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Social Inference from Middle to Older Adulthood

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Abstract

Objective: Inferring the emotional state or the true meaning of another person's utterance is a key aspect of social cognition and critical for successful social interactions. In this study, we assess age-related differences in emotion recognition and sincere and sarcastic social exchanges in the context of cognitive and demographic factors.
Method: One hundred and eighty-seven adults ranging from middle to older adulthood completed the Mini-SEA Emotion Recognition test and Part B of The Awareness of Social Inference Test – Short Form (TASIT-S). Fluid intelligence and executive abilities were also assessed. Sex differences and the relationship with education level were also investigated. Regression models were used to assess age-related differences controlling for baseline cognitive and demographic factors.
Results: Age was negatively associated with accuracy for inferring sincere social exchanges. No differences were identified for accuracy for inferring sarcastic exchanges. Likewise, no age differences were identified for emotion recognition (Mini-SEA). Fluid intelligence was associated with accuracy for inferring sincere exchanges, but this was independent of age-related effects. A female advantage was identified for emotion recognition.
Conclusion: Age is associated with difficulty in inferring sincere exchanges, which is not explained by fluid intelligence, verbal abstract reasoning, or auditory verbal attention. A female advantage in emotion recognition is consistent with findings reported in younger adults. Both age and sex should be considered in clinical assessments using the Mini-SEA and the TASIT-S.

Keywords: Ageing; Theory of mind; Emotion; Social cognition; Social inference

The cognitive processes that enable humans to interpret social information and behave appropriately in a social environment are collectively referred to as social cognition. Advanced age is associated with declines across a wide range of cognitive domains including those involved in social inference. Specifically, declining performance has been demonstrated on social cognitive tasks such as Theory of Mind (ToM) (Henry, Phillips, Ruffman, & Bailey, 2013), perspective taking (Martin et al., 2019), and emotion recognition (Sullivan, Ruffman, & Hutton, 2007). Understanding the pattern of social cognitive decline across the lifespan is an important endeavour for geriatric neuropsychology as it is associated with reduced social functioning and quality of life (Bailey, Henry, & Von Hippel, 2008). In addition to declining performance in healthy ageing, poorer social cognitive function is associated with several conditions of pathological ageing, such as frontotemporal dementia (Kumfor et al., 2017), other neurological conditions such as focal lesions (Maggio et al., 2020), or psychiatric conditions such as schizophrenia (Green, Horan, & Lee, 2015). Despite this fact, social cognitive assessment rarely forms part of a neuropsychological assessment largely due to the modest or poor reliability of available measures (Kelly, McDonald, & Frith, 2017).

The demand for a reliable assessment tool for social cognition using ecologically valid stimuli resulted in the creation of The Awareness of Social Inference Test (TASIT), which includes both emotion recognition and social inference tasks (McDonald, Flanagan, Rollins, & Kinch, 2003). Despite excellent convergent validity with other social cognitive measures (McDonald et al., 2006), the TASIT is infrequently used due to the length of administration (~75 min) and a lack of awareness of quantitative

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assessments of social impairments, especially in geriatric neuropsychology. The TASIT-S (McDonald et al., 2018) is a shortened version of the original TASIT created for increased use in clinical settings and improved detection of social cognitive difficulties, including the assessment of older adults with dementias (Kumfor et al., 2017). Therefore, it is beneficial to understand how healthy ageing and general cognitive ability is associated with performance on the TASIT-S.

It is important to understand how older adults interpret social cues such as sarcasm and sincerity in conversational exchanges. People draw conclusions about the intentions and emotions of others using cues such as facial expression or the tone and content of speech. Often the literal and implied meaning of an utterance conflict, and the only way to accurately determine the meaning is through the use of contextual cues. Sarcasm is one clear example that is frequently employed in everyday language. Conflicting evidence exists as to whether older adults have difficulty deciphering nonliteral statements, including those containing humor, lies, proverbs, or metaphors (Mashal, Gavrieli, & Kave, 2011; Newsome & Glucksberg, 2002; Sundaray, Marinis, & Bose, 2018; Uekermann, Thoma, & Daum, 2008; Westbury & Titone, 2011). Determining whether an exchange is sincere or sarcastic also requires discerning literal from nonliteral statements, which is associated with ToM ability (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005). As ToM ability declines with advanced age, understanding how specific-related processes such as sarcasm detection also differ from middle to advanced age, will improve our understanding of the specific cognitive declines that result in social difficulties.

