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Semantic Influences on Ordering Tasks

Introduction

Moeser[1] reports that learning partial ordering[2] structures seems more difficult than learning linear ordering[3] structures when participants are presented with 14-term ordering tasks. The authors' preferred explanation for this phenomenon was that participants do not have a prototype or rule representing comparative relations in partial ordering structures.[4] This seems *prima facie* plausible when considering the apparent frequency of such orderings in daily life, e.g. ranking gas stations for competing gas prices, comparing vehicle horsepower, etc. and the apparent infrequency of exposure to quotidian partial orderings. Such motivation is, however, too quick. Partial orderings too seem rather common in daily life as exhibited by various relations, e.g. 'is covered by', 'is ancestor of'. Indeed, it is not at all clear how to compare frequency of exposure, and so not at all clear whether such observations are in favor of or in conflict with Moeser's claims.

There are further issues. These authors' results are themselves complicated by the fact that the studies employed examining ordering acquisition used the '<' relation to illustrate both linear and partial ordering tasks, since 'greater than' is a relation exhibiting linear order properties, and this is plausibly encoded in the semantic content of the relation as understood by English speakers. It is thus plausible when presented with a memory test of the order of 14 terms, participants would be unable to remember each precise relation introduced in the study, and would then reach for whatever information is available to complete the task. 'Greater than' encoding a linear order is just

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1 (Moeser, 1979).

2 The order discussed in Moeser's paper is, more specifically, a *strict* partial order, i.e. irreflexive (no xRx) and transitive. This is to be distinguished from *non-strict* partial order, i.e. reflexive (xRx), antisymmetric, transitive.

3 Linear orders are antisymmetric (if xRy and yRx then x=y), transitive (if xRy and yRz then xRz), and connected (either xRy or yRx)

4 The authors also claimed when partial ordering structures are presented so that some adjacent elements do not lack common elements, participants had an easier time learning partial ordering structures. Indeed, when these factors are controlled, it seems participants have as easy a time learning partial orders as linear orders. We do not focus on this second claim in what follows.

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such additional information. This complication is, indeed, magnified by the fact that Moeser in the same study demonstrated that participants could be primed to employ partial ordering structures just as easily as they can be primed to employ linear ordering structures. But if participants can be primed to employ either structure and 'greater than' carries with it semantic content representing linear structure, then it seems plausible that the very use of the relation in the study might prime participants towards ordering items in line with a linear structure. Additionally, given the fact that Moeser allowed participants to repeat whatever task they were given – either construct a linear or construct a partial order – it is plausible improvements observed which weighed heavily towards participants becoming better at ordering items in a way that aligns with a linear structure, were in fact due to the very priming effects Moeser observed. What Moeser appeared to overlook was the possibility that priming might stem from the 'greater than' relation itself.

In what follows we examine Moeser's results to determine the extent to which they support the claim that participants employ a prototype or rule for linear ordering by default. The pair of experiments that follow are complemented by another pair which add weight to the results herein. A summary of those experiments and the results are thus in order. In the first experiment of the pair, relations like 'ancestor of' and 'is covered by' – which both exhibit partial ordering – were substituted into Moeser's original experiments for 'greater than' to determine whether the semantic content of these relations influenced participant ordering results. The results of this experiment were that introducing these partial ordering relations to the study diminishes the discrepancy between participant success at constructing linear and partial orders. This suggests that when participants use partial ordering relations in these tasks, they have an easier time constructing partial relations. That said, participants nevertheless appeared to have an easier time constructing linear orderings even with relations like 'ancestor of' and 'is covered by.' In other words, introducing these partial order relations to the original study was insufficient to undermine Moeser's proposed explanation. A

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second experiment, however, strongly suggested there was at least some influence from semantic content in Moeser's original results. In this second experiment, Moeser's original experiments were run with nonsense relations - '*' and '#' – each replacing 'greater than' resulting in near equal success in constructing partial or linear orderings. These results seem to indicate that Moeser's conclusion cannot be correct. Participants using nonsense relations seem no better at constructing one structure rather than another, under such conditions.

