

The explanatory power of sensory reading for early childhood research: The role of hidden senses

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Abstract

Sensory reading refers to reading that engages all six of the human senses – vision, hearing, touch, gustation, olfaction and proprioception. The author proposes that increased attention be paid to the three ‘hidden’ senses of gustation, olfaction and proprioception to advance innovative reading studies. She articulates the problematic of visually dominated multimodal research and print–digital media comparison studies, and extends the reading field to sensory reading that is not tied to a specific medium or mode of engagement but mediated by individualised sensory stimuli. This cross-disciplinary discussion of sensory reading opens up a new vista for affective literacies and integrates the tensions that emerge between psychological and new media studies concerned with material, ephemeral and embodied reading. This approach refines Rosenblatt’s transaction theory and contributes new insights into materiality, ephemerality and the embodiment of reading, which dominate contemporary reading studies.

Keywords

embodiment, ephemerality, materiality, reading, sensory

The global circulation of texts in digital formats has invigorated academic and public interest in the complex, multimodal ways in which stories extend beyond our subjective realities. Widely recognised as a skill required for learning and citizenship, reading transitions into new types of experiences. Researchers have directly traced the transitions not only to the digital medium, including an increasingly mobile culture, algorithms or the self-publishing industry, but also to the sociocultural global influences on modes of communication. Amidst all these macro and micro considerations, it

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has been overlooked that reading can stimulate all *six* human senses – vision, hearing and touch, as well as olfaction, gustation and proprioception.

In this article, I address the implications of focusing on the hidden, or silent, senses of olfaction, gustation and proprioception for advancing the reading field towards new research perspectives and untapped areas. This focus is necessary to set new onward directions for advancing the conceptualisation of affect in education more broadly, and reading studies more specifically. In particular, I propose that *sensory reading*, which connects all six senses in reading, instantiates the theoretical virtue of the coordinated and visionary action necessary for abandoning medium- and mode-dominated reading studies. Medium- and mode-dominated reading studies diffuse the potential of digital reading and implicitly promote the dominance of print-based, visually focused reading. I outline the shortcomings of this approach in the first part of this article. In the second part, I define sensory reading and document how gustatory reading, olfactory reading and proprioceptive reading call into question the key hypotheses proposed by psychology and new media scholars concerning the materiality, ephemerality and embodiment of digital reading. The final part of the article situates sensory reading within the theoretical framework of transactional theory and specifies the implications of inter-sensory transactions for future cross-disciplinary reading studies.

I recognise the importance of learning to read, which is connected with early reading skills such as decoding letters or phonemic awareness, but I do not see these skills as central to the argument advanced in this article. I argue for a sensory approach to reading for pleasure, also known as affective reading, reading for enjoyment (Clark and Rumbold, 2006), ludic reading (Nell, 1988), recreational and leisure (Krashen, 2005) reading, or volitional reading (Cremin and Moss, 2018). Reading for pleasure is reader-driven reading, imbued with readers' agency and characterised by desire and delight (Cremin, 2014).

Medium-dominated studies of reading for pleasure

Despite the explanatory power of socio-material learning theories, the exploration of digital reading has been simplified within a comparative frame of print versus digital reading. A number of experiments have compared paper-based reading with digital reading, leading to meta-analyses that have synthesised quantitative studies from the past 10 years and concluded that the two reading formats lead to different reading outcomes for adult readers (Clinton, 2019; Delgado et al., 2018; Kong et al., 2018; Öztop and Nayci, 2021) and young readers (Furenes et al., 2021). Meta-analyses with adult readers have found that digital reading is characterised by a screen-inferiority effect, whereby paper-based texts outperform digital texts on traditional outcome measures such as reading comprehension. While Furenes (2021) results are not inconsistent with those of adult readers, they only hold for digital books that have no enhancements and are effectively the same as print books but presented on a screen. Most children's digital books, however, contain some interactive features, and these interactive digital books, when well designed, have been found to be more beneficial than paper books in supporting children's reading comprehension (Furenes et al., 2021). Various explanatory factors have been proposed for the different effects of reading paper and digital books, including the quality of the design of digital books (e.g. Christ et al., 2019); the availability of learning supports, such as dictionaries and embedded algorithms; adult support during children's reading (e.g. Strouse et al., 2019); the quality differentials between commercially produced and researcher-produced e-books (Kucirkova, 2019); children's characteristics, such as age (Strouse and Ganea, 2017b) age and gender (Kucirkova et al., 2018); and parent-child dynamics during reading (Dore et al., 2018; Strouse and Ganea, 2017a). Given the wide range of potential influences, a balanced understanding of digital reading effects requires an integration of

