Multimodal Perspectives on Mixed Reality Play in the LEGO House

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DigiLitEY: The Digital and Multimodal Practices of Young Children
Short Term Scientific Mission – Final Report

Summary

Children's playworlds are a complex interweaving of modes, with the border areas between the physical and digital becoming increasingly blurred. Growing in popularity and prevalence, 'mixed reality' presents novel opportunities for designers of toys and play-spaces as well as being of interest to researchers of young children's contemporary play and learning.

This Short Term Scientific Mission (STSM) involved visits to the *Centre for Multimodal Communication* at the University of Southern Denmark in Odense and the world-renowned LEGO toy company. Opened in September 2017, LEGO House in Billund brings together play, creativity and learning through multiple experiences spanning physical and digital domains. This new venture from LEGO offers a rich context for considering multimodal perspectives on play, including turning particular attention to the affordances of materials and spaces for play, and investigating the liminal border-areas where physical and digital play are increasingly mixed.

The visit to LEGO House revealed an innovative space in which digital technologies have been embedded and integrated with physical play experiences, expanding opportunities for meaning-making in new ways. Simultaneously, LEGO House highlights that movement between physical and digital forms always entails both gains and losses, and in this report these issues are discussed in the context of three play experiences. Further multimodal research is needed to explore children's interaction with LEGO House experiences in order to draw attention to children's learning in informal play-spaces that merge physical and digital features.

Sharing my research through presentations to the LEGO Group and the University of Southern Denmark enabled an exchange of perspectives and fostered new connections. This STSM therefore supported knowledge-exchange between researchers and commercial designers with different yet complementary areas of expertise in early childhood, play and digital technologies, and has identified several potential directions for further research.

Background and Rationale

Young children's everyday lives are increasingly permeated by an array of digital technologies which are rapidly changing their experiences of play and the forms in which they make meaning (Flewitt, 2010; Kucirkova, 2011; Plowman, Stephen, & McPake, 2010). A new but growing area is the rise of 'virtual reality', 'augmented reality' and 'mixed reality' which merges the physical and digital to create new opportunities and environments for play (Marsh et al., 2017).
In these hybrid spaces, the distinctions between physical and digital become increasingly hard to discriminate. As a result, contemporary play "moves fluidly across boundaries of space and time in ways that were not possible in the pre-digital era" (Marsh, Plowman, Yamada-Rice, Bishop, & Scott, 2016, p. 250). Emerging research has suggested that young children are particularly engaged by what appears to be a 'magical link' between physical and digital domains and that new technologies might enhance children's play in new ways (Marsh & Yamada-Rice, 2016). The widespread popularity of 'augmented reality' apps such as *Pokemon Go* and the growing use of such apps by young children suggest this field is likely to continue to expand (Marsh et al., 2017). Despite this, much current research on children's use of mixed reality is developed in the disciplines of computer sciences and HCI, and tends not to have focused on children under 10 (Freina & Ott, 2015). It has been argued that theoretical and methodological innovations are urgently required in order to explore the complexity of play in hybrid spaces (Marsh et al., 2017), making this an important and timely area of further study.

A multimodal perspective on play has the potential to offer a balanced, evaluative approach by supporting detailed insights into the design and use of toys and spaces, both physical and digital. Multimodality offers the recognition of meaning-making occurring in many modes beyond speech and writing, such as image, moving image, sound and gesture. Multimodality focuses attention on the *affordances* of such modes to identify both potentials and constraints (Flewitt, 2010; Jewitt, 2006; Kress, 2005; Jewitt & Kress, 2003). From such a perspective, toys such as LEGO can be considered semiotic resources, where their design is recognised to be socially-shaped with distinct potentialities for meaning-making (Van Leeuwen, 2005; van Leeuwen, 2013). Multimodality also provides a frame for considering how such toys are used, recognising the agency and interest players will bring to a plaything, thereby making meaning anew through the ways toys are used in play (Kress, 1997).