The pair of experiments to follow pick up this thread by exploring in more detail Moeser's strategy for priming participants to think of linear or partial orderings. These studies aim to supplement the previous two in illustrating how priming with partial orders conflicts with participant construction of linear orders while supporting construction of partial orders, while priming with linear orders conflicts with participant construction of partial orders while supporting construction of linear orders. In our first experiment, we show there is indeed friction when participants are primed by one order and asked to construct another. These results are consistent with the absence of any obvious differences in participant ability to construct either partial or linear orders when employing nonsense relations like '*' and '#'. Simply put, since there is no semantic content with respect to these symbols, we should not expect there to be any conflict between semantic content and construction task. Unfortunately, our first experiment is not entirely convincing, since participants nevertheless appear to have an easier time constructing linear orders when primed to think of linear orders, than when constructing partial orders when primed with partial orders. Moeser might respond to this discrepancy by claiming a linear order prototype exists that is supported by linear order priming but conflicts with partial order priming.

Our second experiment attempts to rule out this explanation. We focus on the possibility that *the priming exercises given by Moeser and in our first experiment* may themselves somehow prime participants into thinking of linear orders, even when the priming exercises are designed to prime for

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partial orders. In this second experiment, participants were provided priming exercises that eliminated all but the formal properties of the relevant order which was to be primed, and replaced examples such as 'shorter than' with nonsense symbols such as '#'. Running Moeser's experiment again replacing the 'greater than' relation with '*' resulted in participants having just as much difficulty constructing linear orders as they did partial orders, when primed accordingly. In other words, the factor of the previous experiment results that left it open to Moeser's explanation, vanished once the preliminary tests were excised of potentially problematic semantic content. These results strongly suggest Moeser's claim to the existence of a prototype for linear orders is false, since otherwise we should expect discrepancy in this second experiment between the linear and partial order conditions.

Altogether: Moeser suggested participants default to linear ordering elements but they can be primed to impose either linear or partial ordering. This study seems problematic insofar as 'greater than' might be understood to incline participants to favor linear orderings. Recent follow-up studies strongly suggest participants do not default to linear ordering. It seems plausible, moreover, that the observed priming effect is far more pervasive than Moeser countenanced. The present work explores the extent to which priming for linear or partial orders conflicts with the construction of linear or partial ordering lists. Our two experiments suggest friction between priming and task, and also show once the priming tasks are cleared of potentially confounding semantic content, participants perform equally with respect to constructing linear or partial orders under similar priming conditions.

Experiment 1: Linear/Partial Order Priming and Nonsense Relations

Participants

Experiment 1 recruited 20 participants from Amazon's Mechanical Turk (Mturk) and presented each with one of the two ordering tasks below. Each participant had at least a 98% approval rating on at

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least 5000 tasks from Mturk and was paid $1.00 for their work. No participant was allowed to complete the task twice, and no participant was allowed to complete more than one experiment.

Method

Experiment 1 consisted of five phases. Participants evenly divided into two groups. During the first phase, 10 participants were primed to think of linear ordering while 10 were primed to think of partial ordering. During the second phase, members of the group primed to think of partial ordering were further divided into groups of 5, one of which was presented with a partially ordered list, and the other a linearly ordered list. Similarly, during the second phase, members of the group primed to think of linear ordering were further divided into groups of 5, one of which was presented with a partially ordered list, and the other a linearly ordered list. Presentation of these lists was accomplished by sequentially revealing pairs of names flanking the nonsense relation '*', e.g. "G * A". 13 such statements appeared on screen during this phase, each remaining for 5 seconds. Participants were instructed that since this was a memory test, they should try to remember the 13 statements. During the third phase, participants were given 5 simple arithmetic problems as a distraction. Next, during the fourth phase, participants were given 26 T/F questions concerning the statements presented during the second phase. For each question, participants were asked if a given statement such as "G * A" is true or false with respect to the presentation during phase two. 13 of the statements were true of the ordering, while 13 were false, some of which consisted of non-adjacent pairs. During the fifth phase, participants were asked to drag-and-drop names and provide arrows linking the names to reflect the relational structure exhibited. These five phases were then repeated 8 times by each participant.

