratings to scene headers relative to scene actions.

There is further evidence for hierarchical organization of behavior as seen in studies by Heider (1946, 1958), Forgas, Argyle and Ginsburg, G. P. (1979) and Miller, Galanter and Pribram (1960). For example in the study by Heider and Simmel (1944) subjects were asked to describe the movements three objects (a square and two triangles) moving against a screen. It was found that these movements were spontaneously described in terms of the objects' goals and motivations. Goal statements which summarize the behavior of an actor much like a script header, have also been obtained in subjects' recall of textual material describing the actions of an actor (Abbott and Black, 1982, 1986). This type of organization and goal based reasoning has been observed in story understanding (Black and Bern, 1981, Mandler 1978, Mandler and Johnson 1977, Rumelhart 1977, Stein and Glenn 1979), text comprehension (Abbott, Black and Smith, 1985, Bower, Black and Turner, 1979, Haberlandt and Bingham 1978, Seifert, Robertson and Black, 1982, Trabasso, Secco and Broek 1984) as well as in people's responses to videotapes of sequences of actions (Lichtenstein and Brewer, 1980). Further, the specific hierarchical arrangement of actions into goals and subgoals proposed by Newell and Simon (1972) has been observed in several empirical studies (Galambos and Rips, 1982, Bower, Black and Turner, 1979, Wilensky, 1978, 1983). While people engage in causal reasoning and organization of actions when specifically instructed to do so or when faced with an unexpected event (eg: Enzle and Schopflocher, 1978, Hastie, 1984) they have also been shown to construct similar explanations of behavior quite spontaneously (eg: Winter and Uleman, 1984, Smith and Miller, 1979, Sherman and Titus, 1982).

1.2 Motivation and Overview of Study

While scripts and schemata are often employed by people to understand and interpret agent behaviors, these schemata are not guaranteed to lead the reasoner to an accurate reading of the agent's intentions. A sequence of behaviors may be consistent with multiple scripts to varying degrees. This inherent ambiguity must be taken into account both when the agent is attempting to communicate her/his intentions to an observer or, alternatively, to conceal these intentions. That is, the agent must attempt to induce in the observer or listener a certain mental state that is in keeping with the agent's communicative goals. Social commerce typically involves a combination of visual and verbal behaviors and social inferences drawn via both modalities are likely to be affected by the less than certain cue validity of scripts. News agents typically have a "spin" on the story being told and often do more than narrate events in the sequence in which they occurred. The manner in which news items are framed can clearly bias the listener/viewer into forming beliefs about the subject matter. For instance, it was found that describing the effectiveness of a vaccine in terms of the percentage of "lives saved" tended to bias subjects in favor of a new experimental vaccine while a description in terms of the percentage of "lives lost" elicited an unfavorable response to the vaccine (Tversky and Kahneman, 1981). Such "framing effects" have been shown to occur in several decision making contexts involving attitudes towards risks (Kuhberger, 1998), health related choices (Marteau, 1989), willingness to respect laws and a reluctance to exploit opportunities to "free ride" (Andreoni, 1995) and responses to public policies (Buetler and Marchal, 2007). The narrative that accompanies a movie trailer is typically designed to exploit the audience's script knowledge so as to convey something of the plot while also promising a novel experience. Often not-so-novel films manage to draw an audience simply through the use of creative advertisements that bias the observers away from pre-existing scripts(!).

Prosecutors and defense lawyers work with identical sets of evidence to trigger "guilty" and "innocent" scripts in the jury, respectively. The use of rehearsed witness/client testimonies as well as opening and closing statements to bias the jury towards a particular decision reflects an awareness of the interpretive ambiguity of the description of a set of events and the resulting potential for constructing alternative explanations for these events. Authors of journal articles must create an appropriate frame of reference that will enable their readers to make the transition from their current state of knowledge to that which the authors wish to induce, anticipating and addressing questions that might arise in the minds of their readers. Finally, political campaign speeches are constructed so as to deliberately bias observers towards one or other inference, a trend that apparently continues when elected representatives attempt to garner support for their causes via arguments that evoke favorable scripts.

We see that biases induced by certain actions, through deliberate construction or otherwise, in the interpretation of subsequent behaviors and resulting agent related inferences are ubiquitous. The aim of the present set of studies is to examine factors that might contribute to these biases, specifically in the domain of common social events. The role of typicality of an act with respect to the schema in which it appears was explored for this purpose. While there have been studies to show that a) people's representation of social scenarios include scripts consisting of actions/events that are typically expected to occur in these scenarios and b) people make use of these scripts to draw inferences about actions/events not explicitly observed, one could speculate that the various acts within a script might not have the same status in terms of their association with the script as well as their use in the inferences drawn. The subjective *level* of typicality of an act in a certain scenario might be expected to influence the observer's reading of subsequent acts as well as choice of an explanatory schema that best "covers" a sequence of acts.

In experiment 1 we obtained from subjects typicality ratings of action statements with respect to two different scripts that shared a context. It is of interest to examine the extent to which typicalities within a script might be *graded* analogous to objects and their categories. Further, scripts that exist in a common context are likely to contain certain actions that strongly suggest only one of the two scripts and certain other actions that appear to be "torn between" the two scripts. There might even be actions that are only weakly linked to the context itself and might therefore suggest neither script.

In experiment 2 we asked subjects to rate two scripts in terms of how well they matched a given sequence of four act statements. The average typicality level of an act sequence with respect to a particular schema might be expected to influence the perceived support for this script. The script suggested by an act occurring earlier in the sequence might impact the manner in which subsequent acts are processed. The "coverage" provided by the act sequence might also be expected to vary with the number of different *scenes* of the script, represented by the four acts. Therefore this additional factor was also examined for its role in determining the subjective match between the act sequence and a pair of competing explanatory scripts.

In experiment 3 subjects were shown sequences of three acts. Ratings were obtained for a pair of competing scripts, after *each act*. This allowed the examination of changes in script preferences in response to the unfolding 3-act sequence. Each sequence was a combination of high and lower typicality acts which made it possible to study the extent to which high and lower typicality acts acted as frames of reference for each other. We also looked for the existence of a bias in terms of the amount of subjective weight given to an act at a particular level of typicality. If the impact of high and lower typicality acts on subjective script preferences is not symmetric, then knowledge of this fact may be exploited by agents to manipulate observers' script related inferences.

Chapters 2, 3 and 4 describe the three experiments respectively. Chapter 5 discusses the implications of the results obtained in these experiments. Appendices 1, 2 and 3 list the stimuli used in each of the three experiments.

Chapter 2

Experiment 1: Typicality of a single act with respect to a script

2.1 Motivation

2.1.1 Comparing the structure of scripts and categories

The concept of typicality has been studied in the context of categorization in various domains such as objects, natural scenes and dispositions. It has been shown that objects vary in their degree of membership (Rosch et al, 1976) to their categories so that some objects are perceived to be more typical of their categories relative to others. Further it was found that the time taken to classify objects into categories is directly proportional to their typicalities. Typicality has also been a topic of study in the domain of personality traits (eg: John, Hampson and Goldberg, 1991).

While there are certain similarities between object categories and scripts there are differences as well. Bower et al (1979) have compared scripts to categories and actions to attributes while Abbott et al (1985) have pointed out that scripts, unlike object categories, are more appropriately viewed as "partonomies". However both categories and scripts

reveal these two types of structures to varying extents. Both exhibit a kind of partial hierarchy in which any two levels either reflect a difference in the degree of "abstraction" or are linked via a "whole-component" relationship. However, as seen in figure 2.1, below, categories are dominated by the former while scripts by the latter. Objects may be described in terms of the super-ordinate, the basic or the subordinate categories they belong to. For example, a chair may be described more abstractly as "furniture" or more specifically as a "recliner". Thus objects at lower levels in the hierarchy inherit some of the properties of those at higher levels. However acts do not inherit the properties of the sub-goals or scenes they are a part of, neither do sub goals inherit the properties of the scripts they implement. A weaker version of this kind of abstraction exists in scripts only at the level of acts and the manner in which these acts are carried out. For instance, the act of "lifting a book" may be described more concretely as "lifting a book with the left hand". On the other hand, the "whole-component" relationship between acts and scenes and scenes and scripts, doesn't exist between say, "chair" and "furniture" or between "chair" and "recliner". However it can be said to exist between objects at both the basic and the subordinate levels of the object hierarchy and their respective parts.

2.1.2 The Basic Level

While the difference between objects at their basic and superordinate levels seems well defined, the distinction might seem somewhat unclear in the case of actions and plans due to the fact that plans themselves are stated as actions summarizing other actions. This problem can be overcome if we make use of the notion of symmetry in plan-act relationships. While an act may be said to be a component of a plan, it would not make sense to say a plan is a component of an act. For example, the act "withdraws money from an ATM" may be said to be a component of the plan to "visit a restaurant". However,

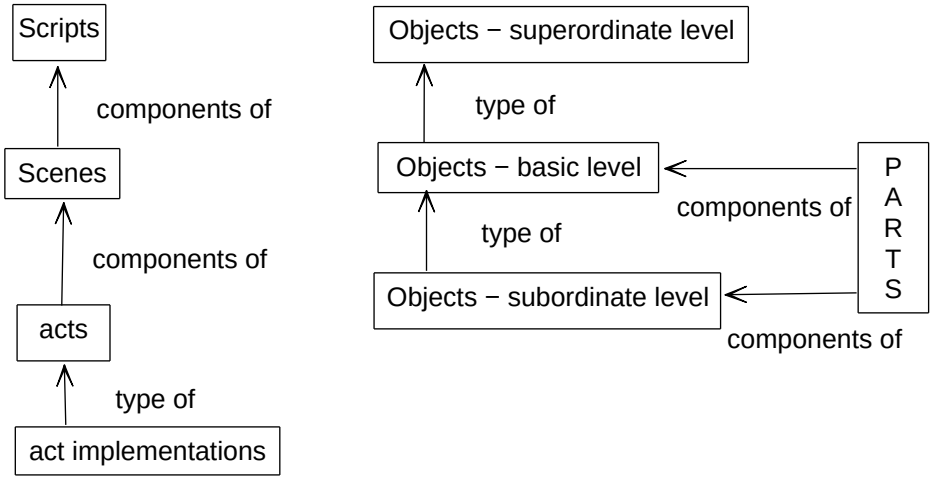

Figure 2.1: A comparison of the structure of scripts and categories and the types of relationships that exist in each.

the reverse would would not hold. Similarly, a scene header corresponding to a sub goal such as "place an order for food" would function as a "plan" relative to the actions "read the menu" and "beckon the waiter".

The focus here is on the typicality feature of objects with respect to their categories and its existence in the domain of scripts and actions. Rosch et al (1976), among others, (eg: Brown, 1958; Cantor and Mischel, 1979; Rifkin, 1985 and Tversky and Hemenway, 1984) have identified a "basic" level within the object hierarchy which is the level that is considered to be most informative, at which both bandwidth and diagnostic value are maximized (John, Hampson, and Goldberg, 1991). This means that a description at the basic level provides a sufficient amount of detail about the attributes of the item to set it apart from items belonging to other categories. Additionally, this description is sufficiently abstract that it includes the majority of the other items in the same category. Studies in typicality of items with respect to their categories attempt to obtain typicality ratings of items at this "basic" level with respect to the corresponding superordinate level.

This is true of both personality trait categories (John, Hampson, and Goldberg, 1991) as well as geographical categories (Zacks and Tversky, 2001). For example, a "chair" is considered a typical member of the category "furniture" while a "piano" is perceived to be one of low typicality. A "robin" is considered a highly typical bird but a "penguin" is bird of low typicality. Note that the 2 atypical examples are considered atypical for different reasons. The low typicality of a "piano' reflects the uncertainty regarding its status as a piece of furniture while there is no doubt about the status of a "penguin" as a bird. The low typicality in the latter case stems from the fact that a penguin is a rare bird, not that it is a "poor" one. In one case atypicality appears to be derived from the features of the item (external cause), while in the other the atypicality is due to unfamiliarity with the item (internal cause). While a script by definition is a set of stereotypical actions it is quite likely that some actions may be more strongly associated with the script than others, in other words, more "typical" of the script. But what in the context of actions does "typicality" mean? Further which two levels within the script hierarchy must we consider for the purpose of evaluating typicalities?

Take the case of trait categories which John et al (1991) suggest, possess a four level hierarchical structure with a 4th "middle" level existing between the basic and the subordinate levels The quadruplet (good, kind, generous, charitable) is an example of this type of structure with "good" representing the superordinate level. An interesting feature of traits is that while they reflect the "type of" relationship observed in the case of objects they also exhibit "part of" relationships observed in the case of scripts and actions. While "generosity" may be considered a type of "good-ness"(John et al, 1991), it may also be viewed as one of the behaviors that are consistent with being "good". Thus the manner in which descriptiveness is maximized varies depending on whether the category reflects a taxonomy or a "partonomy".

2.1.3 Is there a "basic" level in scripts?

The basic level in a script could be the level of the *scene header* since it helps to disambiguate 2 or more scripts but not in the way a basic object description does. A "chair" can be distinguished from say "table" while explaining the set of chairs which is larger than say the set of "easy chairs". But this phenomenon can't be said to be true of scene headers. Both, "chair" and "table", are individually representative of the superordinate level "furniture". This is less true of scene headers. Often it is a particular combination of scene headers that represents a given script. Individual scene headers often belong to multiple scripts. So perhaps the purpose of the basic level scene headers of a script is not to distinguish "order a meal" from "pay for a meal" but to jointly disambiguate one script from another. This would suggest that even actions at the subordinate level could combine to serve the same purpose as that of scene headers. For instance the subordinate level actions "looks at menu" and "extracts credit card" might serve just as well as the two scene headers mentioned above. This shared feature of actions and scene headers might be allow the rating of typicalities of actions at the lowest level with respect to the superordinate script header level, rather than the basic level as is the case with objects. It would seem that objects at the lowest level are likely to be given low ratings of typicality relative to those at the basic level (eg: easy chair versus chair). However the same cannot be said to be true of actions at the subordinate level. Compare the subordinate description "reads the menu" with the scene header "orders food" both of which appear to be equally typical of the script header "visits a restaurant". On the other hand the scene header "pays for meal" appears to be more typical of the restaurant script relative to the subordinate action "extracts credit card". The action in the latter example is consistent with several scripts where as the action in the first example is relatively unique to the restaurant script. In the following study we examine the perceived typicality of acts

with respect to to scripts that share a common context and the existence of a subjective "degree of component-ship" of these acts.

2.2 Method

2.2.1 Overview

Subjects were shown pairs of sentences representing one act and one script header. Their task was to rate the typicality of the given act with respect to the given script using a discrete 5 point scale. Each act was rated with respect to a pair of competing scripts. Differences in typicality ratings of these acts relative to the two scripts were studied as a function of the typicality with respect to one of the scripts. These typicality differences were examined for their implications for the diagnostic value of a given act in terms to the support provided for each script.

2.2.2 Subjects

12 individuals between the ages of 24 and 30 were recruited from public establishments such as libraries and bookstores to participate in this study. They were given book coupons as compensation for participation.

2.2.3 Materials

The stimuli used consisted of sentence pairs describing an act and a plan/script header. The action statements corresponded to 4 different scripts as follows. The number of act statements corresponding to each script are shown in parentheses.

A) BEACH: "preparing for a day at the beach" (26 acts)

B) SCHOOL: "preparing for a day at school" (23 acts)

Figure 2.2: Pairings of acts with MATCHING scripts

C) COUNTRY: "preparing to move to a different country" (27 acts)

D) VACATION: "preparing for vacation" (23 acts)

Each script was divided into several scene headers. Then actions that were expected, to various degrees, to occur in each scene, were listed and paired once with the corresponding (MATCHING) script and again with the competing (ALTERNATIVE) script. The BEACH and SCHOOL scenarios shared their respective acts with each other while the COUNTRY and VACATION scenarios shared theirs with each other (see 2.2 and 2.3). Scenarios were paired in this manner in preparation for Experiments 2 and 3 so that they provided competing explanations for the acts displayed. Appendix 1 lists the script headers, scene headers and act statements that were used in this study.

Note on number of subjects: Typicality ratings with respect to the MATCHING and ALTERNATIVE scripts were obtained in 2 separate sessions. MATCHING script ratings were obtained from 10 subjects while ALTERNATIVE script ratings were obtained from 2 subjects. However MATCHING and ALTERNATIVE scripts shared a certain number of acts which were therefore rated by a total of 12 subjects.

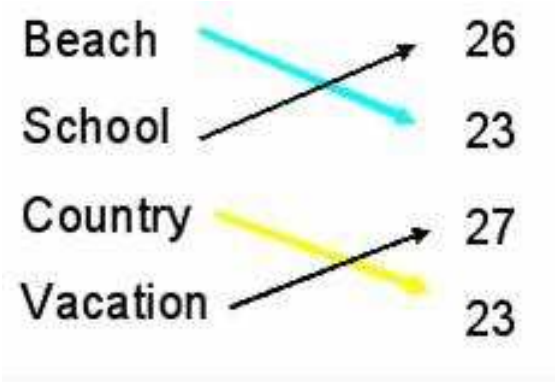

Figure 2.3: Pairings of acts with ALTERNATIVE scripts

2.2.4 Procedure

In Experiment 1a subjects were presented with instructions as well as examples for the rating task. They were shown a pair of sentences and asked to rate the typicality of the first sentence (act) with respect to the second (plan) using a 5 point scale ranging from 1 (= highly atypical) to 5 (= highly typical). The stimuli appeared as follows:

Act: *John applies sunblock*

Plan: *John is preparing for a day at the beach*

How typical is the act with respect to the plan?

SCALE

Act-plan trials were separated by a visual task in which subjects rated the vertical symmetry of a dot pattern using a 5 point scale ranging from 1(highly asymmetric) to 5 (highly symmetric). Subjects were timed on the rating task.

2.3 Results

1. Median values of the typicality ratings assigned by the subjects to each act-script pair were obtained. The full range of typicality values from a minimum of 1 to a maximum

	Matching	**Competing**
HIGH	4	2
MEDIUM	3	3
LOW	2	2

Table 2.1: Median Typicality Ratings of acts with respect to the Matching and Competing scenarios. The HIGH, MEDIUM and LOW labels refer to act groups that were given high, medium and low ratings relative to the Matching scenario.

of 5 was made use of suggesting a subjective notion of the typicality of specific acts with respect to particular scripts and further that this typicality is graded.

2. For the purpose of this study ratings that lie between 3.5 and 5 were treated as "HIGH" typicality ratings, ratings between 2.5 and 3.5 were considered "MEDIUM" and typicality ratings between 1 and 2.5 were considered "LOW". Table 2.1 shows the median typicality ratings assigned to acts relative to their respective "matching" and alternative scenarios. The HIGH, MEDIUM and LOW labels refer to groups of acts that were assigned HIGH, MEDIUM and LOW typicality ratings with respect to the scenarios from which they were derived (the "matching" scenario). We find that the disparity in the median typicality levels was the greatest in the HIGH group (4 and 2) suggesting that these acts are viewed clearly as components of the matching scenario and *not* components of the competing scenario. Acts in the LOW group were perceived to be linked to neither the matching nor the competing scenarios, with low median typicality ratings in either case (2 and 2). However, we observe that the competing scenario was most competitive in the MEDIUM group. Acts in the MEDIUM group appeared to be most ambiguous in terms of which scenario they were components of. Both scenarios were given median ratings of 3 suggesting a moderate link between these acts and both scenarios.

3. Figure 2.4 shows the cummulative distribution of the differences in typicality ratings relative to the Matching and Competing scripts when the ratings relative to the Matching script were HIGH (blue), MEDIUM (pink) and LOW (yellow).

We see that the act group with the greatest typicality differences was the HIGH

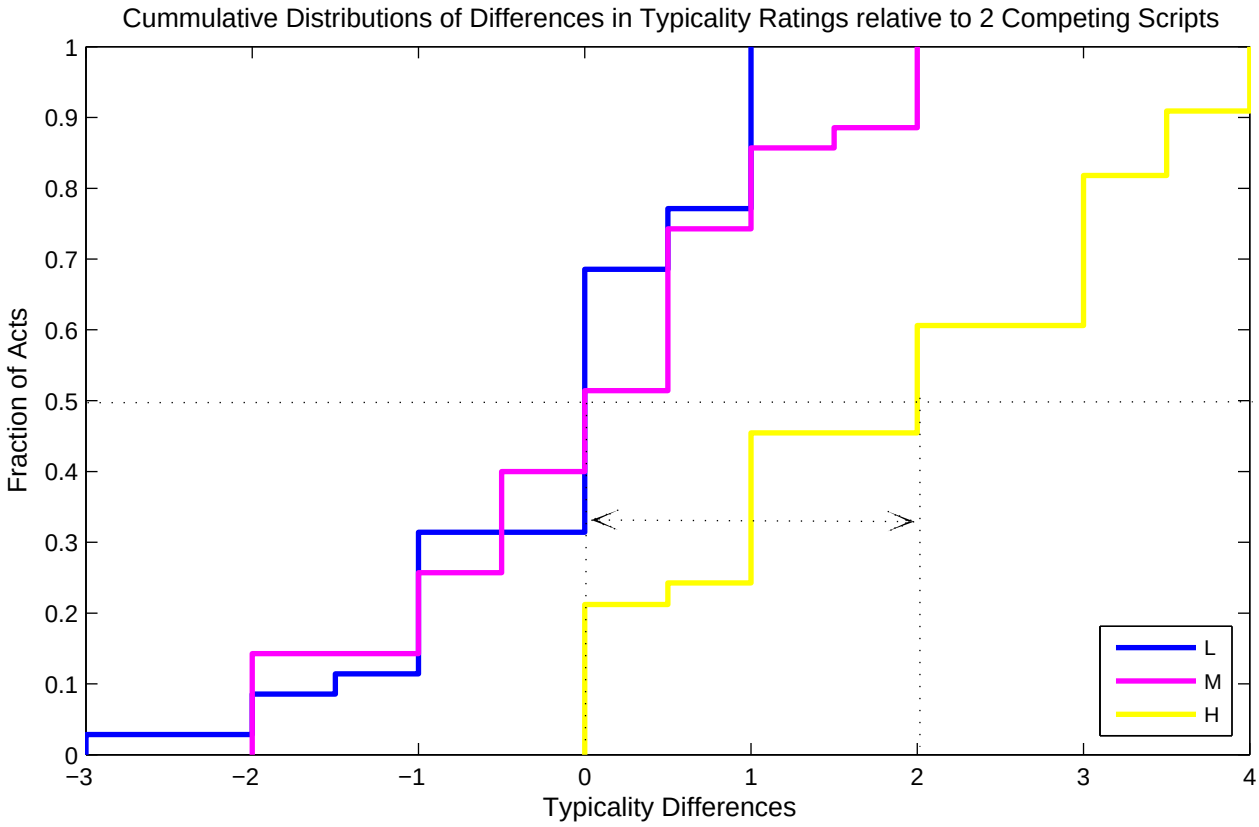

Figure 2.4: Cummulative distributions of act typicality differences relative to the Matching and Competing scripts when the typicality with respect to the Matching script was HIGH, MEDIUM and LOW. The abscissa of any given point on a curve represents a certain typicality difference (say, 'd') while the ordinate represents the percentage of acts whose typicality differences relative to the two scripts were less than or equal to this value 'd'. For each distribution, the upper and lower limits of the abscissa represent the minimum and maximum values between which 100% of the typicality differences in that condition lie. We see that the HIGH distribution and the MEDIUM/LOW distributions occupy non overlapping intervals on the X axis. Further, the MEDIUM and LOW distributions tend to be symmetrical about the origin which suggests that they might be normally distributed with a mean of zero. The horizontal line corresponding to 50% of the acts intersects the HIGH, MEDIUM and LOW distributions at 3 points. The abscissae of each of these 3 points correspond to the median typicality difference in each condition. These medians are indicated by the vertical lines that drop from the 50% line to meet the X axis. The horizontal arrows indicate the separation between these medians. As can be seen, the medians in the LOW and MEDIUM conditions which are no different are each different from the median in the HIGH condition. The Kolmogorov Smirnov test showed the former pair of distributions to be significantly different from the latter.

group, the group of acts that were given high typicality ratings relative to the matching script. Differences in both the MEDIUM and the LOW groups tended to be much lower and clustered around zero. This means that acts that were of MEDIUM typicality with respect to the matching script were also of MEDIUM typicality relative to the Competing script. Similarly, acts that were of LOW typicality with respect to the matching script were also of LOW typicality relative to the Competing script.