To develop a multimodal social semiotic perspective on 'mixed reality play', this STSM was supported by Sumin Zhao, whose research considers early literacy, multimodality and digital technologies, including recent projects studying young children's early digital multilingual practices and children's experiences of picturebook apps (Zhao, Forthcoming; Zhao & Unsworth, 2016). The STSM also involved collaboration with Patrick Otley, product development lead at LEGO. Patrick is an experienced toy designer and was able to offer insights into the development of LEGO House and designers' perspectives on digital play. The *LEGO Foundation* has demonstrated a longstanding interest in research partnerships in order to develop, support and share evidence on play and learning. The contribution of a multimodal perspective therefore has the potential to connect with industry whilst expanding theoretical conceptualisations, collaborative methodologies and understandings of contemporary play.

Aims and Activities

The STSM focused on three interconnected theoretical, methodological and practical aims:

1) To develop multimodal social semiotic **theoretical** perspectives on children's 'mixed reality' play
2) To consider the **methodological** possibilities of collaborative research-design partnerships regarding 'mixed reality' play
3) To examine the **practical** ways in which mixed reality play is designed and built into the new LEGO House play-space

In combination, the visit's aims sought to develop a balanced approach to the merging of physical and digital play. The visit's activities covered three key areas, corresponding to the aims above:

1) **Theory:** Seminars and discussions with staff at the University of Southern Denmark and Aarhus University working in the areas of digital technologies, play and multimodality in order to share perspectives on 'mixed reality' play.
2) **Methodology:** Dialogue with designers at LEGO and consideration of links between research and industry, sharing project insights and perspectives on 'mixed reality' play.
3) **Practice:** Guided visit of the new LEGO House play-space, which bridges research, education and the wider community.

Date	**Activities**
Friday 1st March	**Aarhus** Meetings with Aarhus play scholars including: - Klaus Thestrup, associate professor researching makerspaces and mediaplay at Aarhus University - Marc Andersen, postdoctoral researcher working on the *PlayTrack* project in the Interacting Minds Centre at Aarhus University - Mathias Poulsen, organizer of the *CounterPlay Festival*, Aarhus
Monday 5th March	**Billund** Guided tour of LEGO House by toy designer, Patrick Otley.
Tuesday 6th March	**Billund** Presentation given to the LEGO Group with Sumin Zhao: *'Play and Learning: Making the Invisible Visible,'* Approximately 30 attendees including LEGO Foundation, LEGO Education and members of the design team. Guided tour of the LEGO Idea Studio, an applied research lab developing open-ended play with technology, created by Amos Blanton. **Odense** Meeting with Theo van Leeuwen, Professor of Multimodal Communication at the University of Southern Denmark.

Wednesday 7th March	**Odense** Visit to *ReMida*, the city's creative recycling centre, ran by Karin Eskesen and Kåre Runge, coordinators of the Danish Reggio Emilia Network.
Thursday 8th March	**Odense** Research seminar given to the Centre for Multimodal Communication at the University of Southern Denmark: *'Multimodal Perspectives on Mixed Reality Play*.' Approximately 15 attendees from across departments at the university.
Friday 9th March	**Odense** End-of-STSM meeting with Sumin Zhao, including discussion of possible future collaborations.

Findings and Key Themes

One outcome of this STSM was closer consideration of the concept of 'mixed reality'. The term is usually used to describe the 'merging of real and virtual worlds' (Milgram & Kishino, 1994). It builds upon the concept of 'virtual reality', in which physical environments are simulated in digital forms, whilst recognising that the line between digital and physical is becoming increasingly blurred (Lindgren & Johnson-Glenberg, 2013). Although 'mixed reality' is useful shorthand for a range of technologies that bring together the physical and digital in new ways, it raises issues regarding realism and the nature of reality through the suggestion that the digital is somehow *less real* than the physical. Whilst digital representations may not be tangible, they are nonetheless perceptible often through visual and auditory modes, and are therefore arguably *as real* as physical counterparts whilst being able to take on new non-physical properties. A multimodal social semiotic perspective offers depth to the discussion of these new technologies and environments through careful attention to the affordances of both the physical and digital, including their distinct potentials and constraints, and the effects of transduction between them. Taking a step away from the problematic term 'mixed reality' also enables a broader consideration of the range of technologies featured in LEGO House which bring the digital and physical together in various ways but would not typically be considered 'mixed reality'.

What follows is a discussion of LEGO House highlighting three examples of play experiences that merged physical and digital play in innovative ways. Each is considered from a multimodal social semiotic perspective (Kress, 2010) in order to examine the potentials and constraints of each experience and the consequences for play and meaning-making. As this STSM was limited in its duration and possible scope, this discussion focuses solely on the design of the play experiences and does not examine visitors' interactions with the exhibits. Further research is therefore necessary to build on these insights through considering how LEGO House is experienced in practice.