Phase 1

To prime participants to think of linear ordering, we employed the following test:

Consider the natural numbers, e.g. 1, 2, 3,… The natural numbers form what is called a *linear order* with respect to the 'less than' relation, often represented with the symbol '<'. For example, 1<2 and 2<3 are true statements, while 2<1 is a false statement, given the standard understanding of the natural numbers and the 'less than' relation. A *linear order* relation must satisfy two properties. First, the linear order must be transitive. Using the 'less than' relation as an example, we can see that if 1<2 and 2<3, then it must be the case that 1<3. This is an instance of transitivity. Put another way, the 'less than' relation transitions from two pairs of numbers to a third linked number. The other property that a *linear order* must satisfy is *connectivity*. Again, using the 'less than' relation as an example, we can see that for any two natural numbers, say, 2 and 453, it must be the case that either 2<453 or 453<2. Clearly, the first option is true. More generally, this will be true of any two numbers you choose. So, we can say that 'less than' is, in fact, a *linear order*, as it satisfies these two properties.

There are many examples of linear orders outside the realm of numbers. For example, consider the 'is shorter than' relation holding among a group of people no one of which is as tall as any other. The following list of relationships, we assert, are true of such a group:

Sally is shorter than Mark
Mark is shorter than Eugene
Sally is shorter than Eugene
Eugene is shorter than Abby

We then asked participants the following comprehension questions:[5]

1. Which of the following is true with respect to the preceding list, assuming 'is shorter than' is a *linear order*:
   a) Eugene is shorter than Mark
   b) Sally is shorter than Abby
   c) Mark is shorter than Sally

2. Which of the following is true with respect to the preceding list, assuming 'is shorter than' is a *linear order*:
   a. Either Sally is shorter than Abby or Mark is shorter than Sally
   b. Either Mark is shorter than Sally or Eugene is shorter than Mark
   c. Either Eugene is shorter than Mark or Mark is shorter than Sally

3. Please draw the linear order imposed by the 'is shorter than' relation, linking Sally, Mark, Eugene, and Abby.

   Sally < Mark < Eugene < Abby

4. Select two names from the dropdown menus below that together make a true statement:

   ______ is shorter than ______

[5] Answers shown in red, in what follows.

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Mark is shorter than _Sally_

To prime participants to think of partial ordering, we employed the following introduction and preliminary test:

Consider the relation 'ancestor of' which may hold among people. For example, John may be an ancestor of Nate, and Sally might also be an ancestor of Nate, but neither Sally nor John need be ancestors of each other. This relation reflects what is called a *partial order*. A *partial order* relation must satisfy two properties. First, the partial order must be transitive. Using 'ancestor of' as an example, we can see that if John is an ancestor of Nate and Mark is an ancestor of John, then it must be true that Mark is also an ancestor of Nate. This is an instance of transitivity. Put another way, the 'ancestor of' relation transitions from two pairs of people in this case to a third pair. The other property that a *partial order* must satisfy is *asymmetry*. Again, using the 'ancestor of' relation as an example, we can see that if John is an ancestor of Nate, then it cannot be true that Nate is also an ancestor of John. This is an instance of asymmetry. Since 'ancestor of' has both properties, we can say this relation is a partial order. Just as important as having these two properties, is that a *partial order* does not require that any two items in a list be comparable. As mentioned above, just because both John and Sally are ancestors of Nate, it does not mean that John is an ancestor of Sally or that Sally is an ancestor of John. They may be entirely unrelated in that respect.

Now, consider the 'ancestor of' relation holding among a group of people. The following list of relationships, we assert, are true of such a group:

Sally is an ancestor of Abby
Mark is an ancestor of Eugene
Sally is an ancestor of Eugene
Eugene is an ancestor of Abby

1. Which of the following is true with respect to the preceding list, assuming 'is an ancestor of' is a *partial order*:
   a) Sally is an ancestor of Mark
   b) Mark is an ancestor of Sally
   c) Mark is an ancestor of Abby

2. Which of the following is true with respect to the preceding list, assuming 'is an ancestor of' is a *partial order*:
   a) Either Sally is an ancestor of Mark or Mark is an ancestor of Sally
   b) Either Abby is an ancestor of Eugene or Eugene is an ancestor of Abby
   c) Either Eugene is an ancestor of Mark or Sally is an ancestor of Mark

3. Please draw the partial order imposed by the 'is shorter than' relation holding among Sally, mark, Eugene, and Abby.

   Sally/Mark < Eugene < Abby

4. Select two names from the dropdown menus below that together make a true statement:

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______ is an ancestor of ______
Mark is an ancestor of _Abby_

