computed *length of utterance* in words. Spontaneous utterances (words and non-words) were computed on a per minute basis since the caregivers spent between 26 and 60 seconds in the scenes. Furthermore, we looked into the *prompts per minute* the facilitator had used.

We computed for each child and scene the number of touch screen *interactions* they had *per minute* (*ipm*) and the ratio to the interactions the adult had (child/adult agency ratio, *caar*). This provided us with an estimate of the child's agency vis-à-vis the application and allowed for controlling for the difference in styles the caregivers had in using the application during the dialogic reading. The male caregiver who read to six children controlled the application himself most (*ipm* average of his children was 2) whereas the other two caregivers encouraged and had the children interact with the application more (*ipm* averages of 3 and 5.5).

4. RESULTS

We found a strong positive correlation ($r(10)=.74$, $p<.01$) between the children's age and their response/prompt ratio. Older children responded more often to dialogic reading prompts. There was a nonsignificant correlation 0.1 between age and the utterance length of the children's responses. The response/prompt ratio (ranging from zero to 1.1) and utterance length (from 0 to 3.4 words) across all scenes are summarized in Figure 2. The children's spontaneous utterances were significantly longer (2.5 words) than the ones responding to a prompt (1.8 words) - according to a paired t-test for the children that had replied to prompts and talked spontaneously $t(5)=3.11$, $p=.026$. The large difference was due to a number of closed question prompts from the caregivers, which resulted in yes/no replies from the children. When we excluded simple yes/no responses for both prompted and spontaneous utterances the difference was smaller (prompted 2.4, spontaneous 2.7 words) but still significant. We found no significant correlations between the children's age and the length of their spontaneous and prompted responses but there was a positive trend between age and the length of spontaneous utterances but no such trend with the length of prompted responses (see the trend lines in Figure 4). Older children produced longer spontaneous utterances than younger ones. But when prompted the older children's utterance were of similar average length.

The children interacted with the application on average 2.4 times per minute. Younger children interacted as much with the application as the older ones did. To check whether the children would respond less often or more mono-syllabic when interacting

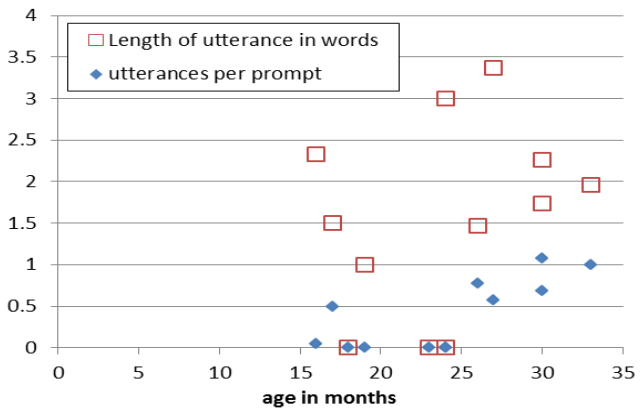

Figure 2: Utterance frequency and average length by age

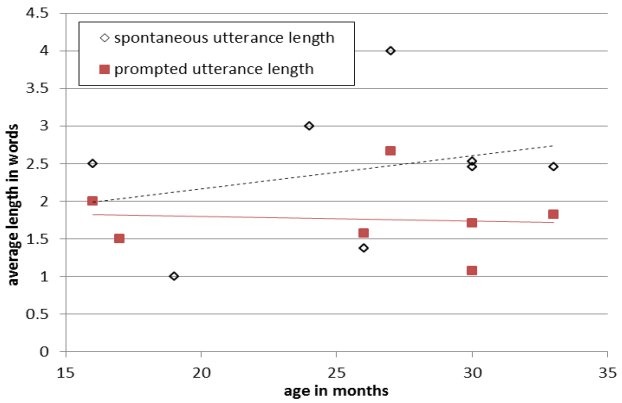

Figure 4: Average length of utterances by age

more with the application we included age in a multiple regression analysis along with *imp* as predictors of the children's *average utterance length* and their response/prompt ratio. We found no significant effects and Figure 3 plots the child's *ipm* against their average utterance length and their response/prompt ratio. In other words, there was no evidence that increased interaction with interactive elements reduced the children's responses to prompts nor the length of t responses.