LEGO House

Figure 1: LEGO House

LEGO House is a 12,000-square metre building which opened in 2017 close to the LEGO headquarters in Billund, Denmark (see Figure 1), described by the LEGO Group as 'an experience house' with the slogan 'Home of the Brick'. Whilst broadly positioning LEGO House as a playful experience for all ages, a pedagogical ethos underpins its design. This reflects the company's strong philosophy of learning through play, articulated on the LEGO House website:

> When children play they are having fun, experimenting, tinkering, messing around and making mistakes. In other words, they are learning.
> (https://www.legohouse.com/en-gb/explore/what-is-lego-house)

The website goes on to explain their view of children's play and learning as 'a holistic balance of five overlapping competences', including creativity, cognitive abilities, emotions, social play and physical play. These 'competences' inform the spatial design of LEGO House, arranged as separate zones of different colours. In each zone are a number of 'experiences' offering opportunities to play with LEGO. The experiences are mostly presented without explicit instructions or directions. Amos Blanton, who supported the development of LEGO House, explained that the concept of 'low floors and high ceilings' had been central to the design of the experiences, meaning that they were intended to be easily accessible but as open-ended and flexible as possible. In addition to the experience zones, LEGO House features outdoor play terraces, a masterpiece gallery showcasing LEGO creations, a small library and a history collection.

Upon arrival at LEGO House each visitor is given a wristband containing a small microchip that can be scanned at 'capture stations' situated throughout the experiences. This system enables visitors to photograph physical creations and save digital creations to an individual online profile that can be accessed through the LEGO House app after the visit. In this way, technology is embedded throughout the entire visit as a means of capturing aspects of the experiences. Technology also features in many of the experiences themselves, bringing together play with physical materials such as LEGO bricks and adding digital dimensions through use of cameras, scanners, sensors, projectors, stop-motion software and programmable robots.

What follows is a discussion of three LEGO House experiences, considering the ways in which the physical and digital are combined in opportunities for play. Adopting a multimodal social semiotic perspective, the discussion focuses on the *affordances* of the particular experiences and the *transduction* between physical and digital modes (Kress, 1997, 2010).

1) Character Creator

The Character Creator experience invites visitors to make their own LEGO minifigures using a vast selection of heads, torsos, legs, hairstyles and accessories which can then be photographed using one of the capture stations situated nearby (see Figure 2). By placing the characters on a plinth in front of a camera, the capture station creates a snapshot of the visitor's creation which is saved to the user's wristband and can be viewed after the visit. The Character Creator capture stations also offer a choice of magazine-style overlays for the image, parodying publications such as Rolling Stone and TIME Magazine (see Figure 3). In addition to the capture stations, the experience also features display areas where the physical minifigures can be left for other visitors to view.

Figure 2: Character Creator capture station

In part, the capture stations seem to support an implied rule of LEGO House that visitors are expected to leave their creations behind for other users to admire, eventually to be disassembled and re-used. The capture stations provide a solution to the issue that many visitors may feel reluctant to leave their creations behind, having often invested considerable time and care in making them. The capture stations also offer an additional layer to the process of making through the possibility of adding digital overlays to the photographs, playfully drawing on conventions of particular media magazine genres. In this way, three-dimensional LEGO models become preserved as two-dimenstional images digitally augmented to transform the minifigures into magazine cover stars.



Figure 3: The Character Creator process, from loose LEGO bodyparts, to minifigures, to the capture station

Whilst a key potentiality of LEGO is that it can be continually assembled and reassembled, the capture stations provide a means of 'freezing' parts of that process so that traces of the making can be preserved and shared. In this way, moments in the 'chain of semiosis' (Stein, 2008) typical to play with LEGO can be made visible. The capture stations therefore offer new possibilities for playful making, inviting the capturing and ongoing transformation of physical creations into digital forms. This process of transduction from physical LEGO minifigure to digital image inevitably involves both gains and losses. The capture stations can only capture what the digital camera can record, so cannot preserve sensory features of the creations such as the feel, temperature or smell of the plastic, the sound of connecting the pieces, and so on. Furthermore, as a momentary snapshot, the photos cannot depict dynamic aspects of play such as the movement of figures, nor the processes of their creation, being geared towards capturing 'the end product'. The images created in the capture stations are therefore partial digital re-materialisations of physical creations, yet they provide insights into traces of the LEGO House play experience that would otherwise remain ephemeral.