Kolmogorov-Smirnov tests showed that the maximum difference between the cumulative distributions of the HIGH and LOW conditions, was D=0.5 with a p of 0.0 and the HIGH and MEDIUM condition was D=0.4682 with a p of 0.00. The mean, median and standard deviations of the three act groups were as follows: LOW(-0.250, 0, 1.07), MEDIUM(-0.04, 0, 1.25) and HIGH(1.758, 1.5, 1.42). Of the three groups the MEDIUM group alone was found to be consistent with a normal distribution with probability p=0.26, where the mean and standard deviation of the normal distribution were -0.022 and 1.162.

4. It must be noted that the above disparity in the MEDIUM and HIGH groups can arise from the fact that an act of HIGH typicality relative to Script-A, is at one extreme of the typicality range (say 5). Therefore the typicality rating of this act relative to a competing Script-B can differ by upto 4 typicality points. On the other hand, an act of MEDIUM typicality relative to Script-A, is in the middle of the typicality range. Therefore, the typicality rating of this act relative to Script-B can differ by a maximum of only 2 typicality points.

Acts of LOW typicality relative to Script-A also lie at one extreme of the typicality range. However, we do not see the same large difference in the typicality of these acts relative to Script-B, that exists in the case of HIGH acts. Further, median rating differences in both the MEDIUM and LOW groups were zero, as seen in table 2.1. That is, in neither the LOW or the MEDIUM case did the rating differences reach the respective

maximum. These two observations give some support to the view that the rating patterns obtained in this study are not simply the result of using a particular typicality scale but rather reflect the perceived informativeness of an act relative to a script.

5. Within subject correlations between the typicality ratings of an act, relative to the matching and competing scripts, were found to be low, over all levels of typicality. However, these correlations were found to be the lowest in the HIGH group.

2.4 Discussion

It was found that subjects do have a subjective notion of the typicality of specific acts with respect to particular scripts. Acts that were given high ratings of typicality relative to one script tended to be assigned low typicality ratings with respect to a second script that shared a context with the first script. Thus the high typicality acts in this study appear to have a high discriminatory value. It was found that acts perceived to be of medium typicality relative to one script were also considered to be of medium typicality relative to the competing script. So the acts in this group were weakly but equally representative of both scripts. The ambiguity associated with such "medium" acts was higher than that of "low" acts which tended to be assigned low ratings of typicality with respect to both scripts. That is, these latter acts were unrepresentative of either script.

The task of estimating the typicality of an action with respect to a script requires the subject to place this act within the script. This might mean that the given script acts as a premise on which the act statement is based. Thus assigning a typicality rating to an act may be akin to evaluating the validity of a conclusion given a premise or a "theory" given a "data" element. Therefore the typicality values obtained in this study may be interpreted as "likelihood" values such as "the likelihood of an Act A, given a script S.

In experiment 1, typicality ratings of actions with respect to particular scripts were

obtained. It is is of interest to know how a these typicalities might combine in a sequence of acts to affect script preferences, especially when the subject has to simultaneously rate 2 scripts that provide competing explanations for the act sequence. If typicalities of individual acts with respect to scripts are interpreted as likelihoods of these acts given the scripts, then ratings given to a pair of scripts at the end of an act sequence may reflect the subject's posterior belief in these scripts in light of the "evidence" provided by the act sequence. However, it is not clear that individual act typicalities will combine in a normative fashion leading to a sequential updating of belief in a particular script. In the following experiment we look at the strength of script inferences derived from a sequence of 4 actions when the typicality of these acts is varied. For instance, the magnitude of difference in final script preferences may or may not be proportional to the magnitude of difference in act sequence typicality, relative to the 2 scripts. It may be the case that when one script is preferred over another, this preference is indicated by the highest available script rating, independent of the level of sequence typicality. In experiments 2 and 3 we examine these and other related issues involved in the drawing of script related inferences on the basis of a sequence of acts, of uniform and non uniform typicality respectively.

Chapter 3

Experiment 2: Typicality and homogeneity of act sequences

3.1 Motivation

3.1.1 Role of act typicality in explaining action sequences

An act in the real world almost never exist in isolation and is typically embedded in a sequence of actions. Thus explaining any one action involves a reference to one or more of the remaining actions in the sequence. The resulting explanation is an attempt to construct a story that is both coherent and plausible (Pennington and Hastie, 1986), one that allows predictions to be made about the agent's future actions and plans through the use of social knowledge structures such as scripts. Thus the explanation of the action sequence results in a representation that provides information about the relationships that exist between the actions that make up the sequence as well as their connection to the existing knowledge base.

According to the constructionist account (Read, 1987; Lalljee and Abelson, 1983; Schank and Abelson, 1977) people explain actions by first categorizing the agent into

the appropriate race, gender and role as well as the current situation. This activates a large body of knowledge structures about the agents and the situation such as scripts and themes which they attempt to connect to the observed event via a plan. If such a plan is found then an attempt is made to incorporate the next incoming action into the current plan. There is some evidence to show that the interpretation of current actions is constrained by those that have already occurred (Read, 1987). Other studies have shown that subjects engage in hypothesis testing while inferring plans from actions (eg: Einhorn and Hogarth, 1982; Hastie 1983; Kruglanski 1980; Lalljee, 1981).

However these studies did not examine the effect of the typicality of individual act statements in a sequence on the strength of the inferred script. Given that subjects' representation of actions includes the attribute of script related typicality one can ask how this attribute comes to affect script inferences drawn from a sequence of actions. Actions are inherently ambiguous as a single action may be consistent with several different scripts or plans. For example, the act of picking up a coffee pot may suggest the script *"making breakfast"* or alternatively the script *"buying kitchenware"*. Although different scripts can share actions, many of these actions are often perceived to be more typical of one script relative to the others. Consider the pair of scripts stated below and the following three acts.

Script-A: getting ready for a day at college

Script-B: getting ready for a day at the beach

Act1: Puts book into bag

Act2: Puts on a shirt

Act3: Puts towel into bag

Act1 is more typical of Script-A but not inconsistent with Script-B, as the "book" may be a novel to read on the beach. Act3 is more typical of Script-B but not inconsistent with Script-A, as the "towel" may be for later use, after a game of football. Act2 is neutral with respect to Script-A and Script-B and may be considered to be of medium typicality with respect to both scripts. Thus, in general, a single act could be explained by more than one script. The typicality values obtained in experiment-1 may be viewed as measure of subjects' preference for a particular script as a possible explanation of these individual acts. The selection of a script that explains a particular sequence of actions (Argyle et al, 1981; Ginsberg, 1980; Harve and Secord, 1972) may reflect a preference whose strength may vary depending on the typicality of these actions.

An act that is highly typical of a script should presumably activate this script more strongly than a medium typicality act. When all the acts are of high typicality with respect to a particular script, then the subjective preference for this script over any other competing script might be expected to be strong. However, the effect of act typicality may be modulated by the presence of a second factor, which may be described as the extent of script "coverage" afforded by the acts in a sequence. In the following section we describe this additional feature of act sequences and then discuss the hypothesized effects of the two factors on the manner in which these sequences are processed and used to draw script related inferences.

3.1.2 Script "coverage" provided by act sequences of varying homogeneity

Consider a sequence of acts corresponding to a particular script. All of these acts might belong to a single "scene" of the script. Alternatively, each act in the sequence might

correspond to a different scene. Thus the script "coverage" provided by the sequence of acts would vary with the number of individual scenes represented by these acts. While it is the typicality of a *single* act that determines the extent to which it supports a given script, there is the additional factor of script "coverage" that influences the strength of support provided by a *sequence* of acts. Consider the following 4-act sequences.

A) *looks for a table, picks up menu, reaches for fork, extracts wallet*

B) *picks up menu, examines wine list, reaches for fork, uses salt shaker*

The acts in sequence-A refer to 4 different scenes of the restaurant script *(entering, ordering, eating, paying)* while the acts in sequence-B refer only to 2 scenes of the restaurant script *(ordering, eating).* The coverage of the restaurant script provided by sequence-A is greater relative to sequence-B. Scene coverage reflects the relationship of these acts to each other, relative to the hierarchical structure of a script, as shown in figure 3.1 (adapted from Abbott, Black and Smith, 1985). It has been shown that people readily group acts under various scene headers and also infer scene headers from actions (eg: Abbott, Black and Smith, 1986). As the number of scenes represented by these acts increases, so does the number of scene headers inferred. As more and more actions corresponding to different scenes are presented, more of the script becomes available to the observer. Actions appearing later in the sequence are more likely to be subsumed under the currently activated script owing to the availability of scenes of this script in the subject's working memory. The use of the availability heuristic in problem solving has been shown by several studies in the area of decision-making (eg: Tversky and Kahneman, 1974). The homogeneity of the acts in a sequence relative to the scenes in the script

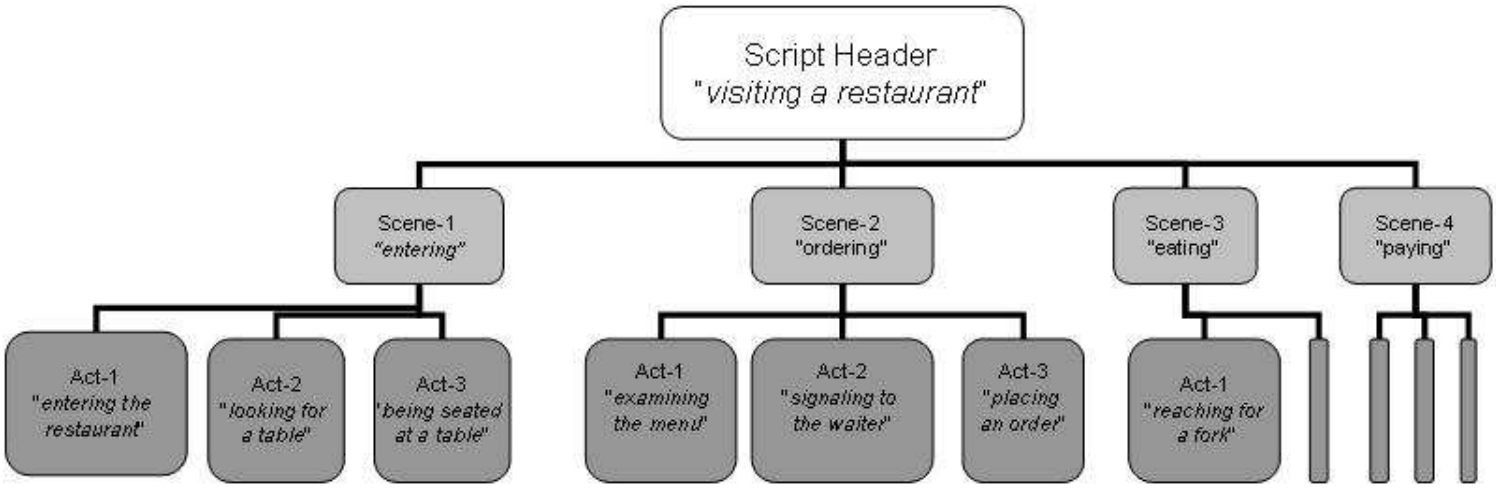

Figure 3.1: The Restaurant Script Hierarchy

might be expected to determine the perceived support for the script. In the above example, sequence-A, which is less homogenous, makes more of the restaurant script available and should appear to support the restaurant script to a greater extent than sequence-B. This is analogous to the greater shape information provided by the parts of an object relative to an equal number of components of a single part of that object.

3.1.3 Combined effects of typicality and homogeneity on script preferences

It may be the case that the level of homogeneity of a sequence might have a negligible effect on the perceived support for a particular script when the acts are of high typicality. That is, the lower script coverage provided by a homogenous sequence might be offset by the greater support for the script derived from the high typicality values of the acts in the sequence. In general the combination of greater homogeneity and lower typicality should decrease the amount of perceived support for the script. It is not clear what the relative effects of greater homogeneity would be when the acts in a sequence are all of medium or low typicality with respect to a particular script. It may be that medium typicality

sequences would benefit more from greater heterogeneity than low typicality sequences.

3.1.4 Impact of homogeneity on act processing times: 2 accounts

The time taken to read an act statement has been used as a measure of the amount of processing applied to the act (eg: Haviland and Clark, 1974; Haberlandt and Bingham, 1978) where "processing" of act statements involves the generation of an explanatory hypothesis that links an observed sequence of acts as well as the testing of this hypothesis (eg: Hastie, 1983; Einhorn and Hogarth, 1982; Kruglanski, 1980). Further, these hypotheses consist of explanations in which acts are described with reference to the actor's sub-goal or main goal (eg: Graesser and Murachver, 1985; Galambos and Black, 1985).

1. Within-scene Linkage: According to one account it is expected that the time taken to process an act sequence will vary inversely with the amount of homogeneity in the sequence. According to studies conducted by (Black and Bern, 1981; Abbott et al, 1985) acts belonging to the same scene are placed close to each other within the mental representation of the corresponding script. This was reflected in the shorter access times to one of the acts in a pair when the other belonged to the same scene as opposed to a second act that belonged to a different scene. On the other hand, tasks involving the temporal ordering of a pair of acts took longer when the acts belonged to the same scene relative to the case where the acts belonged to separate scenes within the script. Both these results suggest that acts belonging to the same scene are linked to each other more strongly than those that are components of different scenes. Keeping these observations in mind one would expect that the presentation of a particular act in a scene should set up a higher level of expectation for other acts within the same scene relative to acts corresponding to a different scene. That is, a second same-scene act should be processed

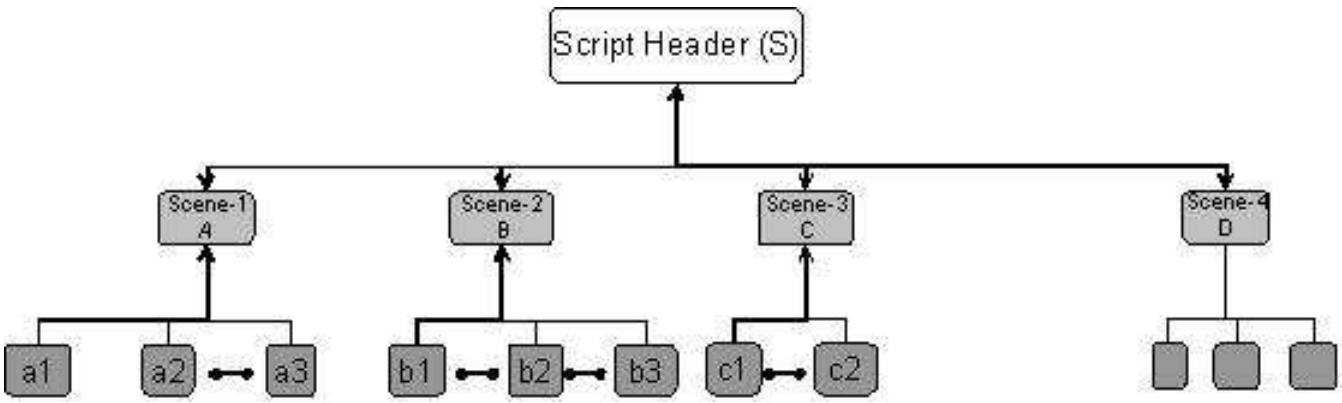

Figure 3.2: Possible links in a script hierarchy

more quickly than a "different-scene" act. The facilitating effect of the link between acts within a scene will be referred to as the the "within-scene linkage" effect.

Consider the following act sequences. The letters a, b, c and d represent different scenes while the numbers represent component acts of the various scenes. Each act of Sequence-1 (HETerogeneous) belongs to a different scene while the 4 acts in Sequence-2 (HOMogeneous) only 2 out of 4 possible scenes.

1. HET: **a1 b1 c1 d1**

2. HOM: **a1 a2 c1 c2**

The presumed link between a1 and a2 should cause a2, in HOM, to be read more quickly than b1, in HET. Act c1, in HOM should be processed longer relative to act a2. But act c1 in HET should be read for the same duration as act b1. Similarly, the link between c1 and c2 should cause c2, in HOM, to be read more quickly than d1, in HET. To summarize, read times within a HOM sequence should drop from the first to the second act and again from the third to the fourth act. There should also be an increase in read time from the second act to the third. Within a HET sequence read times at the second, third and fourth acts should not be different. Overall time taken to read HOM sequences should be less than the time spent reading HET sequences.

2. Possible equivalence of HET and HOM sequences: There is an alternative

account that suggests HET and HOM sequences might be not be perceived differently. According to studies by Abbott et al, (1985) acts lead to scene header inferences but scene headers do not lead to act inferences. Further, scene headers and script headers are equally likely to activate each other. This suggests that the presentation of act a1 in figure 3.2 will lead to scene header, A, being inferred. But A will not necessarily lead to the inference of acts a2, a3. It has been shown that goals inferred in a narrative function as explicitly stated goals, (Graesser et al, 1994). If we assume that a similar fact holds in the present case, the inferred scene header A should act like an explicitly presented scene header and trigger an inference of the script header, S. Script header S should further activate remaining scenes B, C, D, but these scenes would not lead to inferences of their component acts, b1, c1, etc. Thus the presentation of act a1 should lead to inferences of scene header A, script header S and scene headers B, C, D, in that order. Since a1 does not trigger further *act* inferences, both act a2, in HOM and act b1, in HET should be processed in an equivalent manner. Similarly, acts c1, c2 in HOM and c1, d1, in HET should be processed identically. The preceding discussion will be referred to as the "between-levels inference" account.

3.1.5 Effect of typicality on processing times

The effect of homogeneity of the act sequence on sequence processing times is likely to be modulated by the typicality of these acts. A high typicality act is likely to activate a larger body of script related knowledge which may be correlated with greater read time. However, a sequence of high typicality acts may be easier to link as they both provide strong support for a common script "hypothesis". Thus the time taken to read successive high typicality acts should decrease. Both medium as well as low typicality acts would presumably activate a smaller body of information individually and might be correlated

with shorter read times. But for this reason, linking 2 or more medium acts none of which provide strong support for a given script might take longer. However this effect might depend on the amount of effort the subject chooses to expend on linking successive acts in the sequence. This would be the case with act sequences of low typicality, as well.

With reference to the "within scene linkage" account, in a HOMogeneous sequence such as the one described above, the ease of linkage of two acts belonging to the same scene might be offset by the larger body of knowledge activated when the two acts are of high typicality with respect to a particular script. Therefore HOM and HET high typicality sequences might not differ in their overall read times. However, when the act sequences are of medium typicality and linkage of acts requires greater effort then a readily available scene that facilitates the linking of the two acts would decrease time spent on linking these acts. But this effect would be determined by how "readily" available this scene is, given that the first medium typicality act in the sequence provides relatively weak support for the corresponding script. Therefore the read time for medium typicality HOM acts (at positions 2 and 4 in the sequence) would be less than that for medium typicality HET acts, if the acts at positions 1 and 3 in the sequence activate the corresponding scenes to a degree that is sufficiently strong. Otherwise HET and HOM sequences of medium typicality acts would be read at the same pace. The possible facilitation provided by "within scene linkage" in HOM sequences might be negligible in the case of low typicality act sequences.

In the event that the alternative "between-levels inference" account of processing time holds, any read time differences between HET and HOM sequences would be due to differences in typicality alone.

3.2 Method

3.2.1 Overview

Subjects were shown sequences of 4 acts, one at a time at the subject's own pace. They were then shown 3 plan options and were asked to rate these options in terms of how well they captured the 4 acts. The first two options described 2 specific scripts. The third option referred to any other plan that the subject could specify if desired. Each script option was rated using a 3 point scale. The time taken to read each of the 4 acts in the sequence as well as the time taken to respond to the script options was recorded. The acts in a sequence were all of high, medium or low typicality with respect to one of the 2 scripts specified. Further, the 4 acts in a sequence either belonged to 4 different scenes of this script or covered only 2 different scenes of the script.

3.2.2 Subjects

7 subjects between the ages of 24 and 30 were recruited from public establishments such as libraries and bookstores. They were given book coupons as compensation for participation.

3.2.3 Materials

The stimuli consisted of sequences of 4 sentences each describing an act. All the acts in a sequence corresponded to one of the following scripts:

A) BEACH: "preparing for a day at the beach"

B) SCHOOL: "preparing for a day at school"

C) COUNTRY: "preparing to move to a different country"

D) VACATION: "preparing for vacation"

The sequences varied along the 2 dimensions of typicality (3 levels) and homogeneity (2 levels). Each sequence consisted of acts that were all of high, medium or low typicality with respect to one of the 4 scripts listed above. This particular script will be referred to as the MATCHING script. HIGH typicality sequences were composed of acts whose typicalities ranged from 3.6 to 5.0, in Experiment-1. MEDIUM typicality sequences consisted of acts whose typicalities ranged from 2.5 to 3.4 and LOW typicality sequences contained acts whose typicalities ranged from 1 to 2.3.

In addition, a sequence was either HETerogenous so that each act belonged to a different scene of the MATCHING script, or HOMogeneous, so that Act1 and Act2 belonged to one scene while Act3 and Act4 belonged to a second scene of the MATCHING script. Thus there were 6 different types of sequences used in this study.

The SCHOOL, COUNTRY and VACATION scenarios contributed 4 HIGH, 4 MEDIUM and 4 LOW typicality HETerogenous sequences and 4 HIGH, 4 MEDIUM and 4 LOW typicality HOMogeneous sequences, a total of 24 sequences per scenario. The BEACH scenario contributed 20 sequences because the typicality data obtained in Experiment-1 did not yield a sufficient number of MEDIUM typicality acts which could be grouped into 2 scenes. That is, the BEACH scenario did not contribute MEDIUM-HOMogenous sequences. A total of 24x3 + 20 = 92 sequences were used in this study. These sequences were presented in random order.