Phase 2 and Phase 3

Following the preliminary comprehension test, participants in the linear condition were presented with the following statements, randomized in presentation order over the 8 trials:

G * A   D * G   J * D   R * J   C * R   M * C   B * M

T * S   H * T   F * H

P * B   S * P

N * F

Following the preliminary comprehension test, participants in the partial condition were presented with the following statements, randomized in presentation order over the 8 trials:

G * A   J * G   M * J   B * M   T * B   H * T   N * H

J * D   R * J   C * J

S * P   T * S

F * H

After the second phase for either condition, participants were presented with 5 arithmetic questions as a distraction before moving on to the fourth phase.

Phase 4

During this phase, participants in the linear condition were presented with 26 statements - randomized through each of the 8 trials - and for each, participants were asked whether the statement was true or false with respect to the lists presented during the second phase.

1. G * A
2. D * G
3. J * D
4. R * J
5. C * J

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6. M * C
7. B * M
8. T * A
9. H * T
10. F * T
11. P * B
12. S * P
13. N * F
14. A * G
15. G * D
16. D * J
17. J * R
18. G * C
19. C * M
20. M * B
21. S * T
22. M * H
23. H * F
24. B * P
25. P * S
26. B * N

Similarly, for participants in the partial condition, the following list was presented with associated T/F questions:

1. G * A
2. J * G
3. M * J
4. B * M
5. T * B
6. H * T
7. N * H
8. J * D
9. R * J
10. C * J
11. S * P
12. T * S
13. F * H
14. A * G
15. A * J
16. J * M
17. M * B
18. B * T
19. T * H
20. H * N
21. D * J

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22. J * R
23. J * C
24. P * S
25. P * T
26. H * F

Phase 5

During the final phase, participants in either linear or partial conditions were asked to draw from memory the relationships holding among the items presented earlier: A, G, D, J, R, C, B, M, T, H, S, P, N, F. For the linear condition, the correct illustration looks as follows:

N * F * H * T * S * P * B * M * C * R * J * D * G * A

For the partial condition, the correct illustration looks as follows:

N/F * H * T * S/B * P/M/R/C * J * G/D * A

Results

*	Recognition Test				Illustration Test			
	Prime Partial		Prime Linear		Prime Partial		Prime Linear	
Trial	**Partial**	**Linear**	**Partial**	**Linear**	**Partial**	**Linear**	**Partial**	**Linear**
1	.38	.21	.24	.43	.23	.18	.11	.39
2	.45	.25	.26	.49	.28	.23	.13	.46
3	.50	.33	.31	.58	.31	.27	.18	.57
4	.53	.37	.33	.63	.35	.33	.22	.63
5	.61	.43	.38	.70	.40	.37	.27	.71
6	.63	.49	.43	.78	.43	.41	.30	.75
7	.68	.57	.47	.85	.49	.46	.37	.82
8	.70	.62	.51	.89	.53	.49	.38	.88

Table 1: Priming for Recognition and Illustration Tasks

Perusing the table, we see participants divided into groups of 10, one group being primed with linear orders and the other with partial orders. All participants took both the recognition and illustration test, and all participants completed 8 trials during the experiment. Each of the decimal values reflects a mean accuracy score[6] from 5 participants with respect to the third phase of the experiment. For

[6]For the recognition test, participants were given 1 point for each correct T/F answer given. This scoring applies to both adjacent and non-adjacent pairs. Note, participants were given 1 point in each order task for non-adjacent pairs *only if* the pair was true in *all models of the order structure* provided in the relevant second phase.

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example, consider the first value ".38" in the first trial. This number reflects the mean number of correct answers to the 26 T/F questions posed in the third phase of this experiment to 5 participants. These participants were primed to think of partial orders in the first phase, and then given a partial ordering task to complete in the remainder. These five participants are paralleled in the illustration task. For example, moving to the illustration test and the value ".23" in the first trial, we see the same 5 participants primed to think of partial orders then asked to illustrate the partial order they were presented in the second phase. Similar remarks apply to the 5 participants in the first cell of the partial primed linear column under the recognition test with value ".21" and the partial primed linear column under the illustration test with value ".18". Moving to the second trial, and returning to the first column value ".45" we see the same 5 participants repeating the preceding experiment, with corresponding values for the illustration task. In other words, the columns represent the same 5 participants completing each phase of the experiment through 8 trials, and the recognition and illustration columns are paired.