2) City Architect

The City Architect experience features large interactive tables with a bustling cityscape projected onto the surface from digital projectors above (Figure 4). This birds-eye view of a virtual city is reminiscent of the open-ended city building video game *SimCity* and operates on a similar premise. The implied aim of this experience is to meet the needs of animated citizens moving across the cityscape. The citizens indicate their needs through the colour of their clothing and coloured icons in small speech bubbles (e.g. a red house in a citizen's speech bubble shows a request for more housing). Situated near the tables are colour-coded building stations where these additions to the city can be created (Figure 5). When the constructions are placed into the square grooves on the table's grid-like surface, the city responds with sound effects and projected animation, changing the dynamics of the city based on the colour of the base-brick that is positioned (e.g. a red brick meeting the citizens' need for housing). If their needs are met, the animation will show citizens moving from the streets of the city to a pre-built entertainment centre (e.g. a football stadium). When all the citizens are satisfied, an animation will show the city enjoying the football game, with sound effects simulating the cheering crowd. In this way, the play experience offers a simple city simulation, with the city's rhythm digitally changing depending on what bricks are physically placed on the table.

Figure 4: City Architect interactive table

Figure 5: City Architect building stations

City Architect is one of the more technologically complex experiences in LEGO House, making use of interactive table interfaces and projectors. Notably, it involves a departure from screen-based uses of digital technology. Instead, in the City Architect experience the projected cityscape is manipulated through the positioning of physical LEGO bricks, which causes digital animations and sound effects. Multimodal perspectives have drawn attention to the profound shift in communication as the screen increasingly replaces the page as the central medium of communication, with visual modes becoming increasingly foregrounded over print (Kress, 1997). The movement away from screen-based digital interaction now brings other modes to the fore (Yamada-Rice, 2018). For instance, in City Architect the gestural placement of physical, three-dimensional constructions is the prompt for two-dimensional digital animations and sound effects. As technologies continue to develop and invite further screen-less digital experiences, embodied modes, physical materials and spatial arrangement seem likely to take on newly prominent significance. The digital dimension also sustains the goal-oriented component of the play, by communicating the citizens' needs and showing when these have been met, although there is no penalty for choosing not to complete this goal and focus instead just on the constructions. In this way, it serves as a reminder that whatever the intended design of a particular play experience, attention must also be given to the player's own meaning-making in response to certain invitations.

Whilst creating buildings and cities might be common to 'traditional' play with LEGO bricks, in City Architect the digital technology is used to augment these three-dimensional structures, appearing to 'give life' to the city through animating inhabitants and adding sound effects. Experiences such as City Architect invite parallels with similar play in non-digital means. For instance, in traditional LEGO play children might have 'given life' to their constructions through moving minifigures, adding their own sound effects or *imagining* a bustling cityscape. In digitally augmented experiences such as City Architect, a digital realisation of this is offered in pre-designed forms. Whilst on the one hand such technologies may offer a 'magical' dimension to the experience of construction, adding digital layers onto a traditional play experience, it raises questions regarding the place of imagination in play. Future studies that explore the merging of physical and digital aspects of play might turn to children themselves to explore the issue of imagination further, exploring the extent to which children resist or re-make designers' intentions for play experiences.

3) Fish Designer

The Fish Designer experience invites visitors to make a physical fish using a selection of coloured LEGO bricks (Figure 6A) then scan and convert their fish design into a digital form by placing the construction on a capture station platform (Figure 6B, 6C, 6D). Once scanned, visitors can add eyes and a mouth to their fish (Figure 6E) and watch it become animated in a digital aquarium alongside other visitors' fish. Through customizing the eyes and mouth, fish will display different personality traits as they swim together and respond to aquarium animations such as sharks. As new fish populate the tank, older fish will gradually fade into the distance of the aquarium and eventually disappear, whilst the capture stations save an image of the digital fish to the user's wristband to be accessed via the app after the visit (Figure 6F). Near to the capture stations and screens is a display area where the physical LEGO brick fish can also be left on display.