multiple social and technological factors. Mangen and Van der Weel (2016) outline a cross-disciplinary model of human–technology interaction, and Kucirkova (2019) proposes a framework that integrates the bidirectional influences of adult–child–book and the environmental characteristics implicated in the reading process.

While richly theorised, these models suffer from the same fallacy as the empirical research they aim to unite – namely, they follow a comparative print–digital outlook on reading. A key factor that has framed the rationale behind much of the extant research is the difference, evolution and distinguished boundary between paper and digital reading. Yet there are empirical, theoretical and practical issues with this approach. Empirically, the comparative frame fails to explain the growing number of studies that show no difference between reading on paper and on screen (Buch and Puck, 2021; Danaei et al., 2020; Feis et al., 2021; Jeong and Gweon, 2021; Sheen and Luximon, 2021). Theoretically, print–digital comparisons propagate the false dichotomy between social and material influences on children’s learning, which disregards the temporal and contextual influences on the nexus of the reading technologies that today’s children interact with (Truman et al., 2021; Wohlwend, 2015). Practically, print-versus-digital considerations feed into a pedagogically narrow outlook on texts’ potential, which carries educational, economic and social justice implications (Barshay, 2021).

As material and social aspects of reading dynamically interweave on digital reading platforms, definitions of literacies shift towards socio-material concepts of ‘assemblages’ that challenge the divisions between the social and material aspects of reading (Kucirkova, 2021; Kumpulainen et al., 2020; Medina et al., 2022; Merchant, 2021). The importance of embodiment in contemporary reading practices foregrounds how these literacies are relational, contingent on the context and content of interactions (Mangen, Hoel and Moser, 2019).

Sensory literacies are part of the socio-material shift in literacies and have been, thus far, discussed mostly in relation to the absence of research haptics and kinesics in reading (Mangen, 2008; Mills, 2015). I connect to these studies with a specific focus on the role of gustation, olfaction and proprioception in sensory reading. I do not suggest that sensory reading constitutes a new model for studying all aspects of reading, or that it comprehensively addresses the concerns levelled at the limitations of digital reading. Rather, I argue that sensory reading transcends the print–digital reading dichotomy by focusing on hybrid reading experiences through readers’ sensory engagement with texts. This shift is necessary to decentre the role of dominant reading modes (particularly the linguistic and visual modes) in early childhood.

Mode-dominated studies of reading for pleasure

Reading has been traditionally viewed as engaging the visual, auditory and haptic senses, which relate to readers’ physical interactions or ergonomics with texts. The focus on the three visible senses mirrors that of preschool curricula and the book market, which target children’s visual, hearing and haptic senses. Digital books – particularly interactive digital books for children – have expanded the array of sensory stimuli, with, for example, interactive story e-books designed to be manipulated through virtual touch in order to advance in a story through turning print pages or pressing buttons on a digital page.

Recently, critical literacy scholars have used innovative arts-based methods to study children’s aesthetic choices when engaging multiple senses in reading, and the rich sensory possibilities in children’s self-created stories (Kuby and Rowsell, 2017; Lemieux and Rowsell, 2020). In early childhood practice, arts-based methods have brought together interests in multisensory aspects of learning, especially with infants (Shin, 2021) and children with special educational needs (e.g. Robb et al., 2017). Yet, when it comes to the design of print and digital books, the reading activity

can be criticised for targeting visual and linguistic capabilities at the expense of affective responses. The focus on the cerebral and cognitive aspects of reading has led some scholars to contend that extant reading practices are distributed across all sensory modalities but reading on digital surfaces is disembodied and lacking in affect (e.g. Mangen, 2016). The disembodiment theme has also been taken up in multimodal studies, with a call for more attention to the affective value of different modalities, such as the visual (see Leander and Ehret, 2019), audio (e.g. Shamir et al., 2010) and touch aspects of reading (e.g. Jewitt and Leder Mackley, 2019).