At the end of each sequence 3 script options were presented along with the question *"How well do the following plans capture the 4 acts shown"*. One of the scripts presented was the MATCHING script described above. The second option described an ALTERNATIVE script which shared the same context as that of the MATCHING script. The scripts

corresponding to the BEACH/SCHOOL scenarios and the COUNTRY/VACATION scenarios were paired for this purpose. These script pairs were intended to provide competing explanations for the acts sequences observed. The third option was simply presented as the "OTHER plan". The subject was free to specify this 3rd plan option to describe the act sequence. The different sequences along with their average typicality values with respect to both the MATCHING script as well as the ALTERNATIVE script are listed in Appendix 2. One example of an act sequence and the corresponding script/plan options is shown below.

Act Sequence:

1. John puts notebook in bag
2. John makes coffee
3. John goes over previous days notes
4. John combs hair

Plan Options:

Plan A. John is getting ready for a day at the beach

Plan B. John is getting ready for a day at school

Other Plan.

A 3 point scale was placed next to each plan option (1 = Very Well; 2=Fairly Well; 3=Poorly)

In order to minimize the influence of earlier act sequence trials on later ones, during the course of the study, each act sequence trial was followed by a numerical comparison task in which subjects were asked to identify the two largest of four rational numbers randomly chosen between -1 and 1.

Procedure

Subjects were first briefed orally about the experiment after which they were presented with written instructions for both the act task as well as the numeric task, displayed on a monitor. The two types of tasks were explained with examples. Subjects were taken through 10 practice trials after which the experiment began.

In each act trial, subjects were shown a sequence of 4 acts, one at a time at the subject's own pace. The time to read each act was recorded. At the end of the fourth act the subject was shown 3 plan options, as described above, and was asked to rate these options in terms of how well they captured the four acts. Each script option was rated using a 3 point scale with as many radio buttons. The subject was free to assign the same rating to multiple plan options. The 3 ratings, the subject's description of the "other plan" (if any) and the time taken to respond to the script options was recorded.

This act trial was followed by a number trial in which the subject saw a list of 4 rational numbers randomly chosen between -1 and 1. The subject had to select the 2 largest numbers of the 4 by clicking on the appropriate check boxes placed next to the 4 numbers. Again the subject's responses as well as response times were recorded but these data were not used.

3.3 Results

3.3.1 Ratings assigned to script options

1. There was a strong effect of act sequence typicality on subjective ratings given to the matching and alternative scripts. In the present and following section of this study, "*Match*" and "*Alt*" will be used to refer to "the Matching script" and "the Alternative script", respectively. Figures 3.3 and 3.4 show box plots of ratings assigned to *Match* and

Alt, in response to the HET and HOM sequences.

In the case of HETerogeneous sequences, as the average typicality of the acts in a sequence increased (LOW, MEDIUM, HIGH) ratings given to *Match* increased (1.25, 2.1, 3). These differences were significantly different as indicated by Wilcoxon's signed rank tests on median ratings un each condition; MEDIUM-HIGH (z=-2.449, p=0.014, n=7), LOW-HIGH (z=-2.456, p=0.014, n=7) and LOW-MEDIUM (z=-2.264, p=0.024, n=7). Ratings given to *Alt* decreased as sequence typicality increased but did not follow a linear trend. The rating to *Alt* in the LOW, MEDIUM and HIGH typicality conditions were (1, 1.95, 1). The MEDIUM condition differed significantly from both the HIGH (z=-2.53, p=0.011, n=7) and the LOW (z=-2.46, p=0.014, n=7).

We observe the above pattern of script ratings in the case of HOMogeneous sequences, as well. The *Match* ratings increased significantly with increase in sequence typicality as indicated by Wilcoxon's signed rank tests; MEDIUM-HIGH (z=-2.53, p=0.011, n=7), LOW-HIGH (z=-2.428, p=0.015, n=7) and LOW-MEDIUM (z=-1.89, p=0.059, n=7). The rating to *Alt* in the LOW, MEDIUM and HIGH typicality conditions were (1.25, 2, 1). Again, the MEDIUM condition differed significantly from both the HIGH (z=-2.41, p=0.016, n=7) and the LOW (z=-2.232, p=0.026, n=7).

In both HETerogeneous and HOMogeneous conditions we see that ratings given to the 2 scripts were equal when the sequences were of either MEDIUM or LOW typicality indicating that at these typicality levels both scripts were perceived to be equally supported by the sequences. Only in the HIGH condition does one script appear to be supported to a greater degree. Thus, HET and HOM sequences lead to identical script ratings indicating that there was no main effect of homogeneity of the sequence.

Figures 3.5 and 3.6 show cummulative distributions of ratings assigned to the Matching and Alternative scripts in the HET and HOM conditions. We observe that the variance

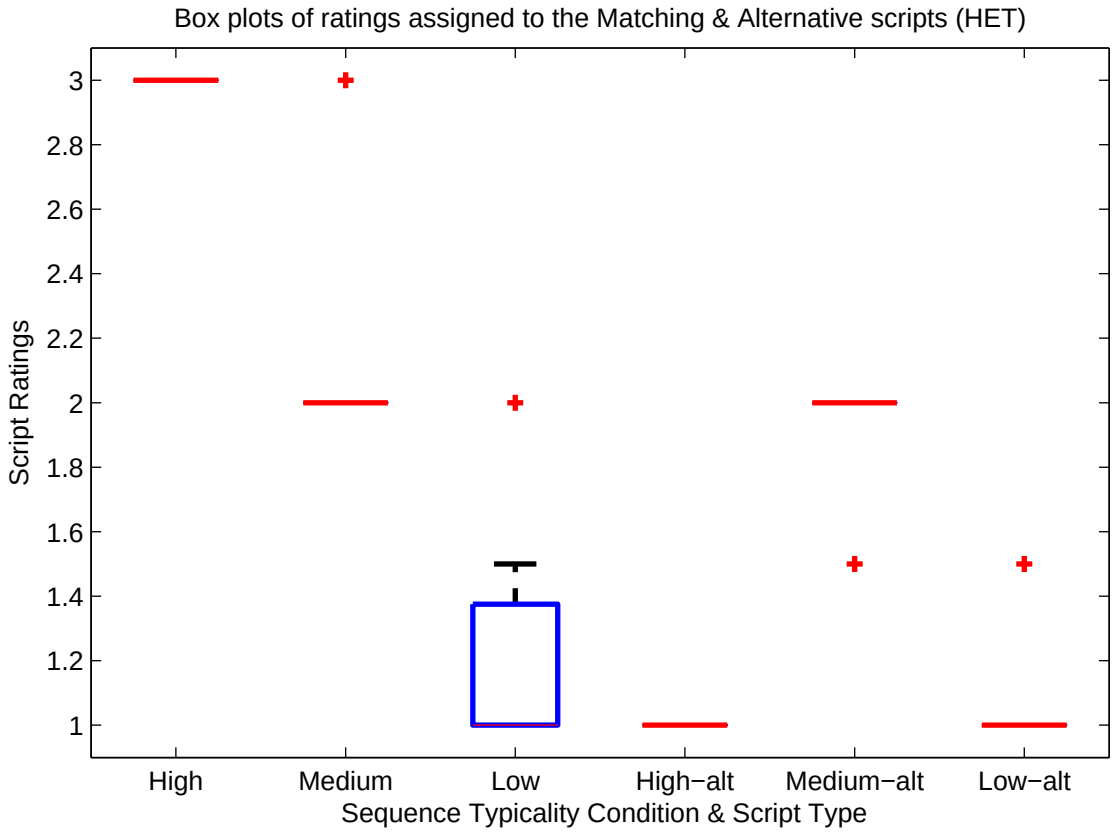

Figure 3.3: Box-Whisker plots of ratings assigned to Matching and Alternative Scripts in response to HETerogenous sequences. The horizontal bars represent median ratings in each condition. The lower and upper edges of the boxes represent the first and the third quartiles, respectively. The crosses in red are outliers. The whiskers extending from the bottom and top of the box represent the minimum and maximum values, respectively. The absence of a box, in a particular condition, indicates the lack of variability in the ratings. Notice the absence of variability in all but one of the typicality conditions indicating an unequivocal effect of typicality on script ratings. The absence of a whisker at the bottom of the single box shown indicates that the median, the first quartile and the minimum rating to the Matching script in the LOW typicality condition were all identical. Median ratings assigned to the Matching script were found to differ in the three typicality conditions as can be seen by the 3 horizontal bars at 3 different heights, on the left half of the figure. Pairwise t tests showed these differences to be significant. While median ratings assigned to the Alternative script in HIGH and LOW conditions were not found to differ significantly, the two conditions did differ significantly from the MEDIUM condition. This can be seen in the identical heights of the horizontal bars in the high-alt and low-alt conditions.

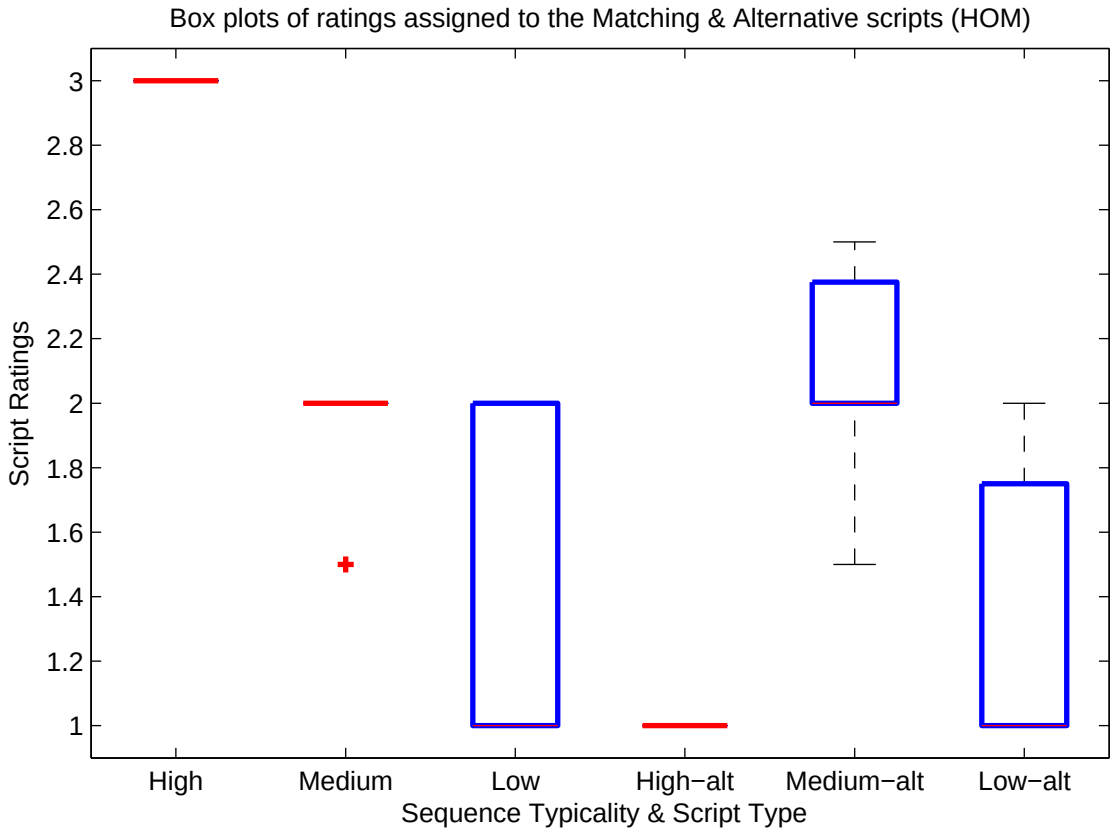

Figure 3.4: Box-Whisker plots of ratings assigned to Matching and Alternative Scripts in response to HOMogenous sequences. Here we see greater variability relative to the HETerogeneous conditions. Only in the MEDIUM typicality condition were the minimum, the first quartile, the median, the third quartile and the maximum ratings distinct from each other. Median ratings assigned to the Matching script were found to differ in the three typicality conditions as can be seen by the 3 horizontal bars, representing the medians, at 3 different heights, on the left half of the figure. Pairwise t tests showed these differences to be significant. Like the HETerogeneous conditions, median ratings assigned to the Alternative script in HIGH and LOW conditions were not found to differ significantly, but the two conditions did differ significantly from the MEDIUM condition. This can be seen in the identical heights of the median bars in the high-alt and low-alt conditions.

is very low in all conditions of typicality and homogeneity.

2. The differences in ratings given to *Match* and *Alt* were found to be proportional to the differences in average sequence typicalities relative to *Match* and *Alt*. (The typicalities of the individual acts were obtained in Experiment-1 which ranged from a minimum of 1 to a maximum of 5.) These differences after normalization, in the case of HETerogeneous sequences, are shown in figure 3.7. Subjects in assigning ratings were sensitive not only to the relative degree of support offered by a sequence for the two script options but also the absolute amount of support provided by a sequence for each script, individually. Thus while HIGH sequences resulted in the largest rating differences in the *Match* and *Alt* scripts, subjects appeared to be aware that MEDIUM sequences supported both scripts equally and b) this support allowed for only moderate ratings to both scripts, as discussed above. For example, faced with this equally support scenario, subjects did not simply assign a high rating to both scripts. Nor did they arbitrarily choose one script and assign it a higher rating than the other script. Identical patterns of rating-typicality correspondence were observed in the case of HOMogeneous sequences as well, as shown in figure 3.8.

The highest rating (=3) assigned to a script-A makes it possible for the rating given to Script-B to differ by zero, one or two points, unlike a medium rating (=2) to a Script-A in which case Script-B ratings could differ by a maximum of only one point. This feature could have led to the observed larger differences in script ratings in the HIGH condition relative to the MEDIUM condition. However, it must be noted that in the HIGH condition *all* subject responses corresponded to the highest possible rating difference of two points. In no case were the smaller rating differences of one or zero, observed, as indicated by the lack of variability in the box plots shown in figures 3.3 and 3.4. Further, like the highest possible rating to a Script-A, the lowest rating (=1) to Script-A makes it possible for the

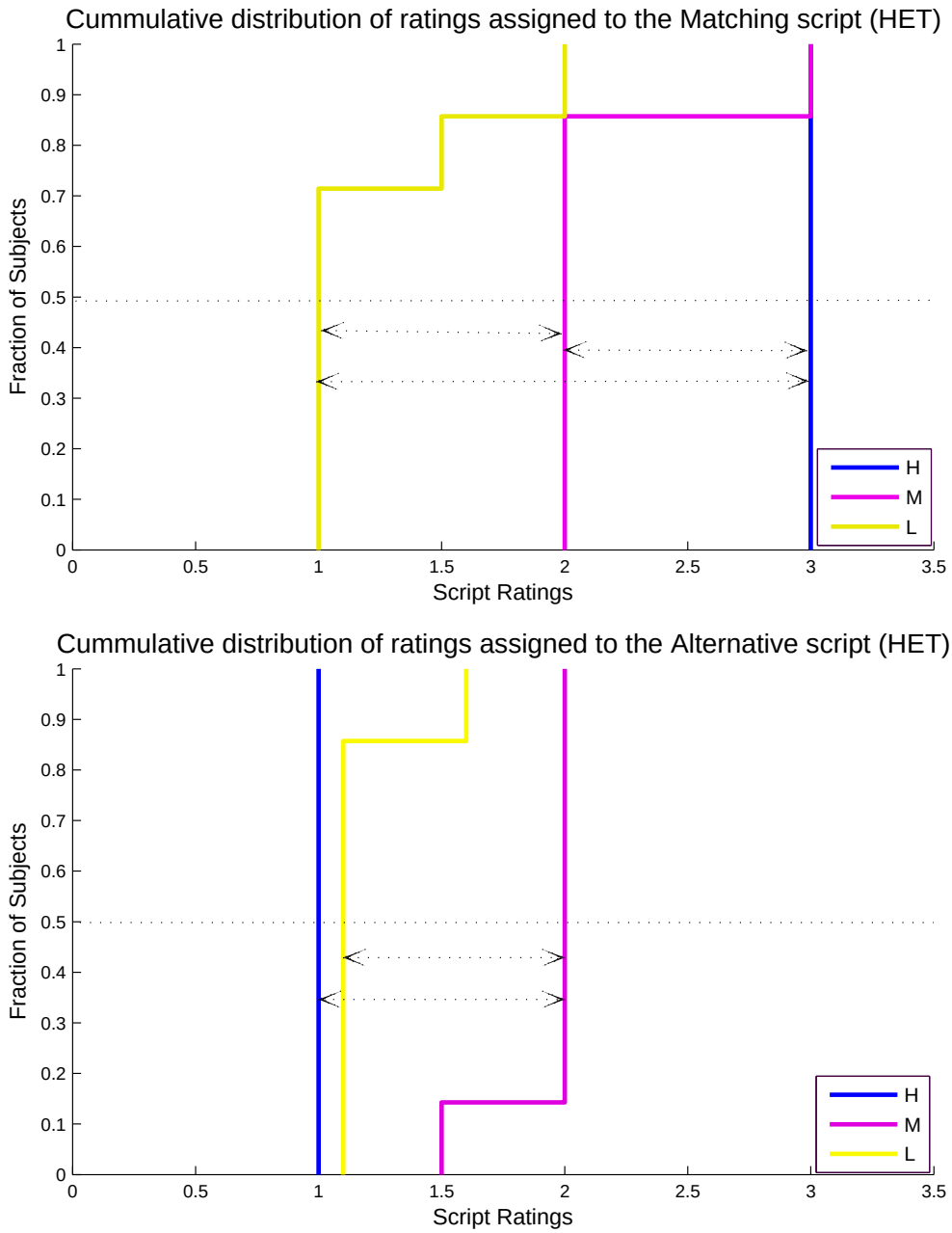

Figure 3.5: Cummulative distributions of ratings assigned to the Matching (top) and Alternative scripts in the HET condition with N=7. In both plots the distributions rise almost vertically upwards which reflects the absence of variability also see in the box plots shown above. The arrows indicate the separation between the medians of the three distributions. Pairwise T tests showed that all 3 differences in the top figure were significant. However only the differences significant in the bottom figure were between the HIGH/LOW and the MEDIUM conditions as can be seen by the negligible separation between the medians in the former two conditions.

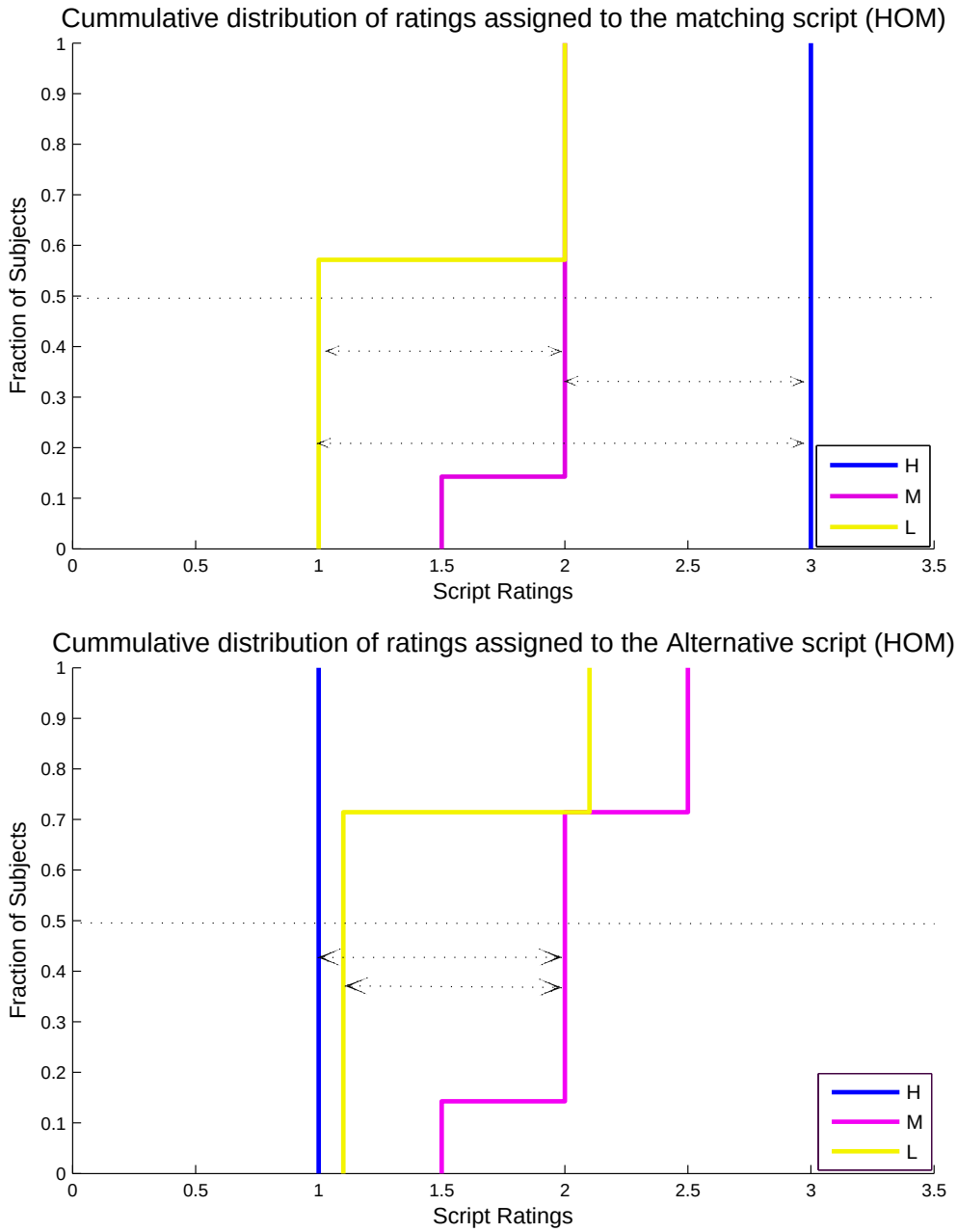

Figure 3.6: Cummulative distributions of ratings assigned to the Matching (top) and Alternative scripts in the HOM condition with N=7. Like the plots in the HET conditions, shown above, in both plots the distributions rise almost vertically upwards reflecting the absence of variability also see in the corresponding box plots. The arrows indicate the separation between the medians of the three distributions. Pairwise T tests showed that all 3 differences in the top figure were significant. However only the differences significant in the bottom figure were between the HIGH/LOW and the MEDIUM conditions as can be seen by the negligible separation between the medians in the former two conditions.

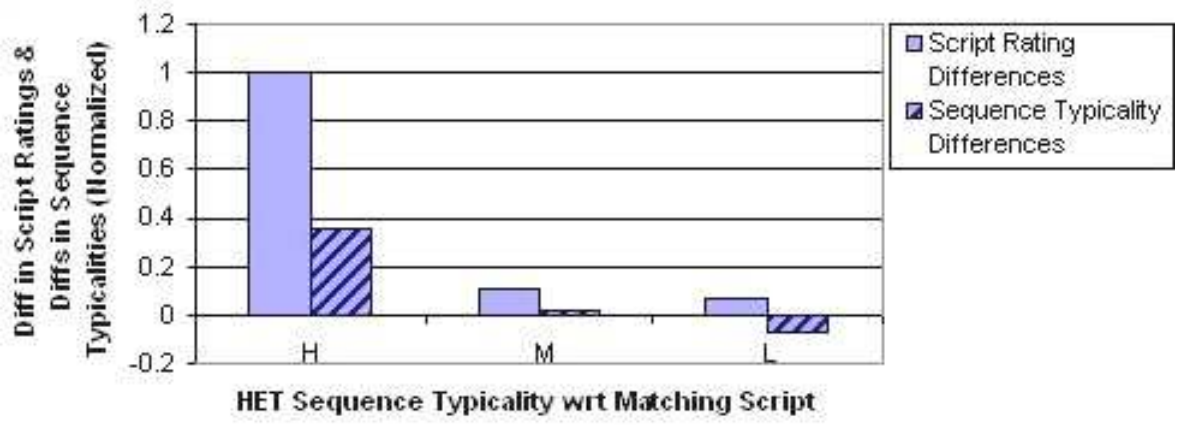

Figure 3.7: Normalized differences in HETerogenous Sequence Typicalities (relative to *Match* and *Alt*) and differences in corresponding Script Ratings (relative to *Match* and *Alt*).