The TASIT was designed to assess the interpretation of literal (sincere) and nonliteral (sarcastic) statements. Advanced age has been associated with reduced performance on the social inference component of the TASIT, although evidence differs depending on the version used. With the original version, Phillips et al Phillips et al., 2015 identified a specific effect of ageing for the detection of sarcasm. However, using the shortened version, McDonald and colleagues McDonald et al., 2018 identified a specific effect of ageing for the detection of sincerity. The study from Phillips et al Phillips et al., 2015 also demonstrated that auditory verbal attention, as measured using digit span, did not mediate the effects of age on sarcasm detection. However, a similar approach has not been adopted for the shorter TASIT-S. Therefore, this study will assess the role of baseline cognition on age-related differences on sincerity and sarcasm detection using the TASIT-S.

Although age-related differences have not been identified for the emotion recognition component of the TASIT-S (McDonald et al., 2018), age-related decline has been observed in other static emotion recognition tasks (Ruffman, Henry, Livingstone, & Phillips, 2008). Moreover, pathological ageing conditions, especially frontotemporal dementia, are associated with emotion recognition difficulties (Bora, Velakoulis, & Walterfang, 2016; Goodkind et al., 2015; Lavenu, Pasquier, Lebert, Petit, & Van der Linden, 1999). For example, The Mini Social and Emotional Assessment (Mini-SEA), including the emotion recognition subtest, is often used to diagnose the behavioural variant of frontotemporal dementia (Bertoux et al., 2014). However, little is known about age-related differences on the emotion recognition component of the Mini-SEA. Therefore, this study will examine age-related differences in the emotion recognition task from the Mini-SEA, providing baseline data for future clinical studies.

It is important to understand the relationship between age-related differences in other cognitive domains and that observed in social cognition. Fluid intelligence is the ability to think abstractly and solve problems independent of any previously acquired knowledge. Fluid intelligence is often measured with a single test (e.g., Raven's progressive matrices (Raven, 1938) and it is highly correlated with a general common factor or Spearman's *g* (Duncan, Chylinski, & Mitchell, 2017; Martin, Mowry, Reutens, & Robinson, 2015). An age-related decline in fluid intelligence is well-documented and this has been suggested to partially (Martin, Barker, Gibson, & Robinson, 2021) or fully (Rabbitt & Lowe, 2000) mediate age-related declines in other frontal processes such as executive abilities. As social cognition is also reliant on frontal processes (Schurz, Radua, Aichhorn, Richlan, & Perner, 2014) and is associated with executive processes and fluid intelligence (Martin, Barker, Gibson, & Robinson, 2021; Roca et al., 2011; Wade et al., 2018), it is important to assess the unique social cognitive processes captured by the TASIT-S. As the TASIT-S was designed to improve the assessment of social cognition in a clinical setting (McDonald et al., 2018), it is essential that age-related differences are not captured using alternate measures that already form part of a standard neuropsychological assessment.

A female advantage on social inference tasks has been identified (Gur et al., 2012) but the extent of the advantage is disputed (Di Tella, Miti, Ardito, & Adenzato, 2020). Moreover, the consistency of this advantage across the lifespan is understudied. Previous studies using the TASIT have failed to find an advantage in older female adults (McDonald et al., 2018), although an older female advantage on emotion recognition using alternative measures has been identified (Abbruzzese, Magnani, Robertson, & Mancuso, 2019). Understanding age-related and sex-related differences on social cognition is essential for the correct measurement of cognitive decline or for the assessment of impaired social inference in pathological ageing conditions such as dementia. This is particularly relevant considering the higher prevalence of Alzheimer's Disease (AD) and frontotemporal lobar degeneration in females and sex-related differences in both the onset and specific characteristics of both diseases (Illan-Gala et al., 2021; Mielke, Ferretti, Iulita, Hayden, & Khachaturian, 2018; Nebel et al., 2018).

Education level is another key factor often overlooked in studies reporting age-related cognitive differences using cross-sectional designs, which is problematic due to the complex interaction between education level and cognition

(Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000). Higher education level is associated with greater cognitive reserve that may act to buffer against healthy or pathological age-related brain changes (Stern, 2012). Moreover, a higher education level is associated with reduced risk for pathological ageing conditions such as dementia (Prince, Albanese, Guerchet, & Prina, 2014) and cognitive impairment in general (Makkar et al., 2020), and should be considered in studies addressing cognitive differences from middle to older adulthood.