Overall, however, the field of reading has paid scant attention to the role of olfactory (smell), gustatory (taste) and proprioceptive senses in affect and reading for pleasure. In what follows, I propose that a focus on olfaction, gustation and proprioception offers new insights into processes of reading that cut across diverse modes of meaning-making. I spotlight the role of these three senses first on a general level as part of multisensory learning; this is followed by their specific role in reading, which is referred to as ‘sensory reading’.

Sensory reading

Sensory reading is reading that brings together and targets all six human senses – vision, hearing, touch, smell, taste and proprioception. Sensory reading harnesses the learning value of multisensory stimulation, which, broadly speaking, translates into increased attention, learning and remembering (Shams and Seitz, 2008). The leading hypothesis for interpreting these learning effects is that multisensory stimulation approximates natural settings and presents information in a more salient way than learning via a single sensory channel (Jordan and Baker, 2011). The learning advantage of multisensory processing is assumed to be part of natural memory processing (Gardner, 1983), which makes multisensory learning superior to unisensory engagement (Shams and Seitz, 2008).

Thus far, studies documenting the advantages of multisensory engagement have tended to focus on adults and children with special needs (see Pagliano, 2012). Collectively, these studies show that the stimulation of multiple senses is, in adult learners, linked to stronger memory of objects (e.g. Murray et al., 2004; Seitz and Dinse, 2007) but, for learners with lower cognitive capacity, it needs to be introduced gradually to impact their learning in a positive way (Mayer et al., 2001). The benefits of multisensory stimulation are thus age-dependent – with children with a cognitive maturity of six years and above showing similar learning benefits to adults (Broadbent et al., 2018) – and task-dependent (Petrini et al., 2015) – that is, the extent to which engaging multiple senses can result in increased learning is conditioned by the type of activity. The close connection between pleasure or affect in learning and sensorial engagement has been highlighted by studies on sensorial disabilities (see Pagliano, 2012) and in the recent innovative design of digital reading surfaces for visually impaired children (Edirisinghe et al., 2018). Similarly, the use of interactive toys and art activities by children with autism has been documented to stimulate their sensory engagement and activate feelings of joy, wonder and ludic creations (e.g. Parés et al., 2005). Research with typically developing children and their sensory reading is scarce. In a typical reading activity, some senses become salient in the reading experience, depending on the reading context and purpose. The impact of the selected senses is the point where the following question arises: What are the learning potentials of olfaction, gustation and proprioception for reading?

The value of olfaction and gustation

The sense of smell, or olfaction, refers to processing odorants through olfactory receptors. Gustation refers to the sense of taste and the sensations that arise from our taste buds as we ingest and detect harmful food. Smell and taste are chemosenses and have a significant prediction

value for a number of degenerative diseases (Doty, 2015). The sudden olfactory and gustatory loss in COVID-19 (Callejon-Leblic et al., 2021) patients has increased public interest in chemosenses, but research in the area is limited. Experiments have shown that olfaction is connected to processing contextual memories and facilitating memory retrieval in children as young as three months (Suss et al., 2012). Looking at, touching and smelling food is a basic part of enjoyable (hedonic) eating practices in most cultures (Monin and Szczurek, 2014). Consumer studies with adults have shown that, together with smell, taste perception increases positive associations with a product (Torila, 2007). However, different communities associate different values with odours, particularly in relation to food odours (Ayabe-Kanamura et al., 1998), and this difference is reflected in the variation of processing various tastes across cultures (Sulmont-Rossé et al., 2019). Several studies with adult learners indicate a close relationship between a higher quality of experience and chemosensory stimulation (e.g. Ghinea and Ademoye, 2012) but, to date, this potential has not been formally researched in reading activities.