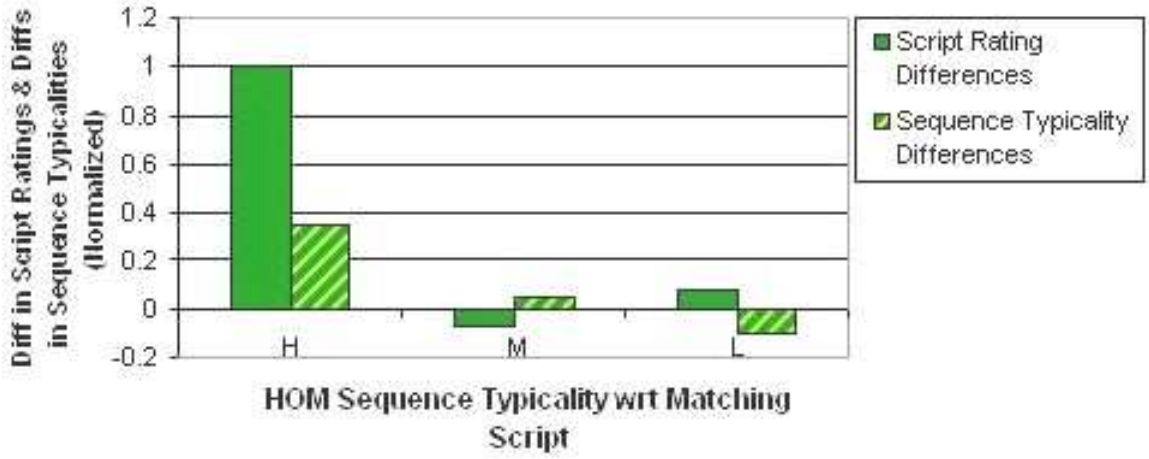

Figure 3.8: Normalized differences in HOMogeneous Sequence Typicalities (relative to *Match* and *Alt*) and differences in corresponding Script Ratings (relative to *Match* and *Alt*).

rating given to Script-B to differ by up to two points. Again, we find that this rating difference is always zero in the LOW typicality condition with almost no variation, as indicated by the low variability in figures 3.3 and 3.4. Therefore, differences in ratings given to *Match* and *Alt* appear to be a reflection of subjective script preferences and not simply an artifact of the particular script rating scale.

3.3.2 Response Times

It was expected that response time would be the lowest in the HIGH typicality condition as HIGH sequences provide unambiguous support for *Match* which would facilitate the

decision making involved in determining script ratings. This was borne out by subject response times as shown in 3.9.

Response times in both the MEDIUM and LOW conditions were greater than RTs in the HIGH condition (HIGH-MEDIUM: t=-5.227, p=0.001, n=7; HIGH-LOW: t=-3.69, p=0.01, n=7). However, these differences in RT were significant only when subjects were responding to HETerogeneous sequences. The response times in the three conditions of sequence typicality were not significantly different when the sequences in question were HOMogeneous. We see that the effect of sequence typicality was attenuated by the HOMOgeneity of these sequences. These results were reflected in the 2x3 ANOVA carried out on Response Times under 3 conditions of typicality (High, Medium, Low) and 2 types of sequences (HETerogeneous and HOMogeneous). Only the main effects were significant; Sequence type (F=6.394, p=0.045, n=7, df(b/n)=1, df(w/n)=6) and Typicality (F=8.831, p=0.004, n=7, df(b/n)=2, df(w/n)=12).

Figure 3.10 (top panel) shows the cummulative distribution of response times in the HET condition. Kolmogorov-Smirnov tests showed a significant maximum difference of D=0.7143 (p=0.001, n=7) between the HIGH and MEDIUM groups and D=0.6374 (p=0.004, n=7) between the HIGH and LOW groups. Figure 3.10 (bottom panel) shows the cummulative distribution of response times in the HOM condition. The maximum difference between the HOMogeneous HIGH, MEDIUM and LOW groups was not found to be significant, suggesting that the HET and HOM sequences had non identical effects on subjective script ratings times.

3.3.3 Read Times

1. *Time taken to read the first act in a sequence* was expected to be greater than or equal to the read time remaining acts. In general the first act in a sequence activates a large

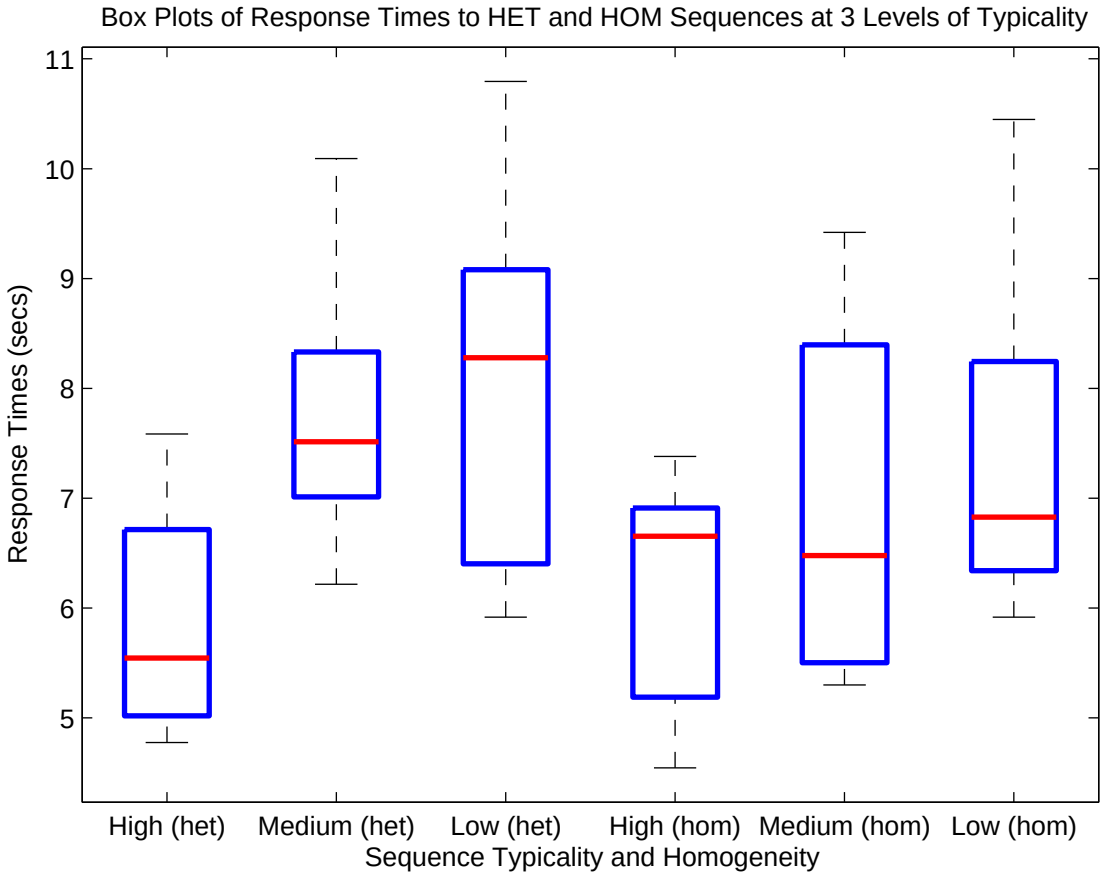

Figure 3.9: Box-Whisker plots of the time taken to rate the matching and alternative scripts in all conditions of sequence typicality and homogeneity. The 3 boxes on the left half of the figure represent response times in the HIGH, MEDIUM, and LOW HET conditions. The 3 on the right represent response times in the corresponding HOM conditions. The heights of the horizontal (red) bars represent medians response times in each condition. The lower and upper edges of the boxes represent the first and third quartiles while the lower and upper whiskers indicate the minimum and maximum response times in each condition. We see that the median response times in the HET condition increase with decreasing typicality. Pairwise T tests showed that median response time in the HIGH condition was significantly different from the response times in the MEDIUM and LOW typicality conditions. The median response times in the three HOM conditions were not significantly different as also indicated by the nearly equal heights of the horizontal median bars in the right half of the figure.

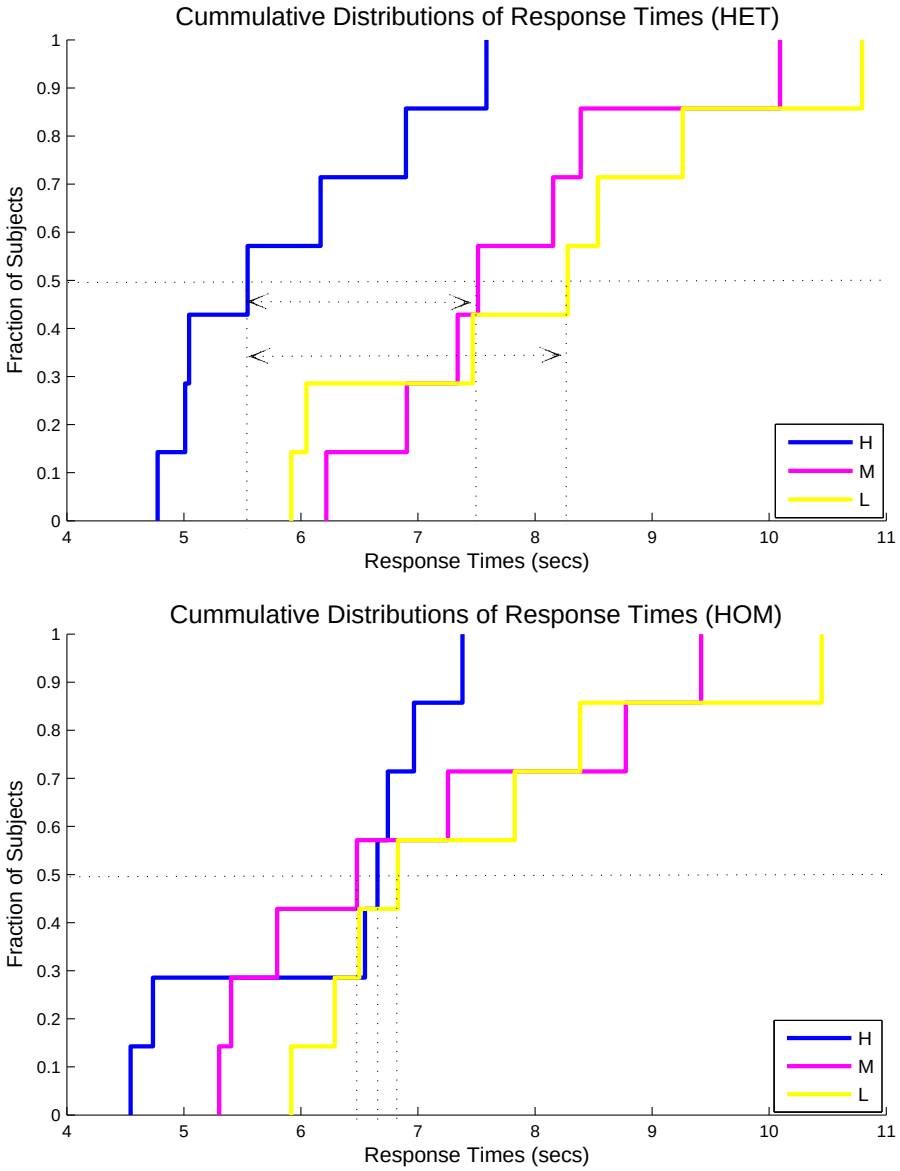

Figure 3.10: Cummulative distributions of the time taken to rate the matching and alternative scripts in response to HETerogeneous (top) and HOMogeneous (bottom) sequences of HIGH, MEDIUM and LOW typicality. The abscissae of the intersections of the 50% line with the distributions represent the median response times in the various conditions. The horizontal arrows indicate the separation between these median response times. As can be seen the MEDIUM and LOW distributions in the HET condition overlap and the gap between their medians is correspondingly small. The gap between the medians of the HIGH and MEDIUM/LOW distributions is large and significant as indicated by pairwise T test. The three distributions in the HOM conditions are seen to overlap with non significant separations between the medians in the three conditions.

body of knowledge which at this stage is undifferentiated in terms of the relative weight given to the different parts of this body. Subsequent acts have an "anchor" in the form of this first act which imposes a non uniformity on the body of knowledge activated by these later acts, directing certain parts to have more weight relative to others. Therefore the time spent reading acts 2, 3 and 4 should drop off. These predictions were supported by the read time data obtained from subjects. Figures 3.11 and 3.12 show cummulative distributions of the 4 read times in the HET and HOM conditions respectively, each under the three conditions of typicality. Kolmogorov-Smirnov tests on the read times of the HETerogeneous sequences showed that the cumulative distributions of the read time of act-1 was significantly different from the read times of act-2, act-3 and act-4 in the HIGH typicality condition (D=0.857, p=0.00, n=7, for all three comparisons). This was also the case in the MEDIUM typicality condition (m1-m2: D=0.857, p=0.00, m1-m3: D=0.857, p=0.00, m1-m4:D=0.5714, p=0.012). In the LOW typicality condition, the read time distribution for the first act, l1 was no different from l2 and l3. However, l1 and l2 were distributed significantly differently with a maximum difference of D=0.7143 and corresponding p=0.001.

Kolmogorov-Smirnov tests on the read times of the HOMogeneous sequences showed that the cumulative distributions of the read time of act-1 was significantly different from the read times of act-3 and act-4 in the HIGH typicality condition (D=0.857, p=0.00 for both h1-h3 and h1-h4). In the MEDIUM typicality condition read-1 was distributed differently from read-2 and read-4 (m1-m2: D=0.7143, p=0.001, m1-m4:D=0.5714, p=0.012). In the LOW typicality condition, the read time distribution for the first act, l1 was no different from l2 and l4. However, l1 and l3 were distributed significantly differently with a maximum difference of D=0.5714 and corresponding p=0.012.

2. *Pairwise T tests on the 4 read times of HETerogeneous sequences*: Figure 3.13

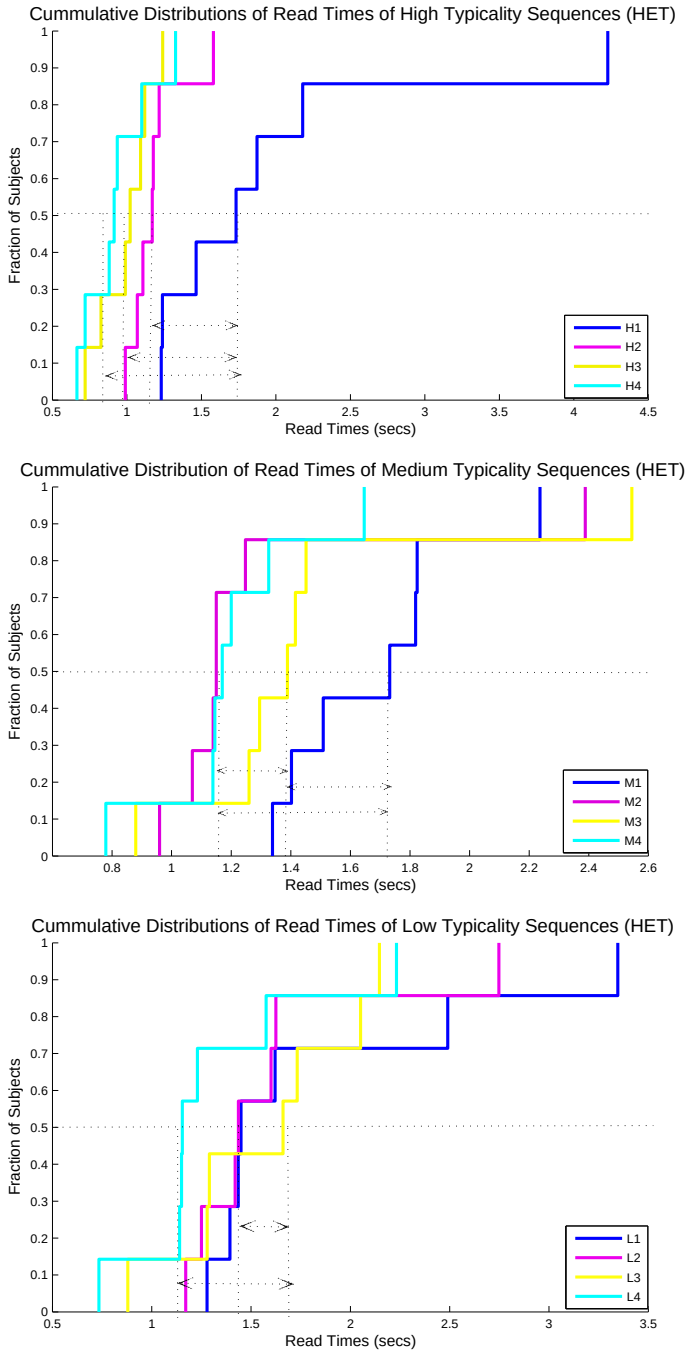

Figure 3.11: Cummulative distributions of median read times of the 1st(dark blue), 2nd(pink), 3rd(yellow) and 4th(cyan) acts in HET sequences of HIGH (top), MEDIUM (center) and LOW (bottom) typicality. We see that the distribution of the first read time Read-1, is shifted to the right relative to the remaining three read times in the HIGH typicality condition. The separation between the corresponding medians (H1 versus H2, H3, H4) as indicated by the horizontal arrows, was found to be significant as shown by pairwise T tests. A similar pattern is observed in the MEDIUM read time distributions. However, the 4 read time distributions in the LOW condition overlap to a large extent as seen in the bottom panel. The corresponding medians were not found to be significant as can be seen by the shorter arrow lengths.

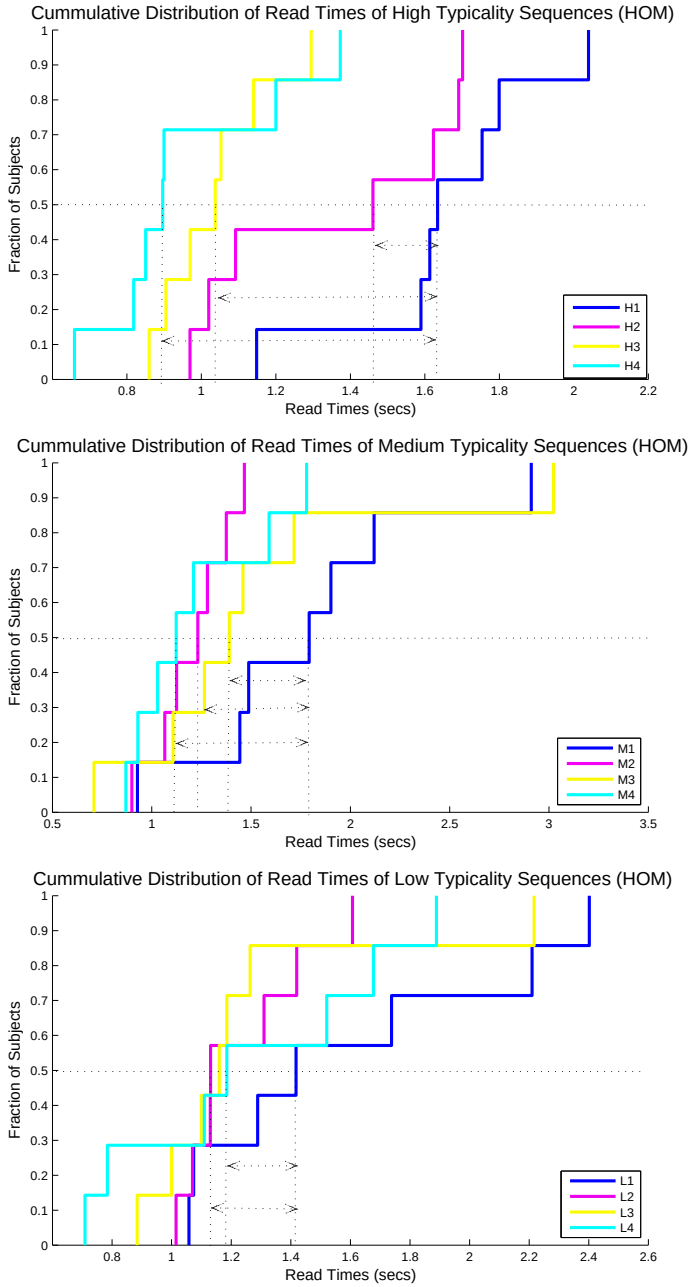

Figure 3.12: Cummulative distributions of median read times of the 1st(dark blue), 2nd(pink), 3rd(yellow) and 4th(cyan) acts in HOM sequences of HIGH, MEDIUM and LOW typicality. As in the HET condition, we find that the distribution of the read time of the first HIGH typicality act (H1) is shifted right relative to the remaining 3 read times (H2, H3, H4). The magnitudes of the differences between the corresponding median read times are indicated by the horizontal arrows. We see that the separation between the first read time and the remaining 3 read times becomes smaller as the typicality of the sequence decreases. This pattern is indicated by the decreasing lengths of the arrows in the MEDIUM and LOW conditions.