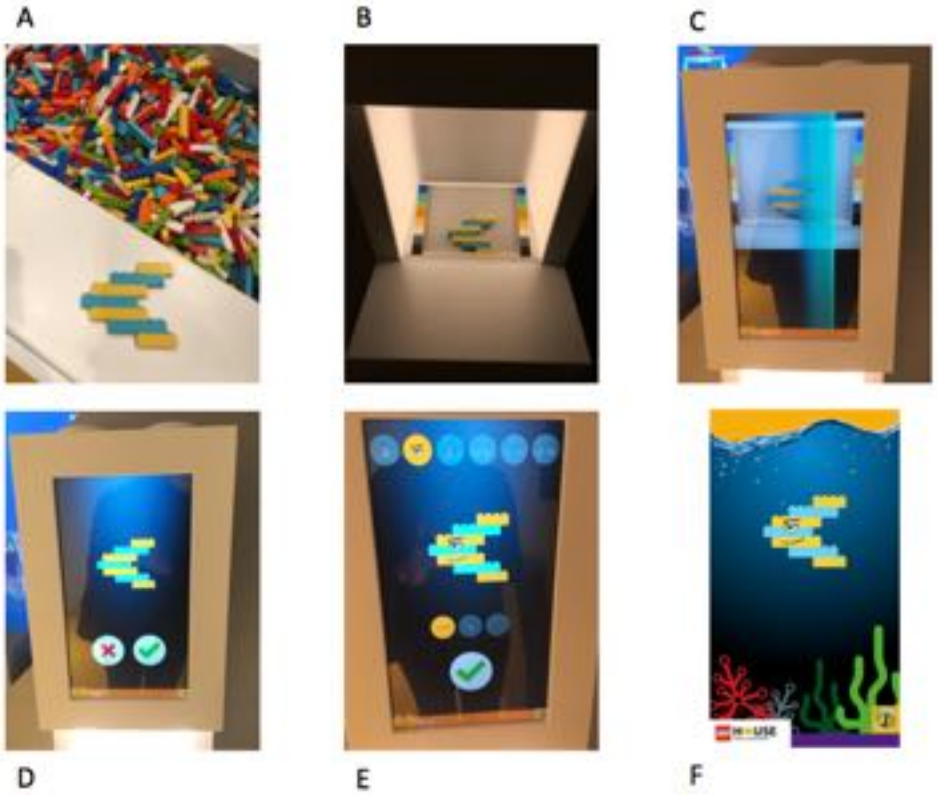

Figure 6: Stages of fish design

Use of sound and animation at the capture stations helps sustain an illusion that the physical LEGO brick fish is becoming virtual. For instance, through an on-screen 'scanning' animation and sound effect, and through animation showing the fish swimming from the small capture station screen into the large aquarium screen through a connecting tube (see Figure 7). In this way, the process of transduction between a three-dimensional object, two-dimensional image and two-dimensional animation is brought to the fore. The process of re-making becomes the main feature of the experience, playing with the idea that a brick construction has been 'brought to life'. The digital technology draws upon affordances of digital moving image to give the appearance of 'life' to an inanimate construction through moving image and sound. The experience also plays with time and space, allowing visitors' fish to exist in the same space simultaneously despite being made at different times, and to live on after the physical blocks have been disassembled. In this way, the experience highlights the potential of digital technologies to support play opportunities which enable play across physical, temporal and spatial boundaries.

Figure 7: Virtual aquarium (left) and digital fish swimming from the capture station (right)

However, once the digital fish is released into the aquarium it is out of the control of its designer. It can be watched as it interacts with other fish but can no longer be played with as the physical LEGO brick fish might. The Fish Designer therefore highlights again the gains and losses inherent in play experiences which involve movement between physical and digital forms. On the one hand, the experience creates a re-materialisation of a brick fish that takes on life-like animate qualities and can add new spatial and temporal dimensions to play. Yet it also demonstrates limitations of the form and the process of transduction when a physical object is re-made digitally.