The value of proprioception

Proprioception is the sixth, hidden and invisible, sense, and relies on proprioceptors – that is, mechanosensory neurons located in the muscles, tendons and joints. Given that proprioception draws on other senses (e.g. the visual to ascertain the position and movement of the limbs), it is considered the Sense of All the Senses (Chu, 2017). In the classic theory of sensory integration (Ayres, 1972), it is postulated that three senses – tactile, vestibular and proprioceptive – impact motor development. Current theories (see Yardımcı-Lokmanoğlu et al., 2020) define proprioception as the sense that is key to spatial awareness and that coordinates the body's position in the brain. Proprioception forms the sense of self versus the other (Stillman, 2002) and is considered to be the basis for children's sensorial choices (Chu, 2017).

Children growing up in different cultures develop different body awareness – that is, a different conscious perception of sensations from within the body. Cross-cultural studies examining adults' proprioception show differences between individualistic (the USA) and collectivist (Japan) cultures (Freedman et al., 2020). What seems to be a common cross-cultural factor is that body awareness and movement across space can be enhanced in atypically developing children with structured activities such as yoga (Wright, 2017), as well as in typically developing preschoolers with, for example, the teaching of creative dance (Chatzopoulos et al., 2019). In reading, which tends to be a sedentary activity, the learning value of proprioception has yet to be recognised.

This succinct review of the value of gustation, olfaction and proprioception offers an initial orientation to the potential of the three senses to open up new sites of theorising and empirical research in distinct learning activities. I propose that shedding light on these silent senses offers a conceptual shift for studying and understanding three key issues in reading studies: materiality, ephemerality and embodiment.

Key issues in contemporary reading-for-pleasure studies

Materiality, ephemerality and embodiment are ongoing and noteworthy sites of contention in psychological and new media approaches. While not studied in previous analyses of contemporary reading (e.g. Mangen and Van der Weel, 2016; Wolf, 2008), these three issues can be illuminated by according equal weight to knowledge generated by psychological and new media approaches. While discussions of these three issues intersect, and although sensory reading involves the

simultaneous engagement of several senses, I spotlight the individual contributions of gustation, olfaction and proprioception to each of the three issues to make my argument clearer.

The materiality of reading experiences

At first glance, the materiality of a print book versus a digital book is different, but materiality in reading media has both external and internal properties, some of which (e.g. interactivity) are common to digital and print media, giving rise to multilinear literacy practices (Kucirkova, 2019). Externally, digital books have a different texture and physicality than print books (Kovač et al., 2019). Internally, with hyperlinks and artificially intelligent algorithms, digital books are malleable and adaptable in the course of reading. A criticism that has been levelled at digital books in psychological studies is that digital materiality lacks traditional physical anchors, such as the possibility of touching, turning pages and tracing the contours of a physical (print) book. When comparing adults' reading of print and digital books, Mangen noticed readers' enhanced temporal understanding and engagement with literary novels in a print format. Mangen suggests that due to the limited tactile options of digital books, readers lose their sense of spatial orientation in the narrative and therefore struggle to order the narrative temporally (Mangen, Olivier and Velay, 2019). Whether this is a distinct consequence of reading longer texts on screen it is not clear, nor is it clear how it relates to readers' mastery and reading with cognitively efficient user interfaces that contain possibilities for text annotation (Jan et al., 2016). Focusing on the internal material properties of digital reading, Delgado et al. (2018) argue that it is the presence of hyperlinks and options of scrolling text up and down that lowers readers' spatial orientation in digital as opposed to print texts.

A central strand in the psychological approach to the materiality of digital books has been the assumption that materiality is stable over time and across contexts. Yet, as new media scholars such as Burnett and Merchant (2021) and Lemke (2000) have argued, digital media are realised by readers operating within a particular time–space boundary. The material–immaterial boundaries of digital texts blur when readers' subjectivities, and their spatial and temporal instances, are taken into account (Burnett et al., 2014). The reader's agency in creating, assigning and reconfiguring meanings with artefacts, including digital texts, is imperative in understanding the realities of multi-modal communication (Kress and Van Leeuwen, 2020) and situating them in the everyday literacy practices of today's children (Pahl and Rowsell, 2019). Pahl and Rowsell's (2019) notion of 'artifactual literacies' highlights how artefacts can be materially present in homes and communities but also immaterially represented in narratives and historical accounts. This fluid materiality of digital media, and the ways in which media disrupt the long-standing boundaries between digital and non-digital artefacts, has also been highlighted by Burnett and Bailey (2014), who call for greater attention to the fruitful disruptions that digital texts make in taken-for-granted literacy spaces.