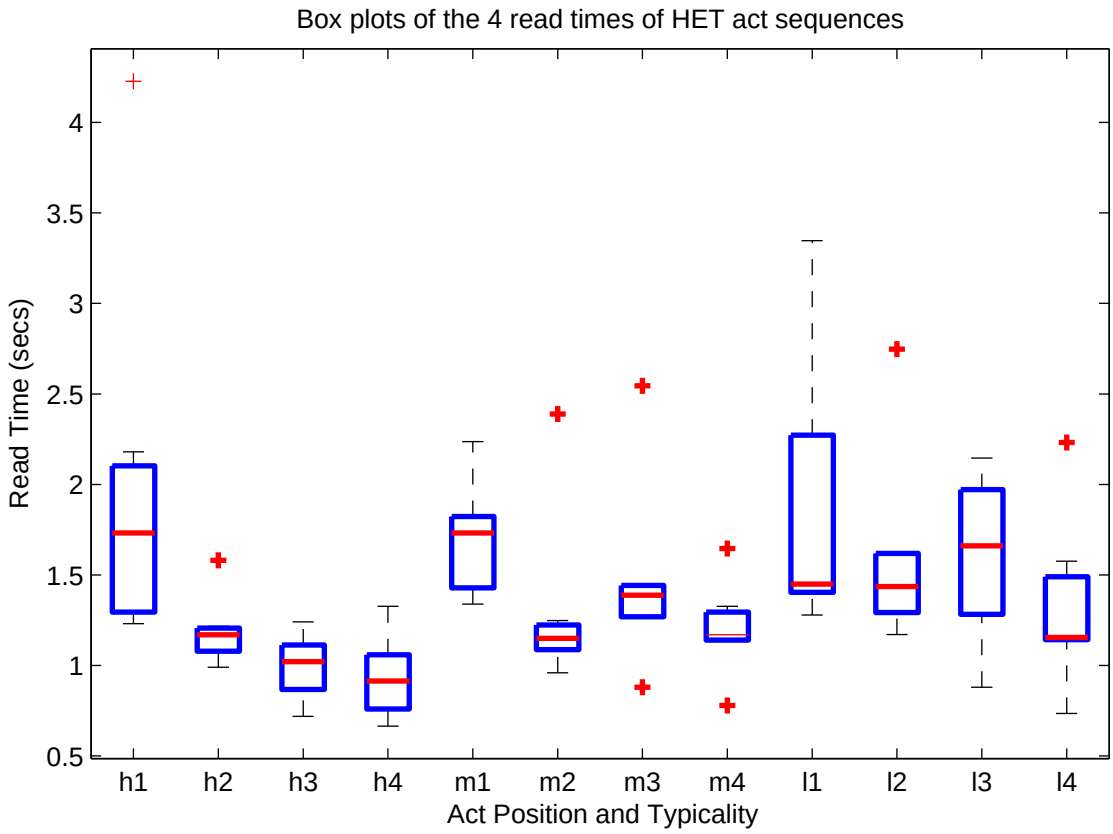

Figure 3.13: Box-Whisker plots of time taken to read the 4 acts of a HETerogenous sequence. The horizontal bars represent median read times corresponding to each act and typicality condition. Notice that the median read time of the first act in the HIGH typicality condition (h1) is placed higher in the plot than the remaining 3 read times (h2, h3, h4). Pairwise T tests showed that these medians were significantly different. The same is the case with the medians of the MEDIUM typicality read times. The medians of the 4 read times in the LOW condition, however, are all clustered together. These observations coincide with those made in the corresponding cummulative distribution plots of the read times, shown above.

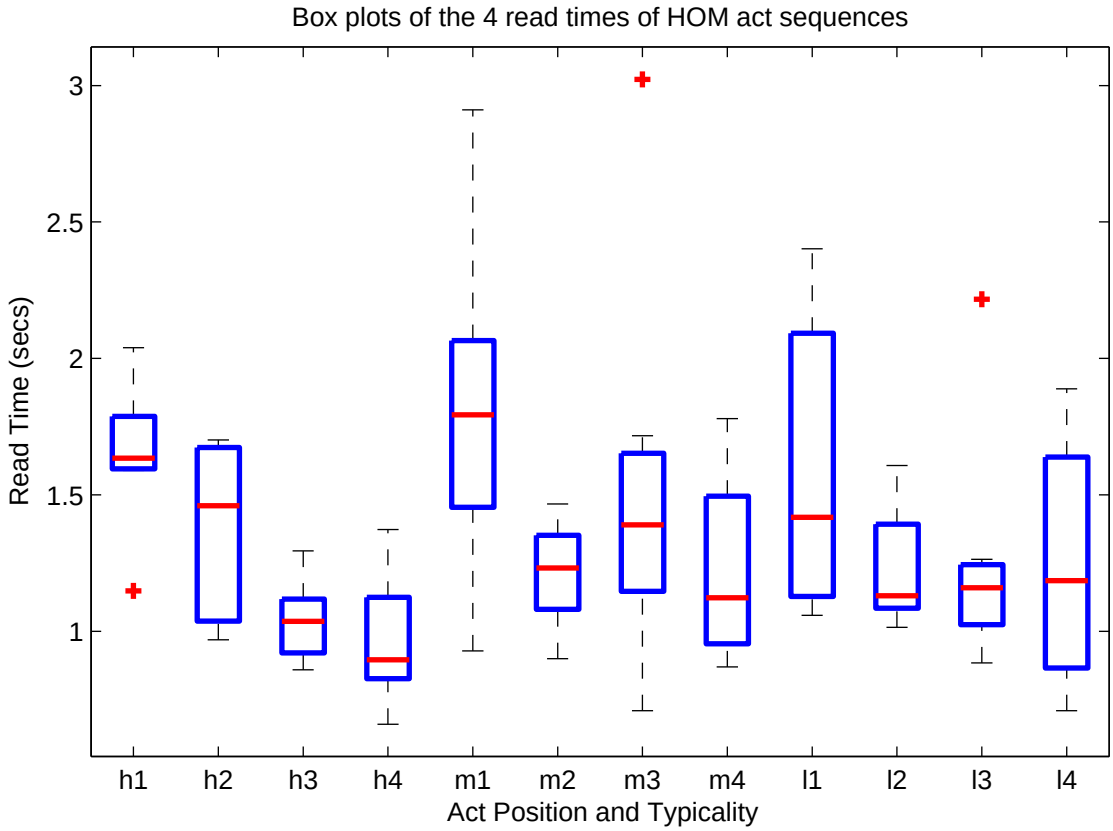

Figure 3.14: Box-Whisker plots of time taken to read the 4 acts of a HOMogeneous sequence. As in the case of the box plots of read times in the HET condition, the horizontal bar representing the median read time of the first act in the HIGH typicality condition (h1) is placed higher in the plot than the remaining 3 read times (h2, h3, h4). Pairwise T tests showed that these medians were significantly different. So also the medians of the MEDIUM typicality read times (compare m1 and m2, m3, m4). The medians of the 4 read times in the LOW condition are all clustered together. These observations coincide with those made in the corresponding cummulative distribution plots of the read times, shown above.

shows the 4 median HETerogenous read times, under 3 conditions of typicality. Pairwise T tests showed that Read-1 was either equal to or significantly greater than Read-2, 3 and 4. In HIGH typicality sequences, Read-1 was no different than Read-2, but Read-1 was greater than Read-2 (t=2.26, p=0.06, n=7) and also greater than Read-4 (t=2.38, p=0.05, n=7). In MEDIUM typicality sequences Read-1 did not differ from Read-2 and Read-3, but Read-1 was significantly greater than Read-4 (t=2.95, p=0.02, n=7). In the LOW typicality condition the 4 read times did not differ significantly. The difference in the size of the body of knowledge activated by a HIGH, MEDIUM and LOW act would lead to these differences in read time patterns.

A sequence of high typicality acts may be easier to link as they all provide strong support for a common script "hypothesis". Thus the time taken to read successive high typicality acts would be expected to decrease. Both medium as well as low typicality acts activate a smaller body of information individually due to which the linking of medium or low acts, none of which provide strong support for a given script, might take longer. T-tests comparing pairs of typicality conditions show these very effects in the HET condition. Referring to figure 3.13, note that as we move from Read-1 through Read-4, HIGH acts take less time to read than either MEDIUM or LOW acts. Read-1 starts off being no different for the HIGH, MEDIUM and LOW sequences. At Read-2, the HIGH and MEDIUM typicality acts are still being read for the same amount of time, but the disparity between the HIGH and LOW acts is beginning to increase (t=-2.0, p=0.09, n=7). At Read-3 the HIGH act is being read significantly faster than either the MEDIUM act (t=-2.23, p=0.06, n=7) or the LOW act (t=-3.89, p=0.008, n=7). This pattern is observed once again at Read-4, with the HIGH act being read faster than the MEDIUM act (t=-4.38, p=0.004, n=7) as well as the LOW act (t=-3.23, p=0.01, n=7). These results suggest that the ambiguity inherent in MEDIUM and LOW acts makes it harder

for subjects to link such acts and also that subjects do attempt to link sequences of acts.

3a. *Pairwise T tests on 4 read times of HOMOgeneous sequences*: Figure 3.14 shows the 4 median HOMOgeneous read times, under 3 conditions of typicality. Pairwise T tests showed that the pattern of Read-1 times described, above, for HET sequences, were also observed in HOMogeneous sequences. That is the time taken to read the first act was not less than the remaining 3 read times. In HIGH typicality sequences, Read-1 was significantly greater that Read-2 (t=1.98, p=0.09, n=7), Read-3 (t=5.06, p=0.002, n=7) and Read-4 (t=4.69, p=0.003, n=7). Read-1, in MEDIUM typicality sequences, tended to be significantly greater than Read-2 (t=2.1, p=0.07, n=7) and did not differ significantly from Read-3 and Read-4. Read-1, in LOW typicality sequences, did not differ from any of the remaining 3 read times.

Once again, one might expect that the time taken to read successive HIGH typicality acts would decrease to a greater extent than in MEDIUM or LOW typicality sequences due to the ease of linking not present in the latter two conditions. T-tests comparing pairs of typicality conditions show these effects. Referring to figure 3.14, we see that Read-1 and Read-2 are no different for the HIGH, MEDIUM and LOW sequences. At Read-3, the HIGH typicality act is being read slightly faster than the MEDIUM/LOW typicality acts as indicated by the negative but non significant differences in the HIGH-MEDIUM and HIGH-LOW pairs. Finally, at Read-4, the HIGH act is being read significantly faster than either the MEDIUM act (t=-5.5, p=0.001, n=7) or the LOW act (t=-2.22, p=0.06, n=7).

3b. *Another prediction regarding the read time of HOM sequence acts* was that the second and fourth acts of HOM sequences would show a decrease in read time relative to their respective preceding acts owing to the fact that Act2 and Act4 might be anticipated given that these acts belong to the same scenes as Act1 and Act3, respectively. Pairwise

T-test on read times showed that, while Read-3 was slightly greater than Read-2 for MEDIUM typicality sequences, this effect was not significant. In no other case was this pattern observed. Thus there was no evidence to show that subjects were taking longer to process acts at scene boundaries. The reason for the absence of this effect may have been that subjects were not restricted in terms of the time available to read act sequences. However, given that the overall pattern of read times in the HET and HOM conditions was not identical, it seems as if HET and HOM sequences were, to some extent, processed differently.

4. *A 2x3x4 ANOVA on the 4 read times* was carried out, with sequence Typicality, sequence HOMOgeneity and Act Position as the 3 independent factors. These results summarize the previous results of various pairwise T-tests. There was a main effect of Typicality (F=3.6, p=0.07, N=7, df(b/n)=2, df(w/n)=12) but no main effect of HOMOgeneity (F=3.9, p=0.09, df(b/n)=1, df(w/n)=6). There was a main effect of Act Position (F=3.3, p=0.03, df(b/n)=3, df(w/n)=18). The only significant interaction was that of Typicality and Act Position (F=3.4, p=0.008, df(b/n)=6, df(w/n)=36)

3.4 Discussion of results and implications

Typicality: It was found that the typicality of the act sequence strongly influenced subjective preferences for the type of script that best captured the act sequence. HIGH typicality sequences lead to a clear separation in ratings assigned to a pair of scripts that offered competing explanations of the act sequence. Such acts may be considered to have a high degree of "cue validity" when an agent's plans must be determined on the basis of an observed sequence of actions. These acts were also found to be correlated with the lowest response times indicating ease of decision making. LOW typicality act sequences provided little support for either script and led to low ratings of both script options. These

sequences appear to be the least informative in terms of the what the observer may infer about the agent's intentions. MEDIUM typicality act sequences led to moderate ratings of both script options. Such acts appear to be associated with the greatest amount of ambiguity, more informative than LOW typicality acts but also more equivocal than HIGH typicality acts. Response times for both LOW and MEDIUM act sequences were much higher than that of HIGH typicality sequences. It would appear that subjects take longer to express their explanatory script preferences both when the act sequence suggests more than one script and also when the act sequence suggests none. Read time patterns in HIGH typicality sequences tended to drop off as the sequence progressed which suggests that initial acts indicative of a particular script facilitate the linking of subsequent acts under this script thereby restricting the body of knowledge that each of these later acts might individually trigger. While this pattern was also observed in MEDIUM typicality sequences, read times 2, 3 and 4 tended to be higher than the corresponding read times in HIGH sequences. This corresponds to the increased difficulty in linking MEDIUM typicality acts which are individually ambiguous. HIGH typicality read times were also lower than LOW typicality read times. However, no drop was observed in the 4 read times of LOW typicality sequences which might have been due to the lack of informativeness of LOW typicality acts and the resulting independence of the acts in the sequence.

Homogeneity: It was expected that the whole-component relationship that exists between scripts and acts would cause them to behave like visual shapes and their parts. Heterogeneous act sequences which represented 4 different scenes were expected to provide stronger support for the script from which they were taken, relative to HOMogeneous act sequences which represented only 2 different scenes. No such advantage was observed in the case of HETerogeneous sequences. Script rating patterns were identical in both types of sequences which were dominated by the factor of act sequence typicality.

The absence of a homogeneity effect suggests an interesting feature about the manner in which acts of different *typicalities* might combine. If we compare the second act of a heterogeneous (*a1, b1, c1, d1*) sequence with that of a homogeneous (a1, a2, b1, b2) sequence we see that act *b1* which represents a new scene in the former, provides more information about the corresponding script relative to act "a2". Thus at the end of the second act we have seen more of the script in the heterogeneous sequence relative to the homogeneous sequence. One might say that *a1, b1* provides greater support for the script than "a1, a2". For this reason act *b1* may be said to *function* like an act whose typicality is higher than that of act "a2". The same reasoning carries over to the latter two acts in each sequence. Thus it appears that when one act at a certain level of informativeness (i.e. typicality) is followed by another that is less informative, the verdict regarding the inferred script may be biased towards the former. The above suggests the hypothesis that a combination of a high typicality act and another of lower typicality will not detract from the perceived support for the script represented by the high typicality act. The hypothesized "dominance" of the higher typicality act is likely to be modulated by how low the lower typicality act is. For instance a combination of a HIGH and a MEDIUM act might fare better than a combination of a HIGH and a LOW act. However, one may expect the effect of the higher typicality to weaken as the acts of lower typicality increase in number. One may speculate that a more extreme case of HOMogeneity in the present study involving sequences, in which *all* acts belong to a *single* scene, might have lead to lower script ratings. The dominance effects of higher typicality acts will be examined in the following study.

The purpose of using "partially" HOMogeneous act sequences in the present study was to determine whether subjects' were aware of crossing the scene boundary within a HOMogeneous act sequence. Read times were expected to drop between 2 acts that

belonged to the same scene and rise when a new scene was entered. This effect was only weakly observed in the case of MEDIUM typicality sequences. The absence of the "scene boundary" effect may have been due to the fact that subjects were allowed to read the act sequence at their own pace. But it seems more likely that the hypothesized "subsumption" of later acts under the very first one helped to offset any "within-scene" advantage that may have existed in HOMogeneous sequences. Note that this subsumption is more likely to occur in the case of HIGH typicality sequences and correspondingly we do not see the "scene boundary" effect in these sequences. LOW typicality acts which were uninformative about both script options are not likely to be easily identified with particular scenes in a script. Therefore, scene boundaries would not have emerged in LOW typicality sequences.

Chapter 4

Experiment 3: Asymmetric anchoring to high and medium/low typicality acts

4.1 Motivation

In experiment 2 it was found that the ratings given to a pair of competing scripts in terms of how well they captured a sequence of acts, were not affected by the decrease in script representativeness of the act sequence. Sequences that consisted of acts taken from 4 different scenes of a script, in one case, and 2 scenes in another, were perceived to be equally supportive of the script.

Consider a sequence of three acts, taken from three different scenes of a given script (A1, B1, C1) and another sequence of acts, all three of which are taken from a single scene (A1, A2, A3). Assuming all 6 acts are at the same level of typicality, the former sequence provides more information about this script. This difference in script related information lies in the second and third acts. A1 by itself triggers information relating to the scene

it belongs to, which would include the acts (A2, A3). Therefore, (A2, A3) add less to the initial act A1 than the pair (B1 C1). Therefore, one might say that the acts (A2, A3) *function* like acts of lower typicality relative to the acts (B1, C1). This suggests that when an act at a certain level of typicality is combined with an act of lower typicality, the former might be given more weight when determining how well this sequence supports a given script. In the context of a sequential presentation of acts this might further mean that the introduction of a lower typicality act after a higher typicality act will cause a smaller change in the perceived support for the script relative to the reverse sequence of a lower typicality act followed by a higher typicality act. Thus, in a sequence consisting of acts at two levels of typicality, the lower typicality act is expected to weaken the effect of the higher typicality act to a lesser extent than the extent to which the high act might interfere with the low act.

The above hypothesized "dominance" of the higher typicality act is likely to be modulated by *how low* the typicality of the lower typicality act is. While a combination of a HIGH and a MEDIUM act or a HIGH and a LOW act might both involve a bias towards using the HIGH act to draw script related inferences, this bias is expected to be weaker in the latter combination of acts. The bias towards the higher typicality might also be expected to weaken as the acts of lower typicality increase in *number*, relative to the number of high acts.

The absence of the homogeneity effect in the high typicality condition of experiment-2, was attributed to the fact that in both homogeneous as well as heterogeneous sequences, later acts could be subsumed under the script suggested by the very first act. It is of interest to know whether this subsumption under the most informative act can occur even when this act does *not* occupy the very first position in the act sequence. That is, we would like to determine if the anchoring provided by the higher typicality act is

independent of the sequential position of this act or whether the first position in the sequence has a special status, independent of its relative typicality.

In the present study, the following hypotheses will be tested:

1. Dominance: Sequences consisting of acts of two different levels of typicality are expected to lead to script preferences that are biased towards the act of higher typicality.

2. Typicality Distance: The dominance effect is expected to weaken as the disparity between the higher and lower typicality acts increases.

3. Number of lower typicality acts: The dominance effect is also expected to weaken as the lower typicality acts in the sequence increase in number.

4. Subsumption and Anchor Position: It is expected that for subsumption to occur, the higher typicality act must occupy the first position in the act sequence.

4.2 Method

4.2.1 Overview

Subjects were shown a sequence of 3 acts, one of which was a HIGH typicality act while the remaining 2 acts were either both of MEDIUM typicality or both of LOW typicality. The act sequences were constructed so that the HIGH typicality act occupied each of the 3 possible positions. After *each* act, the subject was asked to rate 2 script statements in terms of how well they corresponded to the observed act. Subjects were provided with a scale that varied continuously from 1(worst) to 5(best). This was repeated after each act in the 3 act sequence so that the subject was able to modify her script ratings in response to the current observed act. In each trial 3 pairs of script ratings, 3 read times and 3 response times were recorded.

4.2.2 Subjects

Five subjects between the ages of 24 and 30 were used in the present study. These subjects were recruited from public establishments such as libraries and bookstores. They were given book coupons as compensation for participation.

4.2.3 Materials and Procedure

The stimuli consisted of sequences of 3 sentences, each describing an act. These sequences varied along the dimensions of Anchor Position (3 levels) which was the position of the HIGH act in a 3-act sequence and Typicality Distance (2 levels) which the level of the remaining 2 lower typicality acts (MEDIUM or LOW). There were thus a total of 6 types of sequences used in this study.

The typicality of each act was obtained from the results of experiment-1. A HIGH typicality act had a typicality level in the range (3.6, 5); a MEDIUM typicality act had a typicality level in the range (2.5, 3.4); a LOW typicality act had a typicality level in the range (1, 2.4).

Each of the following scripts contributed 12 sequences, for a total of 48, 3-act sequences.

A) BEACH: “preparing for a day at the beach”

B) SCHOOL: “preparing for a day at school”

C) COUNTRY: “preparing to move to a different country”

D) VACATION: “preparing for vacation”

The 12 sequences derived from each script contained 2 instances of each of the 6 types of sequences described above. These 6 types were constructed as follows. There was either **1 HIGH (H) act and 2 MEDIUM (M) acts (HMM, MHM, MMH) or 1**

HIGH act (H) and 2 LOW (L) acts (HLL, LHL, LLH). Appendix 3 lists all 48, 3-act sequences used in the current study.

In each act sequence trial, subjects were shown the 3 acts on a computer monitor, one at a time, at the subjects' own pace. The name of the actor remained unchanged within each act triplet. After *each act* in a triplet subjects were asked to rate a pair of scripts in terms of how well these scripts explained the act statement that was shown. The rating was recorded using a sliding scale that ranged from 1 (=not at all) to 5 (=definitely). The position of the slider on the scale was saved from one act to the next within each 3-act trial. Subjects could view their latest preferences and adjust them in response to the current act.

Of the two script options, one was the MATCHING script from which the sequence was derived. That is, the typicality of an act in the sequence was measured relative to this MATCHING script. The second script option described an ALTERNATIVE script which shared the same context as that of the MATCHING script. The scripts corresponding to the BEACH/SCHOOL scenarios and the COUNTRY/VACATION scenarios were paired for this purpose. These script pairs were intended to provide competing explanations for the acts sequences observed.

Each 3-act sequence trial was followed by a numerical task in which subjects were asked to identify the 2 closest of a set of 4 rational numbers lying between -1 and 1. This task was intended to minimize the influence of earlier act sequence trials on later ones during the course of the study.

In each 3-act trial, 3 pairs of script ratings and the corresponding read and response times were recorded.

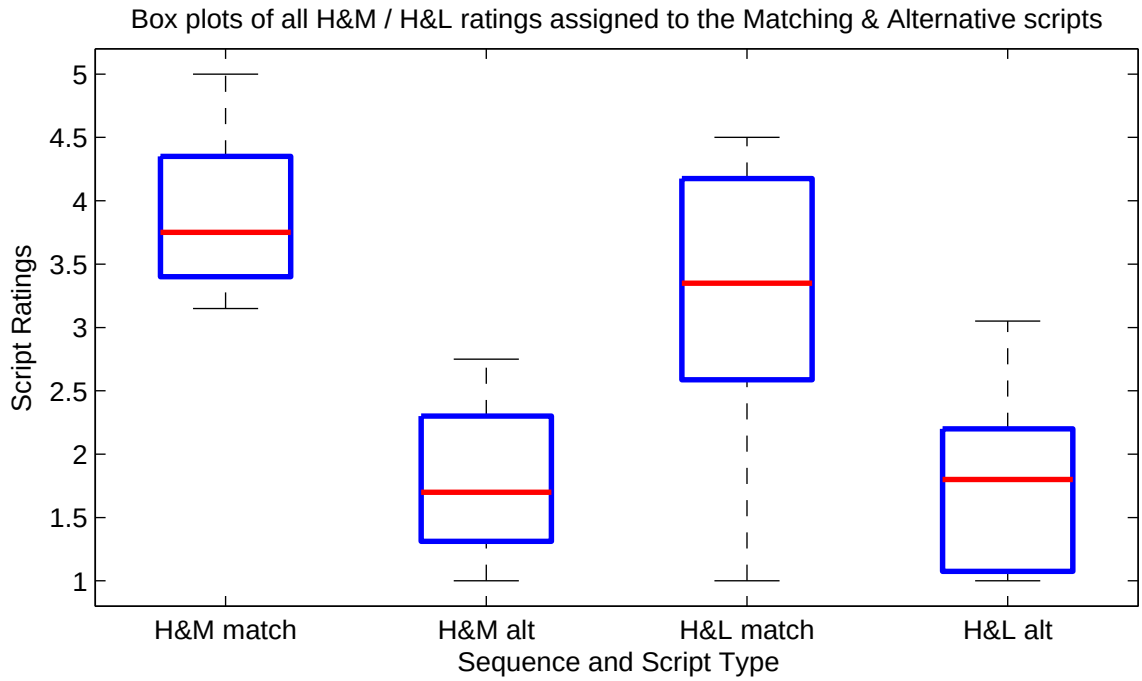

Figure 4.1: Box-Whisker plots of ratings assigned to matching and alternative scripts in response to a combination of a) 1 HIGH and 2 MEDIUM acts and b) 1 HIGH and 2 LOW acts. These ratings have been averaged over the 3 sequence orders (H– ; -H- ; –H). The horizontal bars represent median ratings in each condition. The lower and upper edges of the boxes represent the first and third quartiles of the distribution while the lower and upper whiskers represent the minimum and maximum values of the ratings in each condition. The median ratings assigned to the Matching script were greater than the ratings assigned to the Alternative script in both the H and M and the H and L conditions as indicated by the disparity in the heights of the median bars of the corresponding boxes. T tests showed these median differences to be significant. The difference between the median Matching script ratings in the H and M and the H an L conditions were not found to be significant.