To test the independent variables from our factorial design we ran multiple regressions on children's (both spontaneous and prompted) utterance lengths and their response/prompt ratio. We found no signficant contribution of *gesture*, *sound* or *repetition* as predictors with age, *ipm* and *caar* included in the regression as controls. Of the control variables only age was a significant predictor for the response/prompt ratio. However, the multiple regression, which included the same set of predictors and controls on spontaneous utterances (per minute), showed that both age ($\beta=.16$ $t(90)=4.57$, $p<.001$.) and *caar* ($\beta=.28$, $t(90)=2$, $p<.049$) were significant predictors. Older children and those that interacted more with the application than their caregivers spoke more often spontaneously. The scenes in which the children could repeat actions did not yield significantly more interactions than the scenes not allowing for repetition.

The children derived most fun from the animations and sounds. Of the 39 times the children laughed or giggled, most were triggered by animations (12) and sounds (11). Of the 96 spontaneous utterances the largest number happened because of or in relation to interactions with the application (22) and sound (12). A follow-up regression comparing utterance lenghts of these

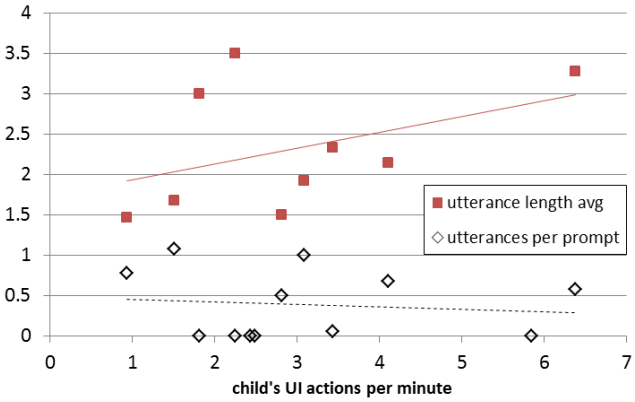

Figure 3: Response ratio and utterance length by the child's UI actions per minute

two with all other triggers of spontaneous utterances showed that these two triggers resulted in significantly longer utterances. The longest spontaneous sentences were evoked by *sound* (3.5 words) and when commenting "*it wants to be down here*" or asking about pointing or dragging *interactions* "can you put it there?" (2.9). Most of the spontaneous utterances around interactions occured in the last scene, which had no sound but various animals could be repeatedly dragged and re-positioned anywhere on the screen. The prompted utterances that fared better than average (1.8 words) were the ones in which the children described an *action* (2.4), *labeled* an object or character (2.3) or talked about a *sound* that was made (2).

The adults prompted the children on average 2.3 times per minute and between zero to 12 times in the different scenes. We tested *gesture*, *sound* and *repetition* impacted on the adult's prompting frequency by entering them along with *ipm*, *caar*, and age as predictors in a stepwise regression in which factors with the smallest p-value (<.05) were entered first. Only *age* and *sound* significantly predicted *prompts per minute*. The adults prompted more frequently when the children were older (β=.14, $t(90)$=2.77, p<.01) and in scenes that did not contain sound (β=.56, $t(90)$=2.02, p<.05.). This was mirrored during the debrief interviews with the caregivers. The caregiver who had prompted least suggested including music and narration while the most prompting caregiver feared that narration would weaken the contact with the child. Both disliked interactive elements not supported by text, as they did not know what to tell about them.

5. DISCUSSION

The initial concern that children might talk less often or with shorter responses when engaged with interactive elements was not warranted in our sessions. The children who interacted with the application more than the caregivers (larger *caar*) made more spontaneous utterances, too. However, since caar represents a covariate this finding would need more controlled follow-up research to provide causal conclusions.