The contention that seems to lie at the core of psychological and new media approaches to materiality is the extent to which materiality is fluid and dependent on the reader's agency. Many psychology scholars assume that material attributes are static, and thus measurable in experimental and intervention studies, while new media scholars perceive material properties as contingent on dynamic, subjectively shaped time–space dimensions of reading. These aspects, I argue, become even more significant when we leverage the concept of sensory reading and the case of gustatory reading experiences.

Materiality and gustatory reading experiences

Thus far, psychology and new media scholars have focused their efforts on the distinct material properties of digital and print reading media. However, the shifting material and immaterial

properties of digital books are not a unique feature of the digital reading format, but rather a feature of possibly several reading formats, some of which are available today and some of which may become available in the future. At the time of writing, edible books are not a common reading format but, with the rapid development of three-dimensional (3D) printers and self-made books based on sustainable materials, such as vegetable peel, edible books could be actualised in the not-too-distant future (Alaca, 2019). Edible books have physical characteristics, such as texture, size, colour and weight, and their internal properties engage the gustatory sense. Thus, in addition to kinaesthetic and haptic feedback through readers' haptic and physical manipulation, edible books offer gustatory feedback. These aspects of edible books constitute an interesting case of pleasure in reading and the role of materiality in reading enjoyment. In particular, the case of edible books promotes the hypothesis that the materiality of reading changes not only with readers' engagement over time, but also with the intensity of readers' sensory engagement. The intensity of engaging the gustatory sense enables or limits the materiality of an edible book (if readers want to taste the book, the book naturally becomes smaller or disappears). If not consumed, edible books, particularly those created with rice paper, decay over time, so their existence is both reader-contingent and time-contingent. The more readers engage with an edible book, the more they embody the shared space between them and the text, but the more they may render this space immaterial.

The ephemerality of reading

A salient issue in the psychologically oriented discussions surrounding digital reading is the claim that digital texts prompt shallow reading, which is characterised by short and quick meaning-processing (Wolf, 2018a). In contrast, deep reading, characterised by readers' ability to reflect, synthesise and slow down information-processing (Wolf, 2018b), is associated with print reading (Jerrim et al., 2020). Reports on some adult readers neatly map onto Wolf's hypothesis that shallow reading is associated with the digital format, but they do not pay attention to alternative explanatory factors that are relevant for early readers, including the intersection of text genres (Hillesund, 2010), readers' motivation, intent and the purpose of reading (Blake, 2021; Johnson, 2021).

While psychology scholars couple different types of reading (sustained and reflective) with the temporal shifts afforded by different reading aims (long reading of fiction versus short reading for information), new media scholars, particularly those working in the critical literacy tradition, suggest that the depth and intensity of engagement with different types of texts is related to readers' subjectivities, which are created, sustained and propagated in different reading contexts. Horst et al. (2021) suggest that readers' depth of engagement with a text relates to the different levels of digital labour invested in the text's production. Related to this argument, Theunissen and Favero (2021) describe how the ephemerality of digital texts is shaped by the friction in live-streamed texts, which are shown for a short time but then automatically archived and thus made durable. Readers navigate complex curation processes online, which afford a 'porous experience' (McDougall and Potter, 2015) of the authorship and consumption of texts. The curatorship of texts that is at the heart of children's popular literacy practices happens exclusively on screen and involves creating, editing and sharing digital texts – a process that requires a certain level of expertise that has value in its own right (McDougall and Potter, 2015) and demands a considerable investment of time and dedication. While the short duration of stories shared on popular social media sites, such as TikTok, does not make visible the time that goes into generating these stories (Abidin, 2020), the personal and often deeply felt connection between the consumers and the creators of digital texts explains the depth of engagement with them. The texts constitute new forms of autofictional literature that seek a deep connection with the audience and self (Campbell, 2019).

In sum, when considered from a cross-disciplinary perspective, the depth and duration of readers' engagement with digital texts seems to reside in the different purposes of reading different types of texts, as well as readers' personal investment in the texts' production. The non-evidence-based claim about shallow reading in connection with digital texts is of serious concern, but the significance of personal value assigned to a piece of text is similarly devoid of empirical evidence. Olfactory reading, which is typically short but associated with a strong personal connection to particular types of texts, provides further insights into the ephemerality of reading.