Conclusions

LEGO House resists easy definition, combining elements of a museum, gallery, studio and playspace, and highlights the close connections between activities such as playing, tinkering, designing, making and learning. As 'Home of the Brick', LEGO House merges physical LEGO bricks with digital technologies in new and innovative ways. Its invitations to combine and move between physical and digital forms offer new opportunities for meaning-making whilst simultaneously highlighting the gains and losses that such movement entails. To explore these new contexts for meaning-making, multimodal social semiotics offers a balanced insight into such forms of play, critically examining what such designs make possible, whilst avoiding the common extremes of moral panics or technotopian ideals often brought into discussions about young children's uses of technology. This STSM has therefore built upon existing multimodal research into children's play and toys (Kress, 1997; van Leeuwen, 2013), looking at the particular affordances brought about by experiences that merge digital and physical elements.

LEGO House can be seen as part of a growing recognition of the power of play, both in its own right and in relation to learning. Through the pedagogy underpinning its design, LEGO House acknowledges that deeply important learning can happen in informal times and places that are not positioned as direct acts of teaching. In this way, LEGO House contributes to ongoing discussions surrounding the educational approaches, spaces and materials that are necessary for supporting playful meaning-making. Specifically, it considers the role of the digital in such an approach, and through its embedded use of digital technologies alongside non-digital forms, can be seen to encapsulate the 'hundred languages' philosophy of the preschools of Reggio Emilia in which digital technologies are means of amplifying and multiplying existing forms (see Cowan, 2017). In many ways, LEGO House might be best described as an atelier or makerspace,

and connects to the rise in 'maker' culture and particular interest in 'digital making' (Johnson et al., 2015). In this way, experiences such as those found in LEGO House might contribute towards conceptualisations of learning which support children to develop the playfully creative skills and knowledge required for the digital age.

Although LEGO House is currently a cutting-edge development for the LEGO Group, technology continues to develop apace. It will be interesting to see the extent to which LEGO update or replace their experiences to reflect new technological developments. For instance, as 'virtual reality' and 'augmented reality' continue to become more prominent, the potential to further blur the physical and digital is likely to invite further possibilities for play experiences. Additionally, whilst the current play experiences focus on turning the physical into the digital (e.g. the capture stations and Fish Designer), the move from digital into physical is not yet an aspect explored in the LEGO House. With technologies such as 3D printers and laser cutters increasingly inviting movement from digital into physical forms, the possibility to design a creation digitally and have it physically realized in LEGO may be one future possibility. Another may be to find further ways to sustain play experiences after the visit through the LEGO House app, for instance through enabling digital creations such as the fish to become animated virtual pets on mobile devices. This STSM has highlighted that there will be an ongoing need to evaluate LEGO House play experiences in light of technological innovation, and that there are productive synergies to be realised by combining the perspectives of designers and insights from researchers to give careful consideration to new possibilities for play.

Whilst this STSM looked at the design of LEGO House experiences from a multimodal perspective, further research is needed to closely explore the ways in which visitors actually interact with these experiences, and how individuals bring their own agency and interest to the intended designs for play. Such research would support insights into visitors' experience of LEGO House and would enable attention to meaning-making and signs of learning in this distinctive and innovative play-based context. Making evident the learning that takes place in informal, play-based settings such as LEGO House therefore has the potential to recognise and give value to playful meaning-making in both physical and digital forms which may otherwise be taken for granted or go unnoticed.

Future Outputs

This visit offered valuable opportunities to connect with others working in the fields of play, multimodality and digital technologies. A range of further activities and outputs are planned relating to this trip, including:

- Invited keynote presentation for the PlayTrack Project, Aarhus University, Denmark (April 2018).
- Presentation at the 9th International Conference on Multimodality (August 2018)
- Seminar at UCL Institute of Education (date TBC)
- Blog post for the DigiLitEY website
- Input into teaching on MA programmes at UCL Institute of Education (online and face-to-face)
- Connections with projects at UCL Institute of Education through my role as a research associate on the EPSRC funded *Playing the Archive* project and my role as lead researcher on the Froebel Trust funded project *Valuing Young Children's Signs of Learning*.

- Input into London ReFocus, the regional network of the UK Reggio Emilia organization 'Sightlines'.

In addition, I hope many of the connections established in Denmark might be sustained and developed in longer-term projects, such as joint publications, conference symposia and reciprocal visits to UCL Knowledge Lab.

Final Comments

I am grateful to DigiLitEY for funding this STSM, to Sumin Zhao and Patrick Otley for supporting my visit, and to everyone who welcomed me so warmly in Denmark and made the time to meet and discuss their work.

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