The engaging effect of sound does not come as a surprise with the number of books available that supplement the visual reading experience with sounds. While sound in the scenes resulted in fewer prompts from the caregivers, it stimulated longer spontaneous utterances from the children. We used only sounds shorter than six seconds and further studies need to include the limits at which sound might begin to have detrimental effects, which the survey results from Vaala & Takeuch suggest.

The sizes of targets and difficulties with dragging might pose a usability problem but we found that these problems fostered verbal exchanges in line with the goal of dialogic reading.

We decided against using one facilitator unfamiliar to the children and relied instead on caregivers they knew. However, we found that facilitation by different adults varied a lot both in terms of dialogic reading and how much they allowed or encouraged the children to interact with the application. While dialogic reading represents an interactive, child-driven situation with large differences between children, we would still advocate for using one trained facilitator to keep this condition more controlled. The fact that the children's spontaneous utterances were longer than the prompted ones was partially due to some caregivers' prompts. This raises an important concern for training, which Zevenbergen and Whitehurst originally addressed with two workshops. Although our caregivers were all familiar with and had received a refresher before the session, they might have facilitated the sessions differently with more training. When engaged in dialogic reading with e-books facilitators might benefit from having access to example prompts as some of the closed questions we observed resulted in short yes/no answers and the caregivers disliked interactive elements not supported by the storyline. Similarly, initial work on teaching facilitators dialogic reading involved example and training sequences.

6. CONCLUSION

The children's agency in manipulating interactive elements did not adversely affect their responses to dialogic reading prompts. Interactive elements did provide triggers for children to speak in addition to dialogic reading prompts in shared e-book readings sessions. Sounds and being able to move objects and characters around produced longer spontaneous utterances in comparison to responses to dialogic reading prompts. Open-ended interactions worked particularly well and future research should explore concepts for spontaneity more in the context of dialogic reading.

7. ACKNOWLEDGMENTS

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8. REFERENCES

1. Anthony, L., Brown, Q., Nias, J., Tate, B., and Mohan, S. Interaction and recognition challenges in interpreting children's touch and gesture input on mobile devices. Proceedings of the 2012 ACM international conference on Interactive tabletops and surfaces, ACM (2012), 225–234.
2. Hargrave, A.C. and Sénéchal, M. A book reading intervention with preschool children who have limited vocabularies: The benefits of regular reading and dialogic reading. Early Childhood Research Quarterly 15, 1 (2000), 75–90.
3. Hourcade, J.P. It's too small! Implications of children's developing motor skills on graphical user interfaces. (2003).
4. Jordan, B. and Henderson, A. Interaction analysis: Foundations and practice. The journal of the learning sciences 4, 1 (1995), 39–103.
5. Mol, S.E., Bus, A.G., de Jong, M.T., and Smeets, D.J. Added value of dialogic parent–child book readings: A meta-analysis. Early Education and Development 19, 1 (2008), 7–26.
6. Preston, J.L., Frost, S.J., Mencl, W.E., et al. Early and late talkers: school-age language, literacy and neurolinguistic differences. Brain 133, 8 (2010), 2185–2195.
7. Sesame Workshop. Best Practices: Designing Touch - Tablet Experiences for Preschoolers. http://www.sesameworkshop.org/assets/1191/src/Best%20Practices%20Document%2011-26-12.pdf.
8. Vaala, S. and Takeuchi, L. Co-Reading with Children on Ipads: Parents' Perceptions and Practices. The Joan Ganz Cooney Center, 2012.
9. Whitehurst, G.J., Falco, F.L., Lonigan, C.J., et al. Accelerating language development through picture book reading. Developmental Psychology 24, 4 (1988), 552.
10. Zevenbergen, A. and Whitehurst, G. Dialogic reading: A shared picture book reading intervention for preschoolers. On reading books to children, (2003), 177–200.