The ephemerality of reading and olfaction

Scents can be added to books through ambient odours (e.g. releasing a lavender aroma into the air through a diffuser) or by scratch-and-sniff cards, as in the children's book *Peter Follows His Nose*, by Beatrix Potter. Digital books can contain hot spots – areas which, when tapped, activate a device that releases scent that is compatible with the content on the digital page, as demonstrated by the eBook prototypes that emit scent through the iPhone smart device. Whether it is scratch-and-sniff books or digital eBooks, the olfactory stimulation is short-lived and swiftly executed, but described to stimulate deep memories and intense reflections (Proust, 1918). The mechanism underlying this deep process is believed to be the ephemeral nature of scents. An olfactory reading experience disappears after a while and is thus transient, or short-lived, in nature. For children who value the permanence and retrievability of print, an olfactory book is effectively equivalent to the ephemerality of digital stories (Margaret Mackey, University of Alberta, personal communication, 2021).

Thus, while researchers have appropriated ephemerality for digital reading, olfactory stimulation suggests that long-term and deep reading experiences could be related to intrinsic memories rather than specific reading formats. Furthermore, the intensity associated with some digital texts could be explained not only by readers' personal investment in their production and curation, but also by the intensity of individual responses to specific sensory stimuli.

Embodiment in reading

The last decade has seen a substantial increase in the amount of attention paid by policymakers to reading for enjoyment or reading for pleasure (see Organisation for Economic Co-operation and Development, 2010). This is partly attributable to the psychological studies of two international surveys – the Progress in International Reading Literacy Study for 10-year-olds and the Programme for International Student Assessment for 15-year-olds – which show a decline in reading for pleasure in some nations (e.g. for Ireland, see Gilleece and Eivers (2018); for Turkey, see Tavsancil et al. (2019)). The macro-focus on reading for pleasure at the population level is, in psychology studies, complemented by a micro focus on specific features in readers' affective engagement with texts. For example, Mangen (2016) draws attention to the deep emotional value of the human hand in reading, particularly in relation to the different manipulative elements of print and digital books.

The macro and micro focus on affect in reading is mirrored by new media scholars, although they engage with the relationship between social structures and affect from a posthumanist perspective that problematises and approximates the digital and the human (Barad, 2003). Similar to psychology studies, affect and embodiment are discussed with attention to specific modes of engagement. For example, Price and Jewitt (2021, p. 274) make an in-depth study of the affordances of touch and conclude that the focus on specific body parts (such as the hands) and the tactile experiences they generate is only one part of the wide range of tactile sensations afforded by digital media.

Virtual touch involves whole-body touch experiences, such as vibration, texture, temperature, stiffness, force, edges, resistance and pressure (Price and Jewitt, 2021).

The differences between psychology and new media studies in theorising the relationship between affect and its influencing factors sometimes give rise to conflicting interpretations. For example, synthesised speech or automated voice-overs on reading platforms have been considered disembodied practices negatively related to affect (e.g. Buckley, 1997), while the presence of audio options in digital reading is ‘a vital component’ in ‘embodied reading’ in Hermansson’s (2017: 22) study of children’s e-book reading.

Proprioception, as a little-studied and little-known sensorial influence on learning, offers a reassessment of the core assumptions underlying affect and embodiment. Indeed, proprioceptive reading takes a fresh look at the centrality of unimodal engagement (e.g. touch through the hands) and accounts for the rich entanglements of the macro and micro factors implicated in affective reading.

Proprioception and embodiment

The contribution of individual modes to the moving and sensing body in literacy is richly conceptualised by Manning and Massumi (2014: 114), who suggest that literacy participation implies ‘reorganizing the body itself, in its commotion with other bodies. It means activating collective rhythm on the level of a relational movement, a level on which form does not single out’. Manning and Massumi (2014) describe how dancers use the surface of their skin as an organ for visualising whole-body movement, and apply the concept of proprioception to explain how the flow of affective experience occurs in digital environments.

