keywords: Numeral Quantifiers, Verification

Verification Procedures for Modified Numeral Quantifiers

1. This paper presents a real time study (using Self-Paced Counting – SPC) of verification procedures for modified numeral quantifiers (*more than n, at least n, …*) in order to investigate to what extent the form of a particular quantifier determines its associated verification strategies. We show that the numeral *n* affects the counting component of the verification process, that the modifier (*more, at least, …*) affects the decision stage, and that these two factors don't interact.

2. SPC is an experimental paradigm that allows one to gather timing information incrementally throughout a verification process that involves counting. In a typical trial, participants hear a sentence such as *more than six of the dots are red* whose truth/falsity they have to determine relative to an array of red and blue dots. The dots are at first masked and uncovered in groups of 1, 2 or 3 as participants press the space bar. Participants respond with "True" or "False" by pressing the appropriate response key and can do so as soon as they have uncovered enough information about the array. See figure 1 for a sketch,

3. Using SPC, we studied verification procedures for sentences as in (1), which vary across two factors, number mentioned and monotonicity of the modifier. (1a,b) and (1c,d) respectively are truth-conditionally equivalent and agree in monotonicity, while (1a,c) and (1b,d) use the same numeral but have different truth-conditions and different monotonicity. Importantly, however, the critical point at which the truth-value switches is the same across all four conditions. That is, once the seventh red dot has been seen, *more than 6/at least 7 of the dots are red* become true, while *at most 6/fewer than 7 of the dots are red* become false. Thus, if the verification procedure is informed by truth-conditions only, the effect of counting to the critical number (*N*) should be constant across all four conditions, while the number mentioned (*n*) should not have an effect. If, however, the verification procedure is informed by component parts within the quantifier, we expect to see an effect when *n* is reached, whether or not *N* has been seen. In addition, since the direction of the switch (true to false, or false to true) is determined by monotonicity (increasing determiners become true while decreasing ones become false), we would expect an effect of monotonicity as *N* is reached.

4. An analysis of the RTs for 25 subjects between successive space bar presses reveals an interaction of "Frame" by *n* across Frames 4-5 ($F(1,24) = 29.078$; $p < .001$) such that on Frame 4, *more than* and *at most* (where $n = N-1$) have increased response times compared to *at least* and *fewer than*, (where $n = N$). On Frame 5, the opposite is true. We also observe two main effects on the answer frame, a main effect of *n* ($F(1,24)=13.228$; $p = .001$), where *fewer than* and *at least* take longer, and a main effect of Monotonicity ($F(1,24)=17.809$; $p < .001$), such that decreasing quantifiers take longer. See Figure 2.

(1) a. More than 6 of the dots are red.
b. At least 7 of the dots are red.
c. At most 6 of the dots are red.
d. Fewer than 7 of the dots are red.

Figure1:

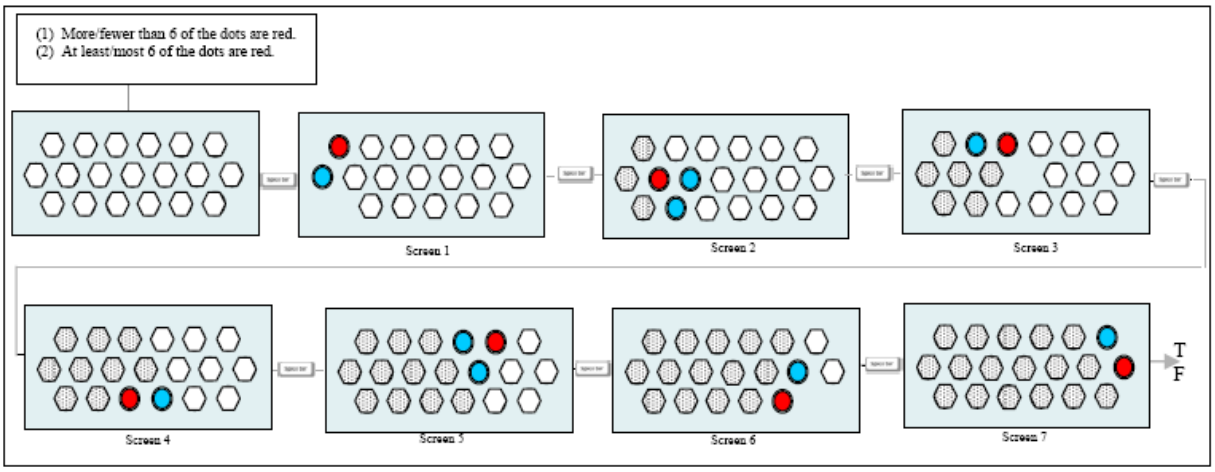

Figure 1. Sequence of events in a Self-Paced Counting trial.

Figure 2: Results Graph

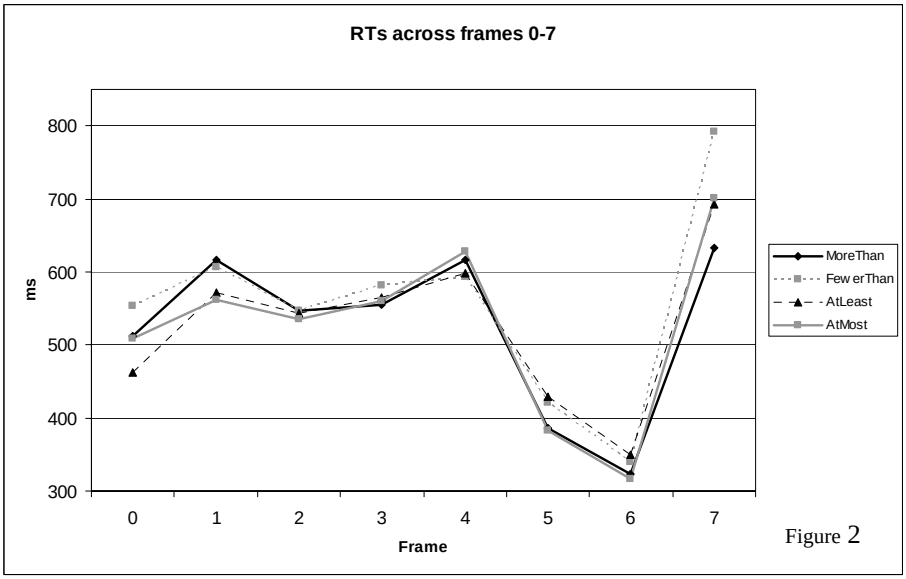

Figure 2