Discussion

It is first worth noting that participants seemed to have difficulty completing the ordering task, whether with partial or linear structures, accurately with the symbol '*'. This was also found in the studies mentioned in the introduction which cast doubt on Moeser's claims by having participants use nonsense relations. It seems plausible that the difficulty participants had in accurately constructing orders is due to the fact that they had little other than memory to rely on when engaged in the ordering task, since '*' lacks any obvious semantic content. This is again in contrast to relations such as 'greater than' which carry semantic content and – if memory fails – might be a source of information participants would be inclined to exploit. In other words, we should expect participants to have a more difficult time constructing accurate ordering structures with nonsense

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symbols given our hypothesis that participants are relying on the semantic content of relations in Moeser's original experiments.

The results show a statistically significant difference within groups and between groups. Specifically, participants primed to think of partial ordering did significantly better at the partial ordering task than those primed to think of partial ordering and given the linear ordering task. This suggests when participants are primed to think of partial orders and then given a linear order task, the priming effect conflicts with the information given in the task. On the other hand, this suggests the priming effect for partial orders makes it easier for participants to successfully complete partial order tasks. Moreover, we see this result sustained through each trial, with participants improving at around the same rate through each task. That is, there does not appear to, say, be a significant increase in improvement of either linear or partial tasks that is not also reflected in the other task. Additionally, we see the apparent friction between priming and task through the remainder of the table. Participants primed to think of linear orders had difficulty constructing partial orders, and an easier time constructing linear orders. This again supports our hypothesis that priming influences participant construction of ordering structures, and that this phenomenon coupled with Moeser's use of the 'greater than' relation which exhibits linear order properties, explains why participants in the original study had an easier time constructing linear orders.

There is one avenue of response that seems open to Moeser that is worth discussing. Compare the columns under the recognition test in which participants were primed to think of partial orders and asked to construct a partial order with those primed to think of linear orders and asked to construct a linear order. There is a statistically significant difference suggesting participants had an easier time under these conditions constructing linear orders. Moeser might thus respond to our explanation by claiming the best explanation for this discrepancy is that participants have a prototype for linear orders already, and this comes into conflict with priming to think of partial

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orders. If we deny this, and also claim participants do not have a prototype for partial orders prior to priming, then we should expect there to be no discrepancy. Since there is, it seems plausible participants have some linear order default in mind, which is conflicting with the partial order priming and thus making it more difficult for them to construct a partial order accurately, even if they can be primed to do so with greater success. This response is bolstered by observing a similar discrepancy in the illustration test.

This response is plausible, but reveals something of a puzzle in our results when compared to those of our companion experiments, in which deployment of the nonsense relation '*' in Moeser's experiments did – in fact – result in no statistically significant difference in ability to complete the assigned ordering task regardless of whether it was linear or partial. Yet here, when participants are primed to think of linear or partial orders, there seems a discrepancy in favor of constructing linear orders. A possible confounding factor may stem from the method of priming itself. These passages were filled with semantic content that may or may not have influenced participant thinking. Indeed, it is possible the very word "order" might prime participant thinking, if it carries with it, say, linear order semantic content. In our next experiment, we alter the priming passage to remove as much potential semantic content as possible to get to the bottom of this puzzle.

Experiment 2: Cleaner Priming and Nonsense Relations

Participants

Experiment 2 recruited 20 participants from Amazon's Mechanical Turk (Mturk) and presented each with one of the two ordering tasks below. Each participant had at least a 98% approval rating on at least 5000 tasks from Mturk and was paid $1.00 for their work. No participant was allowed to complete the task twice, and no participant was allowed to complete more than one experiment.

Method

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Experiment 2 consisted of five phases as in the previous experiment. The only difference between experiments is in what follows participants were presented with priming passages that removed potentially problematic semantic content, while illustrating the formal properties associated with either a linear or partial ordering.