Proprioceptive stimulation in reading can be realised through analogue means – for example, by encouraging children to use books as objects that they can carry around or walk on, as imaginary book bridges that connect their bodies to a story. Proprioceptive stimulation can also be realised through virtual reality (VR), whereby a VR display of a story includes grasping the story-character or story elements in space or moving inside a story setting represented through a VR headset. As such, proprioceptive reading is far more embodied than paper- or screen-based reading, as it immerses the reader’s entire body in a story. This full, embodied experience may give rise to *affective proprioception*, which refers to the intrinsic pleasure involved in movement activities such as dance or yoga (Cole and Montero, 2007: 304). Affective proprioception has been described as ‘a loss of self, a feeling that, at least as a locus of thought, one hardly exists at all’. Although it has not yet been formally investigated, the concept of affective proprioception has strong parallels with the description of a psychological flow (Harvey et al., 1998), which occurs during reading immersion when children enjoy being transported into their favourite story world (Aliagas and Margallo, 2017). Sensory reading connects to Manning and Massumi’s (2014) notion of proprioception in relation to the new possibilities of affective reading experiences.

Taken together, earlier discussions of the materiality, ephemerality and embodiment issues have focused almost exclusively on print–digital comparisons and the unique contribution of the linguistic and visual modes. Less attention has been given to the hybridity of media and the modes stimulated by olfaction, gustation and proprioception. Sensory-rich books interact with the material, ephemeral and embodied dimensions of reading in new, vibrant ways and provide a tool for understanding the tensions between print and digital reading. In the final section, I specify the theoretical, empirical and practical implications of adopting a sensory reading approach to reframe the problematic of digital reading in early childhood and shift the focus from language-dominated modes to reading senses.

Theoretical implications: intra-sensory stimulation

Spotlighting the three hidden senses in reading helps interdisciplinary scholars to appraise in a new way the theoretical implications of intra-sensory stimulation – synaesthesia – highlighted in early multimodal studies (see Kress, 1997) as an antidote to the linguistically driven focus on reading, and as directly relevant to the transactions between the senses and the affect they generate in readers (Kress, 2010). The affective nature of the distinct modes in reading is still to be theorised, but recent work by Ehret and Hollett (2014), Ehret (2018) and Ehret and Rowsell (2021) focuses on the affective atmosphere in reading, which involves complex entanglements between sensory stimulation and affective literacies. I expand this work by highlighting the affective value in the synaesthetic combination of gustatory, olfactory and proprioceptive senses. I argue that sensory reading opens the door to new conceptualisations in classic multimodal and reading theories as it exposes the ways in which reading relies on *sensory transactions*.

Sensory transactions

I take as a key point of departure Rosenblatt's (1982: 35) transactional reading theory, which has laid the foundations for understanding texts as a dynamic resource that readers 'transact' their meanings with, engaging in 'efferent and aesthetic thinking'. Rosenblatt views reading as an active meaning-making process between reader(s) and text(s), and explains that the reader's life, past and present, and the 'physical condition' and 'particular mood of the moment' shape and influence their affective engagement in reading and foster their reading engagement. While Rosenblatt (1988) views reading as an active meaning-making process between reader(s) and text(s), shaped and influenced by readers' affective engagement, the transactional theory does not specify the role of senses in the meaning-making process. My suggestion to include the olfactory, gustatory and proprioceptive senses in reading for pleasure calls into question the received idea that affective reading is a consequence of the interaction of dominant linguistic senses. Meaning transactions occur as visible and invisible, ephemeral and deeply felt, embodied and disembodied sensory transactions. These transactions draw on a combination of senses (inter-sensory reading) or the interplay of senses (intra-sensory reading) in creating an enjoyable reading response. Affect in reading is thus an active by-product and conduit of these transactions.

By placing reading for pleasure within a *sensory transactions* framework, I put forward the thesis that affect resides in the little explored ways in which *all six senses* are leveraged, dispersed across and situated in the act of reading. The sensory transactions framework facilitates a more nuanced understanding of the different learning processes with print and digital media, and the implication of linguistic and non-linguistic senses in affective reading experiences. Such an understanding carries important empirical and practical implications.