4.3 Results

4.3.1 Dominance or Bias towards the high typicality act

It was found sequences consisting of HIGH and MEDIUM typicality acts as well as those made up of HIGH and LOW typicality acts, led to subjective script ratings that were more commensurate with the HIGH act rather than the MEDIUM or LOW acts, respectively. Figure 4.1 shows the final ratings given to the Matching and Alternative scripts (*Match* and *Alt*, henceforth), at the end of the 3-act sequence, in the HIGH-MEDIUM (H-M) and HIGH-LOW (H-L) conditions.

The mean rating given to *Match* was nearly 3.92 in the H-M condition and 3.2 in the H-L condition. There was no difference in the mean rating given to *Alt* in the H-M and H-L conditions, which was about 1.7. The difference between the *Match* and *Alt* ratings in each case was significant (n=5, H-M: t=10.24, $p < 0.00001$; H-L: t=4.26, p=0.0002). We see that subjects' rated the two scripts as if the 3-act sequence clearly supported Match rather than *Alt*.

Figure 4.2 shows cummulative distributions of final ratings assigned to matching (top) and alternative (bottom) scripts. The dotted lines represent the three HIGH+Medium combinations (HMM, MHM, MMH). The bold lines represent the three HIGH+Low combinations (HLL, LHL, LLH). Kolmogorov Smirnov tests showed that there was no significant difference between three HIGH+Medium distributions. This was also case with the HIGH+Low distributions expect for a slight difference between the LHL (pink) and LLH (yellow) distributions (D=0.5, p=0.066). There was no difference between any of the six *Alt* rating distributions shown in the bottom panel of figure 4.2.

In all six conditions (3 HIGH+Medium and 3 HIGH+Low), the distributions of *Match* ratings in figure 4.2 (top panel) were significantly different from the *Alt* ratings (bottom panel of figure 4.2). Kolmogorov-Smirnov tests resulted in maximum differences between the Match and *Alt* ratings in response to the six types of sequences as follows: HLL: D=0.5, p=0.066; LHL: D=0.5, p=0.066; LLH: D=0.5, p=0.066; HMM: D=0.8333,p=0.0; MHM:D=0.833, p=0.0; MMH: D=0.833, p=0.0.

4.3.2 Disparity or typicality distance between the higher and lower typicality acts

While both H-M and H-L combinations lead to greater preferences for *Match*, the preference was slightly more pronounced in the former. The *Match* ratings of 3.92 and 3.2, in

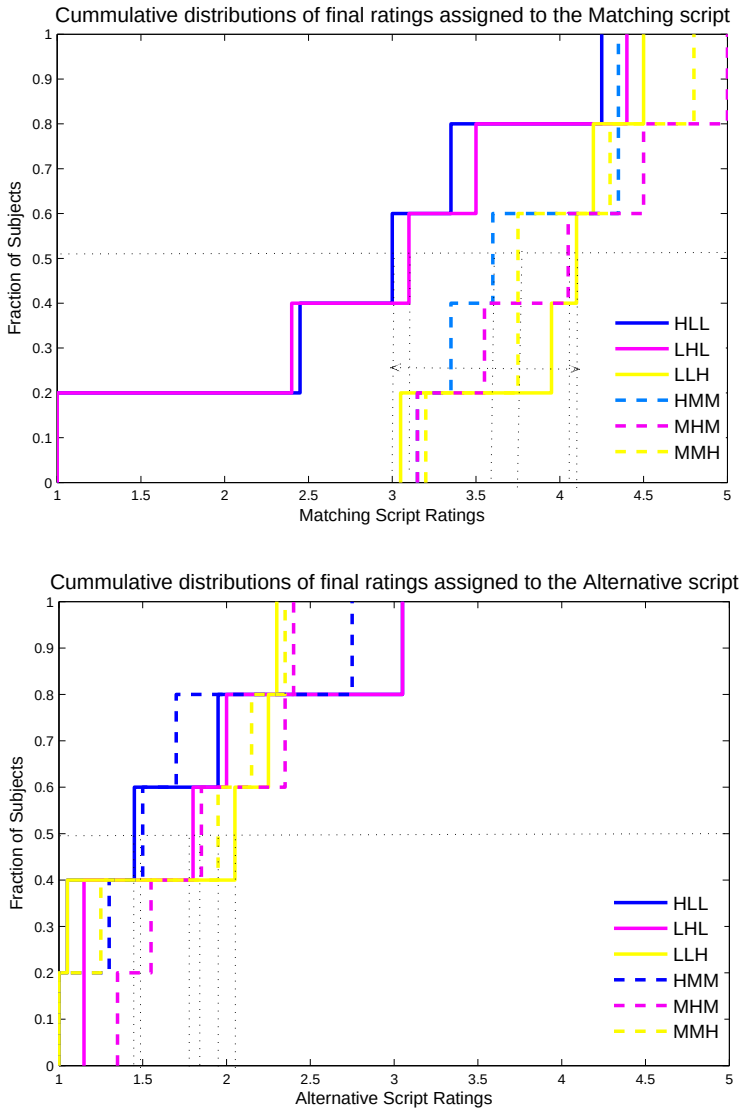

Figure 4.2: Cummulative distributions of final ratings assigned to matching (top) and alternative (bottom) scripts in response to a combination of HIGH+Low acts and HIGH+Medium acts. The dotted curves represent rating distributions in the H and M condition while the bold curves represent rating distributions in the H and L condition. The long horizontal line represents 50% of the subjects and the abscissae of the points where it intersects the distributions, represent the median ratings in the corresponding conditions. The horizontal arrows indicate the separation between these medians. We see that the three types of H and M Matching script distributions are clustered together and so are two of the H and L distributions. The median of the single displaced H and L condition was not found to be significantly different from the remaining H and L conditions. These distributions reflect rating patterns indicated in the box plots above. All six distributions of the Alternative script ratings can be seen to be clustered in the lower panel. The differences in these medians were found to be non significant as indicated by the nearness of the projections from the 50% line to the rating (X) axis.

the two conditions were only weakly significantly different (t=2.1, p=0.04). The slightly weaker dominance of the HIGH act in the HIGH+Low conditions is also reflected in the smaller differences in the corresponding cummulative distributions as indicated in the preceding section. Thus the dominance of the HIGH act appeared to have been only slightly weakened by the presence of the LOW acts. As will be shown and discussed further below, the presence of the MEDIUM acts had no effect on the dominance of the HIGH act.

4.3.3 Number of lower typicality acts preceding the HIGH act

It was expected that as the number of MEDIUM or LOW acts, preceding the HIGH act, increased the reliance on the HIGH act would decrease. However, as described below, increasing the number of preceding acts of lower typicality did not alter the dominance of the HIGH act.

Effect of increasing number of MEDIUM acts

The left panel of figure 4.3 shows the ratings given to *Match* in response to a) the HIGH act, *alone* ; b) HIGH preceded by 1 MEDIUM act ; and c) HIGH preceded by 2 MEDIUM acts.

We see that there is no difference in the rating given to *Match* in the three cases. The introduction of 1 and 2 MEDIUM acts does not decrease preference for *Match*. The fact that ratings for *Match* in the cases (b) and (c) are the highest possible underlines the bias towards the HIGH act. The right panel of figure 4.3 shows the corresponding ratings given to *Alt* in response to the introduction of 0, 1, 2 MEDIUM acts, which did not differ significantly.

Figure 4.5 shows cummulative distributions of successive ratings assigned to *Match*. The left and right panels of these figures show ratings obtained in response to the H-M and H-L sequences, respectively. The blue(top), pink(center) and yellow(bottom) lines in

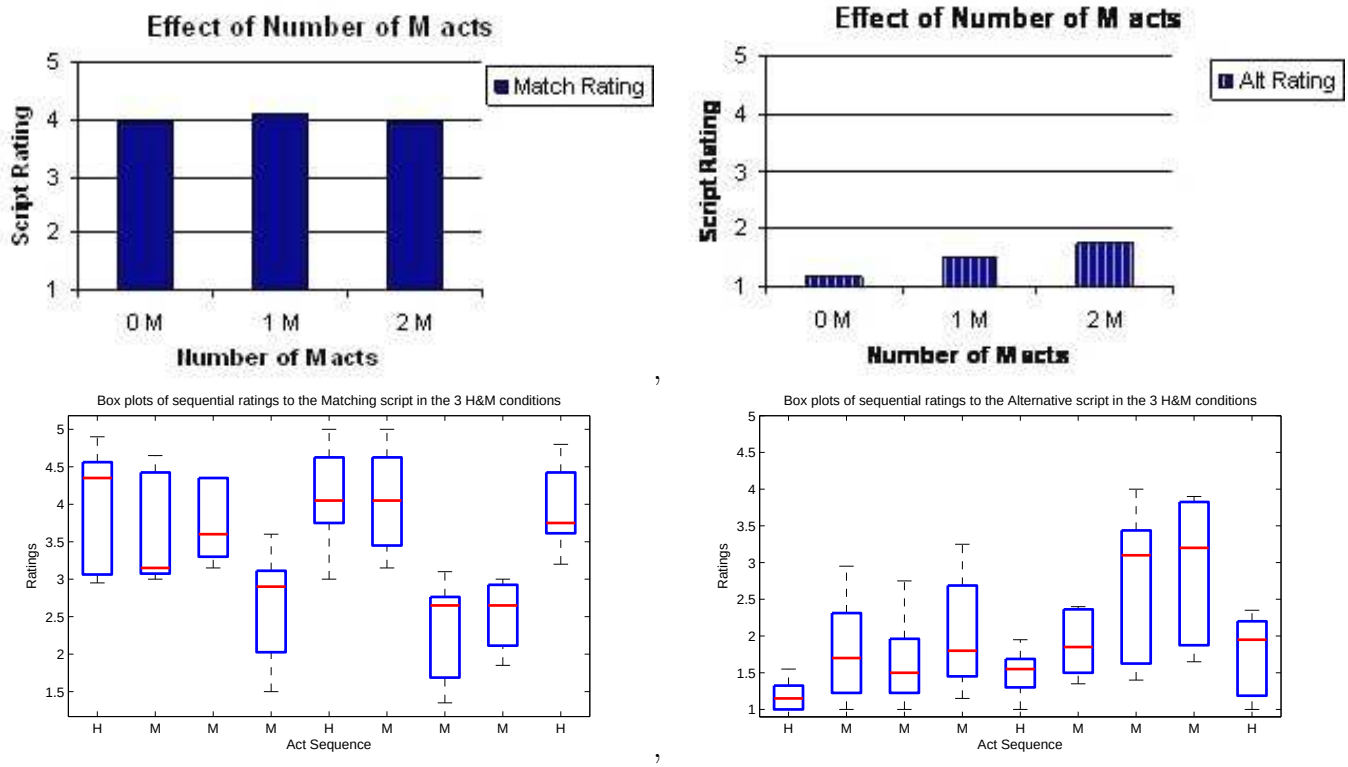

Figure 4.3: The upper panel shows mean ratings assigned to matching and alternative scripts in response to a combination of 1 HIGH preceded by 0 MEDIUM acts, 1 HIGH preceded by 1 MEDIUM act, or 1 HIGH preceded by 2 MEDIUM acts. The bottom panel shows box-whisker plots corresponding to the 3 types of H ratings (boxes 1, 5 and 9). We see that the boxes 1, 5 and 9 describing Matching script (left panel) and Alternative script (right panel) ratings, have nearly equal medians and overlap considerably. These medians were not found to be significantly different indicating that the rating assigned to both the Matching and the Alternative scripts in response to a single HIGH typicality act was no different from the ratings obtained in response to a combination of 1 MEDIUM and 1 HIGH act or 2 MEDIUM and 1 HIGH act.

the left panel of figure 4.5 represent the distributions of the *Match* ratings in response to a HIGH act, one medium act followed by a HIGH act and two medium acts followed by a HIGH act, respectively. We see no difference in these three distributions.

Figure 4.6 shows cummulative distributions of successive ratings assigned to *Alt*. The left panel shows ratings obtained in response to the H-M sequences. The blue(top), pink(center) and yellow(bottom) lines represent the distributions of the *Alt* ratings in response to a HIGH act, one medium act followed by a HIGH act and two medium acts followed by a HIGH act, respectively. The distribution of the *Alt* rating in response to the first HIGH act (blue line, top panel) differed slightly from the *Alt* ratings obtained in response to one one medium act followed by a HIGH act (D=0.5000, p=0.066) as well as the *Alt* ratings obtained in response to two medium acts followed by a HIGH act (D=0.5000, p=0.066). The two latter distributions did not differ and were both shifted towards sightly higher values of *Alt* ratings relative to the former. This suggests that the H act alone provided slightly less support for the *Alt* script compared to the sequence MH or the sequence MMH.

Effect of increasing number of LOW acts

The left and right panels of fig 4.3.3 show ratings given to *Match* and *alt*, respectively, in response to a) the HIGH act, *alone* ; b) HIGH preceded by 1 LOW act ; and c) HIGH preceded by 2 LOW acts.

We see that, here too, the introduction of either 1 or 2 LOW acts prior to the HIGH act did not alter subjective preferences for the script suggested by the HIGH act, i.e., *Match*. The ratings given to *Alt* remained nearly the same despite the introduction of the LOW acts. The apparent differences in the average *alt* ratings seen in the right panel of fig 4.3.3 were not found to be significant.

Again, referring to figure 4.5, the blue(top), pink(center) and yellow(bottom) lines of

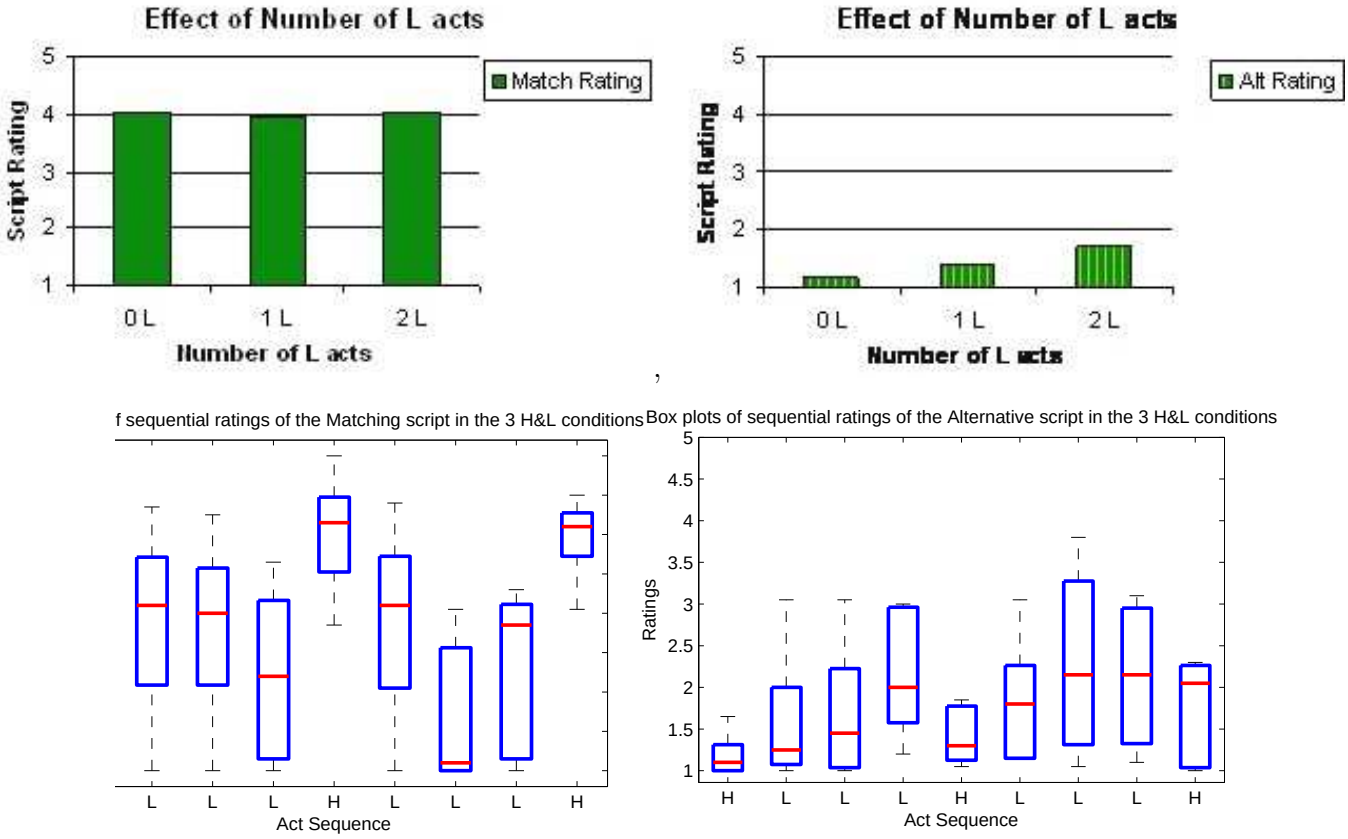

Figure 4.4: The upper panel shows mean ratings assigned to matching and alternative scripts in response to a combination of 1 HIGH preceded by 0 LOW acts, 1 HIGH preceded by 1 LOW act, or 1 HIGH preceded by 2 LOW acts. The bottom panel shows box plots corresponding to the 3 types of H ratings (boxes 1, 5 and 9). The boxes on the left represent Matching script ratings while those on the right represent Alternative script ratings. We see that the boxes 1, 5 and 9 on the left as well as on the right, have nearly equal medians and overlap considerably. These medians were not found to be significantly different again indicating that introducing 1 or 2 LOW typicality acts prior to the HIGH typicality act did not alter the impact of the HIGH act on script ratings.

the right panel represent the distributions of the *Match* ratings in response to a HIGH act, one low act followed by a HIGH act and two low acts followed by a HIGH act. We see no difference in these three distributions.

The right panel of figure 4.6 shows cummulative distributions of successive ratings assigned to *Alt* obtained in response to the H-L sequences. The blue(top), pink(center) and yellow(bottom) lines represent the distributions of the *Alt* ratings in response to a HIGH act, one low act followed by a HIGH act and two low acts followed by a HIGH act, respectively. The distribution of the *Alt* rating in response to the first HIGH act (blue line, top panel) and that obtained in response to one low act followed by a HIGH act differed slightly from the *Alt* ratings obtained in response to two low acts followed by a HIGH act (in each case D=0.5000, p=0.066). This last distribution was found to be shifted towards slightly greater *Alt* ratings relative to the remaining two distributions, suggesting that the sequence LLH was perceived to be slightly more supportive of the *Alt* script compared to the H act alone as well as the sequence LH.

NOTE: It might appear that there is a discrepancy in *Match* ratings in response to H-L sequences reported in figures showing the DOMINANCE and NUMBER effects. Figure 4.1 shows that the *Match* rating in the H-L condition was lower than the H-M condition whereas figures 4.3 and 4.3.3, show that there was no difference in the H-M and H-L conditions. This apparent anomaly is due to the fact that the DOMINANCE figure compares final script ratings, obtained after all 3 acts have been observed. The NUMBER effect figures, on the other hand, compare ratings obtained after 1, 2 and 3 acts as indicated by the labels on the x-axis of these figures. For example, that a rating was obtained in response to a HIGH act preceded by 0 L acts means this HIGH act was the very *first* act of the sequence and therefore belonged to the **HLL** condition. Next, that a rating was obtained in response to a HIGH act preceded by 1 L act means this HIGH

act was the *second* act of the sequence and therefore belonged to the **LHL** condition. Finally, the fact that a rating was obtained in response to a HIGH act preceded by 2 L acts means this HIGH act was the *third and final* act of the sequence and therefore belonged to the **LLH** condition. Notice therefore that the set of ratings shown in the NUMBER effect graphs are a subset of the ratings used to plot the DOMINANCE graph. For this reason the DOMINANCE graph differs from the NUMBER effect graphs. In the following subsection we will discuss the subsumption and anchor effect. To do this ratings obtained after each of the three acts in a sequence will be examined individually which will further clarify exactly which cases NUMBER effect graphs do not cover.

4.3.4 Anchoring and Subsumption Effects

The effects presented above indicate that subjective preferences for scripts showed a strong bias towards the script supported by the HIGH act. This could have occurred if subjects were simply responding the act of higher typicality, the HIGH act, and ignoring the acts of lower typicality. That is, the final script ratings could have been obtained without any kind of interaction between the acts of a sequence. This, however, was not the case. There was a clear "anchoring" effect observed such that responses to current acts were anchored to preceding acts. However, the "anchor" provided by the HIGH act was stronger than that provided by either the MEDIUM or the LOW acts. Figure 4.7 shows the anchor effect in H-M and H-L sequences. The left panel shows the sequential updating of Match ratings in response to sequences consisting of a combination of one HIGH and 2 MEDIUM acts in 3 different orders of presentation (**HMM, MHM, and MMH**). The right panel shows the sequential updating of *Match* ratings in response to sequences consisting of a combination of one HIGH and 2 LOW acts in 3 different orders of presentation (**HLL, LHL, LLH**).

Asymmetric anchor effects in H-M type of sequences

Refer to the left panel of figure 4.7. The top, center and bottom panels show subjective ratings assigned to *Match* in response to H-M type of sequences in which the HIGH act appears in the first, second and third positions of the sequence, respectively. The thin arrows in the top and center panels compare the anchoring effects of MEDIUM on HIGH acts and HIGH on MEDIUM acts, respectively, when transitioning from the first to the second act of the sequence. We see that the change in the rating given to *Match* in going from H to M (top panel), is smaller than the change in the rating given to *Match* in going from M to H (center panel). This change in *Match* rating was found to be non significant in going from H to M but significant going from M to H (t=-5.3, p=0.005, n=5). The thick arrows indicate an analogous pattern of anchoring effects when transitioning from the second to the third act of the sequence. Again, the decrease in *Match* rating was found to be non significant in going from H to M but the increase in *Match* rating going from M to H was significant (t=-12.4, p=0.0002, n=5).