Phase 1

To prime participants to think of linear ordering, we employed the following test, which presumably excluded as much potentially confounding semantic content as possible while still providing participants sufficient information for the priming effect:

> We define the following symbol "#' to relate items such as "G", "B", etc. For example, "G # B" is a grammatical statement using these items and "#". We define "#" so that relates items which flank it, where the relationship has three important properties. First, "#" is *transitive*. This means that if "G # B" and "B # J", then it must be the case that "G # J" as well. The symbol "#" thus creates what might be thought of as chains of items.[7] Second, "#' is *connected*. This means that for any pair of items, say "H" and "F", it must be the case that either "H # F" or "F # H". Third, "#" is not *symmetric*. For some symbol - such as the symbol "$" – to be symmetric, means that if "G $ B" then it must be the case that "B $ G". But as we are defining "#" here, it is not the case that this symbol is symmetric. Rather, according to our definition if "G # B" then it is not true that "B # G". We say instead that "#" is *asymmetric*.
>
> Now, consider the following true claims about the relation "#" and the items "S", "M", "E", and "A".
>
> S # M
> M # E
> S # E
> E # A

We then asked participants the following comprehension questions:

1. Which of the following is true with respect to the preceding list, assuming "#" is *transitive*, *asymmetric*, and *connected*:
    d) E # M
    e) S # A
    f) M # S

[7]Note "chains of items" suggests transitive semantic content. This may or may not be confounding, but it was included largely because both partial and linear orders are transitive.

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2. Which of the following is true with respect to the preceding list, assuming "#" is *transitive*, *asymmetric*, and *connected*:
    a. Either S # A or M # S
    b. Either M # S or E # M
    c. Either E # M or M # S

3. Please draw the relationships "S", "M", "E", and "A" bear to each other with respect to the "#" symbol.

S # M # E # A

4. Select two names from the dropdown menus below that together make a true statement:

____ # ____
_M_ # _S_

To prime participants to think of partial ordering, we employed the following introduction and preliminary test:

We define the following symbol "#' to relate items such as "G", "B", etc. For example, "G # B" is a grammatical statement using these items and "#". We define "#" so that relates items which flank it, where the relationship has three important properties. First, "#" is *transitive*. This means that if "G # B" and "B # J", then it must be the case that "G # J" as well. The symbol "#" thus creates what might be thought of as chains of items. Second, "#" is not *symmetric*. For some symbol - such as the symbol "$" – to be symmetric, means that if "G $ B" then it must be the case that "B $ G". But as we are defining "#" here, it is not the case that this symbol is symmetric. Rather, according to our definition if "G # B" then it is not true that "B # G". We say instead that "#" is *asymmetric*. Third, "#" is not *connected*. For some symbol – such as the symbol "$" – to be connected, means that for any pair of items, say "H" and "F", it must be the case that either "H # F" or "F # H". But as we are defining "#" here, it is not the case that the symbol is connected. Rather, according to our definition it may be the case that some pair of items, say, "R" and "S", it is not true that "R # S" and it is not true that "S # R". We instead say that "#" is *disconnected*.

Now, consider the following true claims about the relation "#" and the items "S", "M", "E", and "A".

S # A
M # E
S # E
E # A

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1. Which of the following is true with respect to the preceding list, assuming "#" is *transitive*, *asymmetric*, and *disconnected*:
   d) S # M
   e) M # S
   f) M # A

2. Which of the following is true with respect to the preceding list, assuming "#" is *transitive*, *asymmetric*, and *disconnected*:
   d) Either S # M or M # S
   e) Either A # E or E # A
   f) Either E # M or S # M

3. Please draw the partial order imposed by the 'is shorter than' relation holding among Sally, mark, Eugene, and Abby.

S/M # E # A

4. Select two names from the dropdown menus below that together make a true statement:

____ # ___
_M_ # _A_

Phase 2, Phase 3, Phase 4, and Phase 5

Following the preliminary comprehension test, participants in the linear condition were presented with the following statements using the nonsense relation '*' in a manner similar to presentation in Experiment 1 and in line with Moeser's presentation. The remaining phases followed in line with Experiment 1.