Implications for future reading-for-pleasure studies

The educational value of transactions between olfactory, gustatory and proprioceptive stimuli has, as yet, not been empirically investigated. However, it is well established that both olfaction and gustation carry significant hedonic (pleasure) value. Anecdotal evidence from Edible Book Festivals reports increased delight in stories that can be consumed. Edible books combine the perennial human enjoyment of stories and food, which brings humans together. The focus on food during reading fuses readers' delight in taste and letters, and is attracting considerable commercial interest, with, for example, edible Disney cake figures and short stories on cereal boxes. Scent – particularly ambient scent – is used in retail to make consumers' experiences more enjoyable (Spence et al.,

2014), and in art experiences, cinemas and multisensory built environments to enhance well-being (Spence, 2020). Yoga, dance and other proprioception-related activities are known for their significant hedonic value and could inspire future reading-for-pleasure studies that hybridise the human body and the reading medium. The design of sensory-rich books could complement these measures in that they draw attention to the unconscious, bodily interaction that often precedes language or action, and thus connect to the immediacy of experiences online.

Sensory reading focuses attention on outcome measures that have not been traditionally associated with early reading, such as physical health. The latest findings from the International Early Learning and Child Well-Being Study show that children's physical development is strongly correlated with multiple educational outcomes, including emergent literacy (Forsyth, 2021), and there is a strong desire among educational researchers and professionals to develop educational activities that combine physical and cognitive learning domains (Tortella and Fumagalli, 2017). Making, sharing and consuming edible and olfactory books taps into these interests and could be rigorously explored in school curricula. In the UK, reading for pleasure has gained mandatory status and is included in the national curriculum, but this has been predominantly supported with print books. The combination of proprioception with olfactory and edible books could lead to novel reading experiences that engage the whole body and the learning value of all the senses, including the chemosenses and bodily awareness.

As an example, edible books can be made by hand with healthy cooking ingredients – a wholemeal-pizza book cover with the main story characters represented with tomatoes or cucumber – or printed on 3D printers as custom-made snacks using dehydrated vegetables. Edible books can have text on the cover or they can have letters inside, depending on which book-making process is followed.

Edible books can also have text connected to their edible parts – for example, by attaching a mini-book on top of a vegetable or connecting a banana, as a conductive object, with a computer displaying an e-book (as tested with the open and closed circuits of the small Makey Makey circuit boards used in schools).

Limitations and future research directions

Within the limits of this article, I have not been able to provide an exhaustive summary of existing approaches in the heterogenous field of reading research. I have focused on sensory reading with the aim of moving beyond surface dimensions of reading, which are medium- or mode-centric. Such a focus may provide insights into the dimensions of reading that are common to all stories but are realised differently with different types of sensory engagement, such as affect. While some small-scale targeted intervention studies have offered promising results, critical empirical and theoretical gaps exist in relation to naturally occurring olfactory, gustatory and proprioceptive inputs in reading. The lack of empirical attention that has been directed at the learning value of the three silent senses makes them important future research foci for reading studies, as well as for early childhood learning pedagogies more broadly. The stimulation of these three senses could carry a prediction value for readers' affective experience, their spatial orientation in texts, the length and intensity of their engagement, and the extent to which they embody a piece of text. Whether and how sensory reading affects younger and older children's comprehension of texts, including over time, is another pertinent consideration for future research. Future research could also address the problematic nature of the print–digital dichotomy that is ingrained in classroom practices worldwide, and inspire less language- and medium-centric reading pedagogies. A close collaboration with book publishers and designers, as well as parents and policymakers, will be important in these endeavours.

Sensory reading connects to multisensory literacies that highlight the role of the body in reading within literary and anthropological frameworks (e.g. Mangen, 2008; Mills, 2015) and the developing methodology of sensory ethnography (Pink, 2009). Sensory reading offers a vocabulary for a balanced consideration of the contribution of individual media and modes to reading. It circumvents disciplinary boundaries and embraces a hybrid approach to the conflicting understandings of materiality, ephemerality and embodiment of psychology and new media scholars. As such, sensory reading sets a new and pressing agenda for researching the characteristics of children's popular reading practices, which are increasingly immaterial, ephemeral and highly affective, and demand urgent scholarly attention.

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