Refer to the cummulative distributions of successive *Match* ratings obtained in response to the H-M sequences, in the left half of figure 4.5. The disparity between the blue and pink lines in the top panel (distribution of *Match* ratings to H followed by M) is is significantly less than the disparity between the blue and pink lines in the center panel (distribution of *Match* ratings to M followed by H). Similarly, The disparity between the pink and yellow lines in the center panel (distribution of *Match* ratings to MH followed by M) is significantly less than the disparity between the pink and yellow lines in the bottom panel (distribution of *Match* ratings to MM followed by H).

Weaker Asymmetric anchor effects in H-L type of sequences

Refer to the right panel of figure 4.7. The top, center and bottom panels show subjective ratings assigned to *Match* in response to H-L type of sequences in which the HIGH act appears in the first, second and third positions of the sequence, respectively. These graphs show asymmetric anchoring effects as in the case of H-M sequences, but these effects were found to be weaker. The thin arrows compare the anchoring effects of LOW on HIGH acts (top panel) and HIGH on LOW acts (center panel), when transitioning from the first to the second act of the sequence. We see that the change in the rating given to *Match* in going from H to L (top panel), is much smaller than the change in the rating given to *Match* in going from M to L (center panel). The change in *Match* rating was found to be non significant in going from H to L but significant going from L to H (t=-3.07, p=0.03, n=5). The thick arrows indicate an analogous pattern of anchoring effects when transitioning from the second to the third act of the sequence. Again, the decrease in *Match* rating was found to be non significant in going from H to L but the increase in *Match* rating going from L to H was significant (t=-3.45, p=0.02, n=5).

Refer to the cummulative distributions of successive *Match* ratings obtained in response to the H-L sequences, in the right half of figure 4.5. The disparity between the blue and pink lines in the top panel (distribution of *Match* ratings to H followed by L) is is significantly less than the disparity between the blue and pink lines in the center panel (distribution of *Match* ratings to L followed by H). Similarly, The disparity between the pink and yellow lines in the center panel (distribution of *Match* ratings to LH followed by L) is significantly less than the disparity between the pink and yellow lines in the bottom panel (distribution of *Match* ratings to LL followed by H).

These anchoring results indicate that the 3 acts were not being responded to independently of each other but that they were both individually and collectively influencing

subject ratings assigned to the *Match* script. This was the case in both sequences consisting of a combination of HIGH and MEDIUM acts as well as sequences consisting of a combination of HIGH and LOW acts.

Subsumption under the HIGH typicality act

The greater anchor strength provided by HIGH acts relative to MEDIUM or LOW acts combined with *Match* ratings that are biased towards the HIGH act suggest that the lower typicality acts were being subsumed under the HIGH act. This feature of the HIGH typicality act was found to be independent of sequential position of the HIGH act. The introduction of the HIGH act at the very end of the sequence led to *Match* ratings that were no different than ratings obtained when the sequence began with the HIGH act. It would appear that, subjects were both reluctant to discount information that was unambiguous as well as eager to discount information that *was* ambiguous. This suggests a preference for information that will allow the subject to form a strong belief rather than an accurate one.

4.4 Discussion of results and Implications

Asymmetric use of HIGH versus MEDIUM/LOW typicality acts: It was found that while determining script ratings in response to act sequences, subjects tended to rely on the one HIGH typicality act in the sequence rather than the greater number of MEDIUM or LOW acts. The bias towards the script suggested by the HIGH typicality act remained unaffected by the increase in the number of MEDIUM or LOW typicality acts that preceding the former. In experiment-2 it was found that a sequence made up entirely of MEDIUM typicality acts led to moderate ratings for both the *Match* and *Alt* scripts suggesting that MEDIUM acts tend to provide equal and moderate support both scripts. However, in the

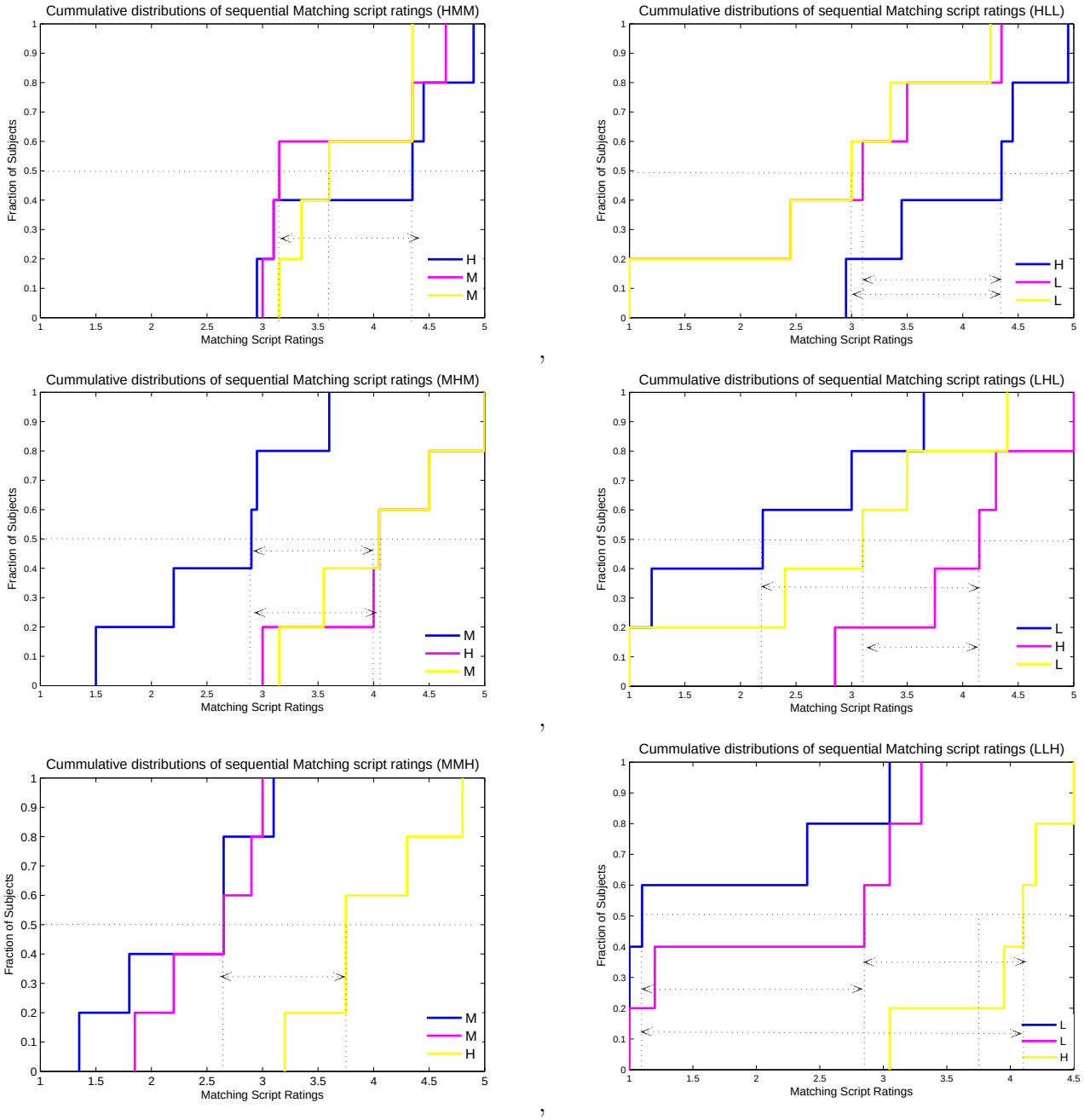

Figure 4.5: Cummulative distributions of successive ratings assigned to the matching script as the 3-act sequence unfolds. The left and right columns show the sequential updating of script ratings in response to the three types of H-M sequences and H-L sequences, respectively. Comparing the top-left and center-left panels we see that the H and the succeeding M distributions overlap significantly in the former but that the M and the succeeding H distributions are clearly separated in the latter. The difference in the medians was shown by a T- test to be significant only in the latter case. Comparing the center-left and bottom-left panels we see a similar pattern of rating distributions. The H (act 2) and the succeeding M (act 3) distributions in the former overlap while in the latter figure, we see a clear separation between the M (act 2) and the succeeding H (act 3) distributions. T tests showed that the medians were significantly different only in the latter case. The observed ratings pattern in the H and M conditions (left panel) were found in the H and L conditions (right panel) too.

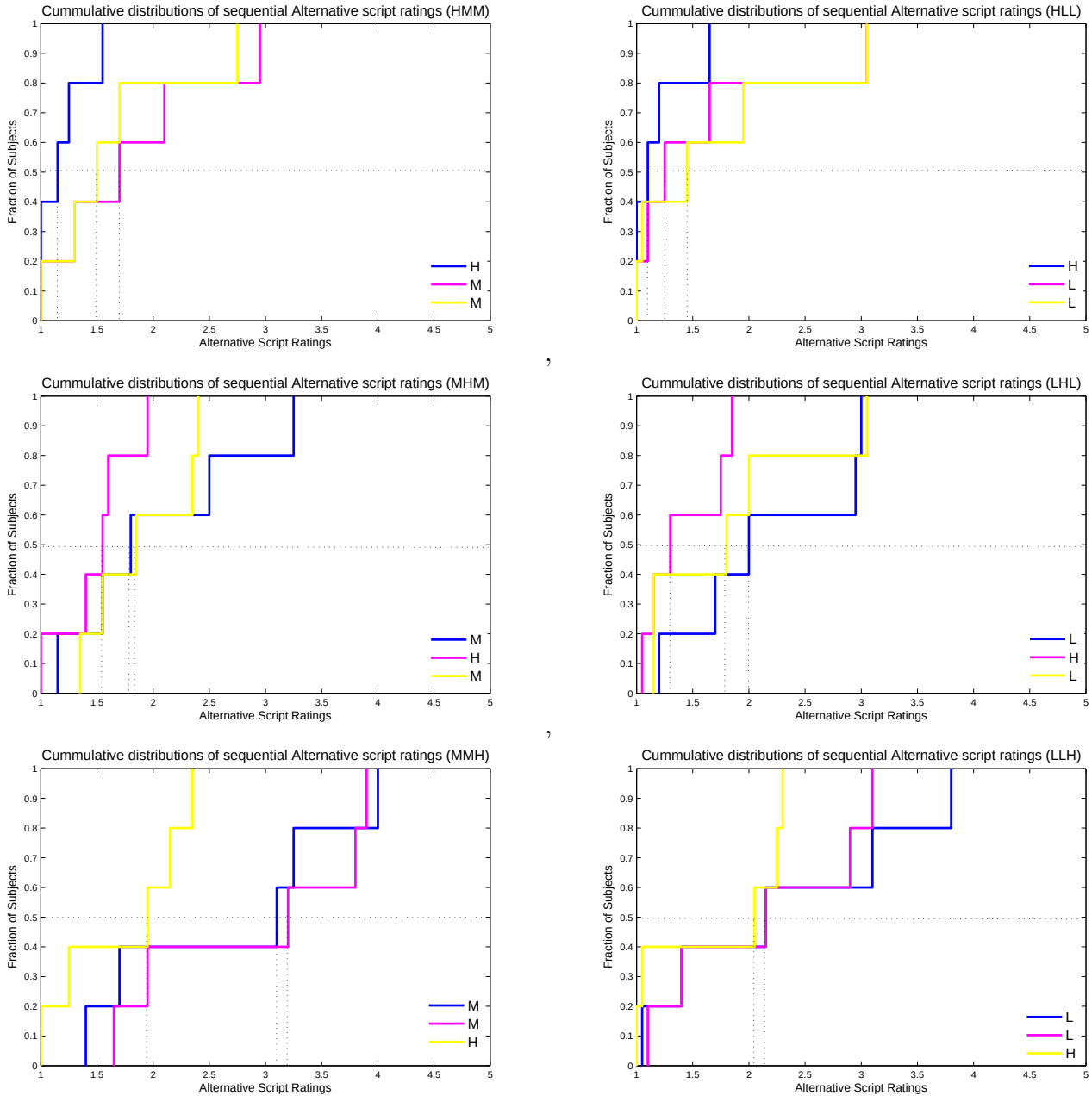

Figure 4.6: Cummulative distributions of successive ratings assigned to the matching script as the 3-act sequence unfolds. The left and right columns show the sequential updating of script ratings in response to the three types of H-M sequences and H-L sequences, respectively. The long horizontal line meets represents 50% of the subjects and intersects the distributions at points whose abscissae represent the medians of the corresponding distributions. The vertical line connect the distributions to the medians on the Ratings axis. These medians were not found to differ significantly.

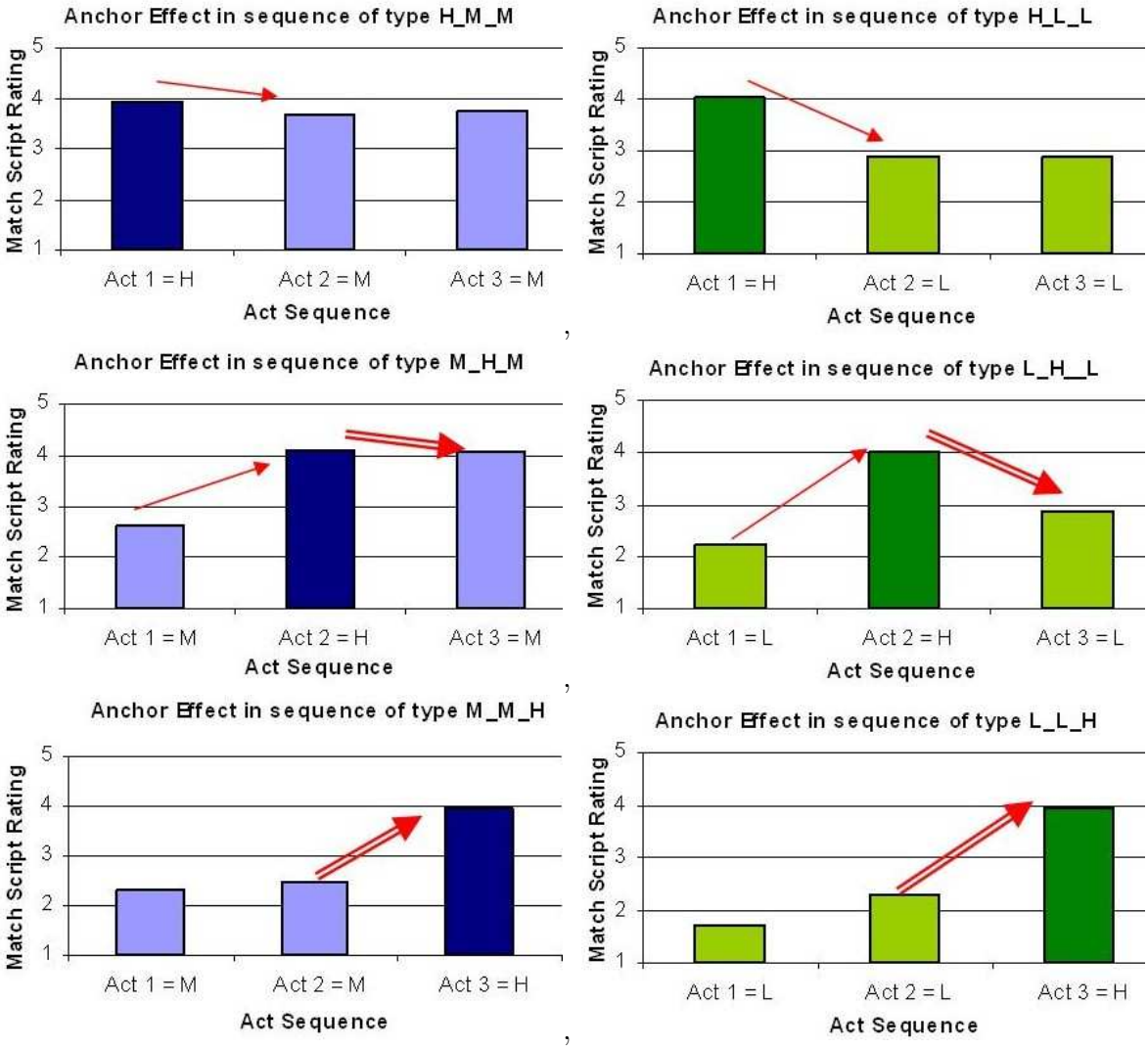

Figure 4.7: Ratings assigned to the matching script as the 3-act sequence unfolds. The left and right columns show the sequential updating of script ratings in response to the three types of H-M sequences and H-L sequences, respectively. The arrows indicate the extent of anchoring to the immediately preceding act in each case. Note that the drop in *Match* ratings going from H to M is less than the increase in *Match* ratings going from M to H. A similar but weaker effect is observed in the case of H-L sequences, in the right column.

present study subjects favored the *Match* script over the *Alt* script as if the H-M sequence were made up entirely of HIGH acts. Subjects appeared to be discounting the evidence provided by the 2 MEDIUM acts in the sequences and weighting the evidentiary support provided by the HIGH act, to a greater extent. These script preferences suggest that when presented with two kinds of information simultaneously, a) one that clearly points to a particular inference and b) another that makes a relatively weaker case for two separate inferences, subjects opt for the one unambiguous inference. It is to be remarked that in making this type of choice, subjects are in effect choosing to "ignore" the information that points to the alternative inference.

The bias towards the HIGH typicality act occurred even in the case of sequences that consisted of a greater number of LOW typicality act. Recall that, in experiment 2, sequences that were made up entirely of LOW typicality acts led to low ratings for both the *Match* and *Alt* scripts suggesting that LOW acts tend to support both scripts only weakly. However, in the present study subjects favored the *Match* script over the *Alt* script as if the H-L sequence were made up entirely of HIGH acts. In this case subjects appear to be discounting the LOW act, a type of information that does not lend itself to any kind of inference, as opposed to the MEDIUM act, which points to multiple inferences.

Thus it appears that observers can be induced to neglect to incorporate information if it is presented in conjunction with a sufficiently salient "distracter". Clearly observers do not have sufficient resources to explain and use all the data that is available for observation. The present study hints at the circumstances under which certain types of data will pass by unaccounted for by the observer. It might be interesting to obtain from subjects explanations of these discounted acts. For instance one might ask the question "If the agent's behavior suggests an inference corresponding to the *"Matching"* script, then why is this agent performing the two MEDIUM acts or the two LOW acts?" It would be

interesting to determine whether subjects classify these acts as "accidents", "the partial implementation of some other script(s) or merely idiosyncratic behaviors on the part of the agent, i.e., unexplainable acts.

Asymmetric Anchoring to HIGH typicality versus MEDIUM/LOW typicality acts: It was found that independent of the sequential position of the HIGH typicality act, a) script ratings in response to *the act following the HIGH act* (MEDIUM or LOW) *were biased* towards the ratings corresponding to the HIGH act but, b) script ratings in response to *the HIGH act following a MEDIUM/LOW act were not biased* towards the ratings corresponding to the MEDIUM/LOW act. The strong anchoring to the HIGH typicality act and the absence of anchoring to the MEDIUM or LOW typicality act suggests that acts that are highly informative in terms of the script they suggest, speak not only for themselves but also influence the weight given to acts that are less informative. In the previous section it was pointed out that subjects were discounting the script related evidence provided by MEDIUM and LOW acts. The asymmetric anchoring effect suggests that this discounting occurs *because* of the presence of the HIGH act. This conclusion is also supported by the observation that in experiment-2, MEDIUM act sequences led to moderate ratings for the *Alt* script, unlike the low ratings given to *Alt* in the current study.

The results obtained from the three experiments described so far, have implications for the manner in which the communicative goals of an agent might interact with the inferences drawn by an observer. The agent might be concerned with either the process by which the observer reasons or the results of the inferential process. These issues will be discussed in the following chapter along with directions for future research.

Chapter 5

Implications and Future Directions

5.1 Use of typicality to manipulate observer inferences

In the domain of plans where there is an actor and an observer, the "actor" is typically the executor of a plan, the agent under observation. However, the term may also refer to one who is describing the behavior of another individual. Examples of the latter include eye witnesses, lawyers who present the events surrounding their clients and news reporters. The communicative goals of an actor could relate either to the the process of observation or the outcome of this process. The manner in which behaviors are executed can determine not only the particular goal inferred but more generally the mental state of the observer. The observed behavior may induce a state of increased uncertainty causing the observer to view the environment or the agent as less predictable than either might actually be. This may cause the observer to consider a greater number of alternative explanations for the agent's behavior. This tendency is often exploited by lawyers who wish to draw their jury away from a guilty verdict towards one of "reasonable doubt". A further outcome of this state of doubt may be an increasing disinclination to commit to a particular inference

when faced with future behaviors.

The process of observation, like the end product, may be manipulated by the agent whose goal may be to engage the observer in extensive deliberation so as to reduce his/her mental resources required to process behaviors at a later time. The actor's attempt to "wear the observer down" via ambiguous behaviors, that appear to be "going nowhere", might be associated with the desire to cause a loss of interest in the agent. Alternatively, the agent might exhibit these resource consuming behaviors in order to distract the observer from other agents or events in the vicinity.

The various results obtained in experiments 2 and 3 regarding the impact of typicality on script inferences as well as reading and response times suggest several implications for the way in which the agent might exercise control over the observer's mental state.

1. In experiment-2, it was found that a HIGH typicality sequence provided unequivocal support for the corresponding script. The act read times gradually decreased as the sequence progressed owing to the ease of subsumption of later acts under the first act. This type of sequence also led to the shortest response times. Therefore an agent who wishes to convey a particular script would have to simply present the observer with a sequence of HIGH typicality acts from that script. However, if the agent wishes the observer to infer this particular script without committing to the corresponding plan, then experiment-3 suggests that the agent could execute a sequence of acts of which only *one* need be a HIGH typicality act.

2. While the observer could be induced to infer a particular script through the inclusion of a single HIGH typicality act in the unfolding sequence, the status of the remaining acts with respect to this script, might be be expected to offer the agent additional means of influencing the observer's mental state. These remaining acts could be of MEDIUM or LOW typicality. Experiment-2 showed that HOMogeneous act sequences lead to script

preferences identical to those obtained in response to HETerogenous sequences. Therefore, choosing MEDIUM/LOW typicality acts that belong to the same scene would presumably reduce the investment required of the agent. If the agent's goal is to convince the observer of a particular script with the least amount of effort, then the HIGH act as well as the MEDIUM/LOW acts could all be derived from a single scene. For example, the script "preparing for travel" could be induced via a sequence of acts such *"placing clothes into a suitcase", "sorting these clothes by fabric", "further sorting by color", "refolding clothes to improve their fit in the suitcase"*.

3. Experiment-2 showed that MEDIUM typicality sequences were perceived to provide equal but weaker support for both the *matching* and *alternative* scripts. Further, act read times did not drop as the sequence progressed and tended to be higher that that of HIGH typicality sequences. The response times associated with determining script preferences were greater relative to HIGH typicality sequences. These features of MEDIUM typicality sequences suggest that these sequences would be appropriate for the purpose of inducing a state of uncertainty in the observer as well as increasing time spent interpreting the agent's actions. It is of interest to determine how a period of exposure to these ambiguous acts involving effortful processing, would affect the observer's responses to acts of a new script. It could happen that the state of uncertainty carries over causing the observer to be cautious in drawing inferences even when presented with HIGH typicality acts, leading to a "spontaneous" consideration of alternative scripts. This effect might be expected to depend on the extent of "exposure" to acts that lend themselves to multiple interpretations.