Results

*	Recognition Test				Illustration Test			
	Prime Partial		Prime Linear		Prime Partial		Prime Linear	
Trial	Partial	Linear	Partial	Linear	Partial	Linear	Partial	Linear
1	.33	.20	.21	.35	.17	.13	.10	.18
2	.35	.23	.25	.40	.20	.15	.14	.24
3	.38	.27	.27	.42	.27	.19	.17	.35
4	.42	.33	.29	.45	.34	.23	.19	.39
5	.47	.40	.34	.49	.43	.26	.22	.42
6	.55	.44	.39	.53	.45	.29	.26	.51
7	.59	.48	.43	.56	.50	.34	.30	.55
8	.63	.50	.47	.59	.54	.38	.35	.60

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Table 2: Refined Priming for Partial/Linear Recognition and Illustration Tests

Discussion

We first note compared to the results of the previous experiment, accuracy scores are quite a bit lower across the board. As before, this may stem from removing much semantic content during the priming test and not including any additional semantic content in the ordering tasks by using nonsense relations. More important for our purposes is observing that the statistically significant discrepancy found between participants primed to think of partial orders who were given a partial ordering task, and those primed to think of linear orders who were given the linear order task, has vanished. Participants appear to have had an equally difficult time accurately constructing the appropriate order of items. If true that semantic content does influence participant performance, it seems plausible that the discrepancy found in the previous results can be explained by the priming tests themselves employing potentially confounding semantic content. Indeed, it seems once much of the potentially problematic content is removed, e.g. "order", and replaced with more neutral terminology and an emphasis on nonsense symbols, we find the results above. What goes for Experiment 1 here then goes just as well for Moeser's experiments, which primed participants with relations carrying semantic content which may have had unforeseen effects on ordering ability.

To be fair, it is unclear *what* terms in Experiment 1 or in the original study problematically primed participants to favor linear orderings over partial orderings. Nevertheless, the results above suggest there is at least *some* priming going on in these tests biasing participants towards one sort of ordering relation over another. When coupled with the results of Experiment 1 which suggest participants experience friction between being primed to think of one sort of ordering structure then being asked to construct another, we have strong reason to think priming passages other than those used here in Experiment 2, generated such conflict. Moreover, this is at least compatible with the results we see in the above table for participants primed to think of partial orders then given linear

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order tasks, and those primed to think of linear orders then given partial order tasks. In Experiment 1 there seemed a statistically significant difference these participants, which may very well have been explained by implicit prototypes of linear orders. But the results above display no such discrepancy, casting doubt on such a prototype.

Conclusion

Moeser presented evidence suggesting participants may employ prototypes of linear orders which they may in turn employ in ordering tasks. Additionally, the authors illustrated how participants may be primed to think of partial or linear orders, resulting in better performance on associated ordering tasks. Building on a complementary pair of experiments which casts doubt on the presence of any such default linear ordering knowledge, here we provided evidence that strongly suggests the priming effects noted in Moeser's original studies confound those earlier studies. Our first experiment prime participants to think of either partial or linear orderings, then tasked them to order lists of items using a nonsense relation '*' rather than the semantic content laden relation 'greater than' used in the original study. This experiment suggested the existence of friction between priming with one sort of ordering while requiring participants to order items in a different manner, while also suggesting the existence of mutually supporting priming and task effects, when the sorts of orders align. Nevertheless, there was a discrepancy suggesting participants had an easier time constructing linear orders than partial, which lends some support to Moeser. In our second experiment, we attempted to test the extent to which this discrepancy might be explained not by a prototype for linear ordering, but rather by illicit priming in the preliminary tests themselves. In other words, it seemed plausible there may – even in the priming test for partial orders – be some manner of linear order priming. To control for this, we introduced linear and partial orders almost entirely in terms of the formal properties they exhibit. We then ran Moeser's original experiment, again using the nonsense '*' relation. The results showed once the preliminary tests were cleaned of

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much potentially confounding semantic content, participants had an equally difficult time constructing linear or partial orders. That is, the observed discrepancy in the previous experiment vanished.

There is, of course, more to be explored here, especially noting there it is unclear what terms used in the original priming test and that of Experiment 1 triggered participants to think of linear ordering. We leave that for another set of experiments. We conclude here that there is at least strong reason to think Moeser's claims to the existence of a prototype for linear ordering seem unsupported given the results of our pair of studies.

Works Cited

Moeser, S. (1979). *Acquiring Complex Partial Orderings in Comparison with Acquiring Similar-Sized Linear Orderings*. Memory & Cognition. Vol. 7(6). 435-444.