5.2 Future Directions

The present set of studies may be extended to address the following questions:

1. Would read times of homogeneous sequences reflect an awareness of scene boundaries if acts in a sequence were displayed for a predetermined duration rather than at the subject's own pace?

2. Would the anchoring to HIGH typicality acts and the corresponding tendency to leave MEDIUM and LOW acts "unexplained" be offset by a) specifically asking for the latter to be explained or b) drawing attention to these acts by increasing their number?

In the context of speech acts, the means by which events are typically communicated, the agent can choose to omit certain events such as in everyday discourse or during the reporting of events by news agents. In other situations, the agent might not have this option available. For instance, a lawyer attempting to persuade the judge/jury of his/her client's innocence, must do so while incorporating all available evidence, even when a portion of this evidence suggests otherwise. In terms of the present set of studies, this situation would be analogous to the interleaving of a combination of acts, some highly typical of Script-A, others highly typical of Script-B. One can therefore ask the following questions:

1. Given a sequence of acts some highly typical of Script-A, other highly typical of Script-B, what are the factors that would cause the observer to favor one script over the other?

2. Given acts derived from a pair of opposing scripts that lead to orthogonal conclusions such as "guilty" and "innocent", would the observer assign a greater weight to some of the acts in order to arrive at a resolution? If so, what might be the factors that determine the weights assigned?

3. Given an act sequence supporting 2 scripts equally strongly what are the kinds of disambiguating questions that the subject might ask and would these be characterizable as reasoning biases?

Chapter 6

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Chapter 7

Appendix 1: Stimuli used in Experiment1

Scenario = BEACH, Script Header = "Getting ready for a day at the beach"	
Scene Header	**Act**
Taking preventive measures	*John obtains swimwear* *John buys sunblock* *John watches program on sea pollution* *John buys dark glasses* *John borrows umbrella*
Preparing breakfast	*John makes coffee* *John bakes apples* *John scrambles eggs*
Getting car ready	*John fills car with gas* *John wipes windshield* *John checks air in car tyres*
Attending to pet	*John feeds dog* *John grooms dog* *John walks dog*
Getting dressed	*John showers* *John polishes shoes* *John presses shirt*
Grooming oneself	*John combs hair* *John gets a manicure* *John applies sunblock*
Preparing picnic basket	*John gets bottles of water* *John makes sandwiches* *John packs porcelain plates* *John packs candles* *John collects paper napkins* *John buys breath mints* *John borrows novel from library*

Table 7.1: Scenes and acts corresponding to the BEACH scenario

Scenario = SCHOOL, Script Header = "Getting ready for a day at school"	
Scene Header	**Act**
Working on assignments	*John does math homework* *John completes lecture notes* *John visits museum of anthropology* *John watches program on deforestation* *John collects insect samples* *John goes over previous days notes*
Preparing school bag	*John places pencil case in bag* *John puts notebook in bag* *John puts video camera in bag* *John puts lunch box in bag* *John places towel in bag* *John puts novel in bag*
Preparing breakfast	*John makes coffee* *John bakes apples* *John scrambles eggs*
Attending to pet	*John feeds dog* *John grooms dog* *John walks dog*
Getting dressed	*John showers* *John polishes shoes* *John presses shirt*
Grooming oneself	*John combs hair* *John gets a manicure* *John applies sunblock*

Table 7.2: Scenes and acts corresponding to the SCHOOL scenario

Scenario = COUNTRY, Script Header = "Preparing to move to a different country"	
Scene Header	**Act**
Canceling paper subscription	John calls to cancels newspaper subscription John informs neighbor of newspaper cancellation *John leaves note about newspaper cancellation on door*
Learning about new place	John watches travelogue John watches foreign movies *John buys a language learning CD*
Packing	John buys suitcases John packs photographs of family and friends *John obtains camera* John packs work folder John buys clothes *John packs medicines*
Attending to pet	John leaves dogs with pet sitter John walks dogs John feeds dogs
Preparing to sell house	John makes copies of ownership papers of house John advertises house for sale John redecorates house John hires landscape gardner John invites people to look at house John paints house
Meeting people	John calls up all his friends John resigns from job John has dinner with boss John buys gift for boss John buys gifts for nieces and nephews John meets with office colleagues John visits parents

Table 7.3: Scenes and acts corresponding to the COUNTRY scenario

Scenario = VACATION Script Header = "Preparing for vacation"	
Scene Header	**Act**
Canceling paper subscription	John calls to cancels newspaper subscription John informs neighbor of newspaper cancellation *John leaves note about newspaper cancellation on door*
Learning about new place	John watches travelogue John watches foreign movies *John buys a language learning CD*
Packing	John buys suitcases John packs clothes John packs work folder John packs family photograph *John obtains camera* *John packs medicines*
Attending to pet	John leaves dogs with pet sitter John walks dogs John feeds dogs
Making house safe	John turns off cooking gas John activates burglar alarm John turns off main electric supply John locks garage door John turns off lights John locks back door
Preparing to ski	John buys a pair of skis John hires an olympics ski instructor John orders a pair of designer ski glasses

Table 7.4: Scenes and acts corresponding to the VACATION scenario

Chapter 8

Appendix 2: Stimuli used in Experiment 2

BEACH, HET, high		
John gets bottles of water, John buys sunblock, John obtains swimwear, John applies sunblock	4.5	2
John obtains swimwear, John buys dark glasses, John applies sunblock, John makes sandwiches	4.25	1.75
John makes sandwiches, John buys sunblock, John buys dark glasses, John gets bottles of water	4	2.25
John buys sunblock, John gets bottles of water, John makes sandwiches, John applies sunblock	4.25	2.5
BEACH, HET, medium		
John walks dog, John showers, John combs hair, John fills car with gas	2.875	4
John combs hair, John collects paper napkins, John feeds dog, John borrows novel from library	2.75	2.75
John collects paper napkins, John walks dog, John combs hair, John fills car with gas	2.625	3
John showers, John feeds dog, John borrows novel from library, John fills car with gas	3	3.25
BEACH, HET, low		
John packs candles, John grooms dog, John polishes shoes, John bakes apples	1	1.5
John packs porcelain plates, John gets a manicure, John scrambles eggs, John presses shirt	1.5	1.5
John grooms dog, John watches program on sea pollution, John makes coffee, John checks air in car tyres	1.75	1.5
John gets a manicure, John bakes apples, John wipes windshield, John watches program on sea pollution	1.5	1.5
BEACH, HOM, high		
John gets bottles of water, John makes sandwiches, John obtains swimwear, John buys dark glasses	3.875	2
John obtains swimwear, John buys sunblock, John gets bottles of water, John makes sandwiches	4.125	2.25
John makes sandwiches, John gets bottles of water, John buys dark glasses, John buys sunblock	4	2.25
John buys sunblock, John obtains swimwear, John makes sandwiches, John gets bottles of water	4.125	2.25
BEACH, HOM, low		
John packs candles, John packs porcelain plates, John polishes shoes, John presses shirt	1.25	1.5
John bakes apples, John scrambles eggs, John collects paper napkins, John buys breath mints	1.75	1.5
John scrambles eggs, John makes coffee, John wipes windshield, John checks air in car tyres	2	2
John wipes windshield, John checks air in car tyres, John presses shirt, John polishes shoes	1.75	1.75

Table 8.1: BEACH: HETerogeneous and HOMogeneous act sequences and their average typicalities with respect to the *matching* BEACH and *alternative* SCHOOL scenarios

SCHOOL, HET, high		
John puts notebook in bag, John goes over previous days notes, John makes coffee, John combs hair	4.75	1.75
John does math homework, John places pencil case in bag, John showers, John makes coffee	4.25	1.75
John combs hair, John makes coffee, John puts lunch box in bag, John completes lecture notes	4.5	2.75
John scrambles eggs, John showers, John does math homework, John puts notebook in bag	4.25	2
SCHOOL, HET, medium		
John presses shirt, John puts novel in bag, John feeds dog, John watches program on deforestation	3.38	2.25
John puts novel in bag, John polishes shoes, John watches program on deforestation , John walks dog	3.25	2
John feeds dog, John watches program on deforestation , John presses shirt, John puts novel in bag	3.38	2.25
John watches program on deforestation , John walks dog, John puts novel in bag, John polishes shoes	3.25	2
SCHOOL, HET, low		
John bakes apples, John grooms dog, John gets a manicure, John visits museum of anthropology	1.38	1.25
John applies sunblock, John places towel in bag, John collects insect samples, John bakes apples	1.63	2.5
John puts video camera in bag, John visits museum of anthropology, John bakes apples, John grooms dog	1.5	1.75
John collects insect samples, John gets a manicure, John grooms dog, John bakes apples	1.375	1.25
SCHOOL, HOM, high		
John puts notebook in bag, John places pencil case in bag, John makes coffee, John scrambles eggs	4.5	1.25
John does math homework, John goes over previous days notes, John scrambles eggs, John makes coffee	4.25	1.25
John puts lunch box in bag, John places pencil case in bag, John completes lecture notes, John does math homework	4.5	2
John completes lecture notes, John goes over previous days notes, John makes coffee, John scrambles eggs	4.25	1.25
SCHOOL, HOM, medium		
John polishes shoes, John presses shirt, John feeds dog, John walks dog	3.13	1.75
John feeds dog, John walks dog, John polishes shoes, John presses shirt	3.13	1.75
John presses shirt, John polishes shoes, John walks dog, John feeds dog	3.13	1.75
John walks dog, John feeds dog, John presses shirt, John polishes shoes	3.13	1.75
SCHOOL, HOM, low		
John gets a manicure, John applies sunblock, John visits museum of anthropology, John collects insect samples	1.75	1.25
John puts video camera in bag, John places towel in bag, John applies sunblock, John gets a manicure	1.75	2.75
John visits museum of anthropology, John collects insect samples, John puts video camera in bag, John places towel in bag	2	2.5
John gets a manicure, John applies sunblock, John collects insect samples, John visits museum of anthropology	1.75	1.25

Table 8.2: SCHOOL: HETerogeneous and HOMogeneous act sequences and their average typicalities with respect to the *matching* SCHOOL and *alternative* BEACH scenarios

COUNTRY, HET, high		
John packs photographs of family and friends, John advertises house for sale, John watches travelogue, John resigns from job	3.75	2.25
John calls to cancels newspaper subscription, John buys suitcases, John advertises house for sale, John buys a language learning CD	4.25	3
John advertises house for sale, John resigns from job, John calls to cancels newspaper subscription, John packs photographs of family and friends	3.75	2
John buys a language learning CD, John advertises house for sale, John resigns from job, John calls to cancels newspaper subscription	4.25	2.5
COUNTRY, HET, medium		
John paints house, John buys clothes , John buys gift for boss, John leaves note about newspaper cancellation on door	2.75	2.25
John visits parents, John packs medicines, John leaves note about newspaper cancellation on door, John paints house	2.875	3
John leaves note about newspaper cancellation on door, John visits parents, John paints house, John buys clothes	2.875	2.75
John obtains camera, John paints house, John leaves note about newspaper cancellation on door, John buys gift for boss	2.75	2
COUNTRY, HET, low		
John walks dogs , John hires landscape gardner, John has dinner with boss, John watches foreign movies	1.875	2.25
John meets with office colleagues, John watches foreign movies, John redecorates house, John feeds dogs	2	2.75
John hires landscape gardner, John leaves dogs with pet sitter, John watches foreign movies, John buys gifts for nieces and nephews	2.125	3.25
John watches foreign movies, John has dinner with boss, John walks dogs , John hires landscape gardner	1.875	2.25
COUNTRY, HOM, high		
John buys suitcases, John packs photographs of family and friends, John watches travelogue, John buys a language learning CD	3.875	3.25
John watches travelogue, John buys a language learning CD, John advertises house for sale, John invites people to look at house	4.25	2.25
John advertises house for sale, John invites people to look at house, John buys suitcases, John packs photographs of family and friends	3.875	2
John advertises house for sale, John invites people to look at house, John watches travelogue, John buys a language learning CD	4.25	2.25
COUNTRY, HOM, medium		
John obtains camera, John buys clothes , John buys gift for boss, John visits parents	2.875	2.25
John buys gift for boss, John visits parents, John packs photographs of family and friends, John obtains camera	2.875	2.75
John leaves note about newspaper cancellation on door, John informs neighbor of newspaper cancellation, John buys gift for boss, John visits parents	2.75	2.5
John obtains camera, John buys clothes , John leaves note about newspaper cancellation on door, John informs neighbor of newspaper cancellation	2.875	2.75
COUNTRY, HOM, low		
John walks dogs , John feeds dogs, John hires landscape gardner, John redecorates house	1.625	2.25
John redecorates house, John hires landscape gardner, John has dinner with boss, John meets with office colleagues	2	2.25
John has dinner with boss, John meets with office colleagues, John walks dogs , John leaves dogs with pet sitter	1.75	3.25
John feeds dogs, John leaves dogs with pet sitter, John buys gifts for nieces and nephews, John has dinner with boss	1.875	3.25

Table 8.3: COUNTRY: HETerogeneous and HOMogeneous act sequences and their average typicalities with respect to the *matching* COUNTRY and *alternative* VACATION scenarios.

VACATION, HET, high		
John watches travelogue, John buys a pair of skis, John packs clothes , John leaves dogs with pet sitter	4.375	3.625
John buys suitcases, John buys a language learning CD, John obtains camera, John activates burglar alarm	3.875	4.5
John orders a pair of designer ski glasses, John leaves dogs with pet sitter, John packs clothes , John activates burglar alarm	4.25	3.75
John buys suitcases, John watches travelogue, John leaves dogs with pet sitter, John activates burglar alarm	4.25	4.375
VACATION, HET, medium		
John turns off cooking gas, John calls to cancels newspaper subscription, John packs medicines, John locks back door	3.125	4
John leaves note about newspaper cancellation on door, John packs medicines, John turns off cooking gas, John locks back door	3.125	4
John informs neighbor of newspaper cancellation, John packs medicines, John turns off main electric supply, John locks back door	3.5	3.5
John packs medicines, John leaves note about newspaper cancellation on door, John turns off cooking gas, John turns off main electric supply	3.125	4.25
VACATION, HET, low		
John walks dogs , John packs work folder, John watches foreign movies, John hires an olympics ski instructor	2.125	2.5
John watches foreign movies, John hires an olympics ski instructor, John feeds dogs, John packs family photograph	2.125	2.5
John hires an olympics ski instructor, John watches foreign movies, John packs work folder, John walks dogs	2.125	2.5
John watches foreign movies, John hires an olympics ski instructor, John feeds dogs, John packs family photograph	2.125	2.5
VACATION, HOM, high		
John buys a language learning CD, John watches travelogue, John activates burglar alarm, John locks garage door	3.625	3.5
John orders a pair of designer ski glasses, John buys a pair of skis, John buys suitcases, John packs clothes	4.5	3.25
John orders a pair of designer ski glasses, John buys a pair of skis, John buys a language learning CD, John watches travelogue	3.75	3
John buys suitcases, John packs clothes , John activates burglar alarm, John locks garage door	4.375	3.75
VACATION, HOM, medium		
John turns off cooking gas, John turns off main electric supply, John calls to cancels newspaper subscription, John leaves note about newspaper cancellation on door	3.125	4.5
John leaves note about newspaper cancellation on door, John informs neighbor of newspaper cancellation, John turns off cooking gas, John turns off main electric supply	3.375	4
John calls to cancels newspaper subscription, John informs neighbor of newspaper cancellation, John turns off main electric supply, John locks back door	3.375	3.75
John turns off main electric supply, John turns off cooking gas, John calls to cancels newspaper subscription, John leaves note about newspaper cancellation on door	3.125	4.5
VACATION, HOM, low		
John walks dogs , John feeds dogs, John packs work folder, John packs family photograph	2	3
John packs work folder, John packs family photograph, John walks dogs , John feeds dogs	2	3
John feeds dogs, John walks dogs , John packs family photograph, John packs work folder	2	3
John packs family photograph, John packs work folder, John feeds dogs, John walks dogs	2	3

Table 8.4: VACATION: HETerogeneous and HOMogeneous act sequences and their average typicalities with respect to the *matching* VACATION and *alternative* COUNTRY scenarios.

Chapter 9

Appendix 3: Stimuli used in Experiment 3

BEACH SCENARIO		
Sequence Type	**Act-1, Act-2, Act-3**	**Typicalities**
HMM1	John applies sunblock, John showers, John borrows novel from library	**4.6 2.9 3.2**
MHM1	Bill borrows novel from library, Bill applies sunblock, Bill showers	**3.2 4.6 2.9**
MMH1	Fred showers , Fred borrows novel from library, Fred applies sunblock	**2.9 3.2 4.6**
HMM2	Dave obtains swimwear , Dave showers , Dave feeds dog	**4.5 2.9 2.8**
MHM2	John feeds dog , John obtains swimwear , John showers	**2.8 4.5 2.9**
MMH2	Bill showers , Bill feeds dog , Bill obtains swimwear	**2.9 2.8 4.5**
HLL1	Fred applies sunblock , Fred packs porcelain plates , Fred bakes apples	**4.6 1.2 1.6**
LHL1	Dave bakes apples , Dave applies sunblock , Dave packs porcelain plates	**1.6 4.6 1.2**
LLH1	John packs porcelain plates , John bakes apples , John applies sunblock	**1.2 1.6 4.6**
HLL2	Bill obtains swimwear , Bill polishes shoes , Bill grooms dog	**4.5 1.4 1.4**
LHL2	Fred grooms dog , Fred obtains swimwear , Fred polishes shoes	**1.4 4.5 1.4**
LLH2	Dave polishes shoes , Dave grooms dog , Dave obtains swimwear	**1.4 1.4 4.5**

Table 9.1: 3 act sequences consisting of 1 HIGH typicality act and either 2 MEDIUM acts or 2 LOW acts, and their typicalities with respect to the BEACH script: "getting ready for a day at the beach".

SCHOOL SCENARIO		
Sequence Type	**Act-1, Act-2, Act-3**	**Typicalities**
HMM1	*John puts notebook in bag* , John feeds dog , John polishes shoes	**4.6 3.3 3.1**
MHM1	Bill polishes shoes, *Bill puts notebook in bag*, Bill feeds dog	**3.1 4.6 3.3**
MMH1	Fred feeds dog , Fred polishes shoes , *Fred puts notebook in bag*	**3.3 3.1 4.6**
HMM2	*Dave places pencil case in bag* , Dave walks dog , *Dave presses shirt*	**4.5 2.8 3.2**
MHM2	*John presses shirt* , *John places pencil case in bag* , John walks dog	**3.2 4.5 2.8**
MMH2	Bill walks dog , *Bill presses shirt* , *Bill places pencil case in bag*	**2.8 3.2 4.5**
HLL1	*Fred puts notebook in bag*, Fred bakes apples , Fred grooms dog	**4.6 1.4 1.5**
LHL1	Dave grooms dog , *Dave puts notebook in bag* , Dave bakes apples	**1.5 4.6 1.4**
LLH1	John bakes apples , John grooms dog , *John puts notebook in bag*	**1.4 1.5 4.6**
HLL2	*Bill places pencil case in bag*, Bill gets a manicure, Bill visits museum of anthropology	**4.5 1.5 1.8**
LHL2	Fred visits museum of anthropology, *Fred places pencil case in bag*, Fred gets a manicure	**1.8 4.5 1.5**
LLH2	Dave gets a manicure, Dave visits museum of anthropology, *Dave places pencil case in bag*	**1.5 1.8 4.5**

Table 9.2: 3 act sequences consisting of 1 HIGH typicality act and either 2 MEDIUM acts or 2 LOW acts, and their typicalities with respect to the SCHOOL script: "getting ready for a day at school".

VACATION SCENARIO		
Sequence Type	**Act-1, Act-2, Act-3**	**Typicalities**
HMM1	John buys a pair of skis, John turns off main electric supply, John calls to cancels newspaper subscription	4 3.1 3.2
MHM1	Bill calls to cancels newspaper subscription, Bill buys a pair of skis, Bill turns off main electric supply	3.2 4 3.1
MMH1	Fred turns off main electric supply, Fred calls to cancels newspaper subscription, Fred buys a pair of skis	3.1 3.2 4
HMM2	Dave leaves dogs with pet sitter, Dave turns off cooking gas, *Dave leaves note about newspaper cancelation on door*	4.3 2.9 3.4
MHM2	*John leaves note about newspaper cancelation on door*, John leaves dogs with pet sitter, John turns off cooking gas	3.4 4.3 2.9
MMH2	Bill turns off cooking gas, *Bill leaves note about newspaper cancelation on door*, Bill leaves dogs with pet sitter	2.9 3.4 4.3
HLL1	Fred buys a pair of skis, Fred walks dogs, Fred watches foreign movies	4 1.3 2.2
LHL1	Dave watches foreign movies, Dave buys a pair of skis, Dave walks dogs	2.2 4 1.3
LLH1	John walks dogs, John watches foreign movies, John buys a pair of skis	1.3 2.2 4
HLL2	Bill leaves dogs with pet sitter, Bill packs work folder, Bill watches foreign movies	4.3 1.9 2.2
LHL2	Fred watches foreign movies, Fred leaves dogs with pet sitter, Fred packs work folder	2.2 4.3 1.9
LLH2	Dave packs work folder, Dave watches foreign movies, Dave leaves dogs with pet sitter	1.9 2.2 4.3

Table 9.3: 3 act sequences consisting of 1 HIGH typicality act and either 2 MEDIUM acts or 2 LOW acts, and their typicalities with respect to the VACATION script: "preparing for vacation".

COUNTRY SCENARIO		
Sequence Type	**Act-1, Act-2, Act-3**	**Typicalities**
HMM1	*John buys a language learning CD*, John buys clothes, John buys gift for boss	4.4 2.8 2.8
MHM1	Bill buys gift for boss, *Bill buys a language learning CD*, Bill buys clothes	2.8 4.4 2.8
MMH1	Fred buys clothes, Fred buys gift for boss, *Fred buys a language learning CD*	2.8 2.8 4.4
HMM2	Dave advertises house for sale, Dave visits parents, Dave packs work folder	4.2 3.3 2.5
MHM2	John packs work folder, John advertises house for sale, John visits parents	2.5 4.2 3.3
MMH2	Bill visits parents, Bill packs work folder, Bill advertises house for sale	3.3 2.5 4.2
HLL1	*Fred buys a language learning CD*, Fred feeds dogs, Fred hires landscape gardener	4.4 1.5 1.8
LHL1	Dave hires landscape gardener, *Dave buys a language learning CD*, Dave feeds dogs	1.8 4.4 1.5
LLH1	John feeds dogs, John hires landscape gardener, *John buys a language learning CD*	1.5 1.8 4.4
HLL2	Bill advertises house for sale, Bill walks dogs, Bill has dinner with boss	4.2 1.4 2.2
LHL2	Fred has dinner with boss, Fred advertises house for sale, Fred walks dogs	2.2 4.2 1.4
LLH2	Dave walks dogs, Dave has dinner with boss, Dave advertises house for sale	1.4 2.2 4.2

Table 9.4: 3 act sequences consisting of 1 HIGH typicality act and either 2 MEDIUM acts or 2 LOW acts, and their typicalities with respect to the COUNTRY script: "preparing to move to a different country".

Curriculum Vita

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