Therefore, this study aims to provide evidence for age-related differences on two specific social cognition measures, the TASIT-S and Mini-SEA, and identify the contribution of general cognitive functions and differences attributable to sex and education level. We hypothesized that performance on both social cognitive measures would would show a negative relationship with age that would not be explained by differences attributable to fluid intelligence or executive functions. It was expected that females and those with higher education attainment would show superior social inference and emotion recognition. However, these would not explain age-related differences. In addition, we provide normative data for the TASIT-S Part B and Mini-SEA Part B in a midlife to older adult sample.

Methods

Participants

One hundred and eighty-seven adults aged between 43 and 81 years (cross-sectional study), with no history of psychiatric or neurological disorder, were recruited through the prospective imaging study of aging (PISA; Lupton et al., 2020). Twenty-five participants who completed the Mini-SEA Part B – Emotion Recognition task did not complete the TASIT-S Part B Sincere and Sarcasm task. Therefore, the sample size for the TASIT-S Part B was 160. All participants completed the baseline cognitive tasks and provided the reported demographic information. Participants completed all cognitive assessments at the University of Queensland Neuropsychology Research Clinic or Centre for Cinical Research by trained neuropsychologists. The tasks included in this study form part of a larger battery of tests (see Lupton et al., 2020). However, this study is the first to analyze the TASIT-S and Mini-SEA data. All participants provided informed written consent. The study received ethical approval through the Human Research Ethics Committees (HREC) of QIMR Berghofer Medical Research Institute and the University of Queensland.

General cognitive tests

The Matrix Reasoning and Similarities tasks from the WASI-II (Wechsler, 2011) were used as measures of general intelligence with Matrix Reasoning measuring fluid intelligence and nonverbal abstract reasoning and the Similarities task a measure of verbal abstract reasoning. Auditory verbal attention was measured using the Digit Span Total score from the WAIS-IV (Wechsler, 2003). It should be noted that results were comparable whether Digit Span Forwards, Backwards, or Total was used. Therefore, total scores were used throughout.

Mini-SEA emotion recognition

The Emotion Recognition subtest from the Mini-SEA (Bertoux et al., 2012a; Bertoux et al., 2012b) was used to assess facial emotion recognition. The mini-SEA has been shown to be a reliable and valid measure of emotion recognition in both healthy older adults and clinical cohorts (Bertoux, Michalon, & Blanc, 2020). Participants were shown 35 faces and were asked to identify the emotion from the same seven choices (happy, surprised, neutral, sad, fear, disgust, anger). Five examples of each emotion were presented. A total accuracy score was calculated by summing performance across the seven emotions for a total out of a possible 35.

TASIT-S part B

Part B of the TASIT-S measures the ability to accurately detect sincere and sarcastic exchanges. The TASIT-S has been shown to be a reliable and valid measure of social inference in healthy older adults (McDonald et al., 2018). It consists of nine ambiguous conversational exchanges shown via short video clips that were either sincere ($N = 4$) or sarcastic ($N = 5$) in manner. Each video is accompanied by four questions: What someone is doing? What someone is trying to say? What someone is thinking? What someone is feeling? A total accuracy score was calculated out of 16 for sincere exchanges and 20 for sarcastic exchanges.

Table 1. Demographic characteristics, baseline cognitive scores, and performance on Mini-SEA Part B and TASIT-S Part B across the whole sample ($N = 187$) and separated by age groups

	All	43–54 years	55–64 years	65+ years
N	187	37	92	58
Sex	48 M/ 139 F	9 M/ 28 F	22 M/ 70 F	17 M/ 41 F
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
Age	60.43 (6.84)	50.32 (3.26)	59.74 (2.69)	67.97 (3.11)
Education (years)	13.61 (2.96)	14.51 (3.12)	13.59 (2.91)	13.07 (2.84)
Matrix Reasoning	19.46 (3.19)	18.62 (3.91)	17.62 (4.43)	18.48 (3.99)
Digit Span	19.86 (4.07)	19.70 (3.69)	19.79 (4.44)	20.07 (3.72)
Similarities	32.50 (4.37)	32.46 (4.95)	32.36 (4.20)	32.74 (4.30)
Mini-SEA Part B	27.86 (3.08)	27.65 (3.07)	28.18 (2.90)	27.47 (3.36)
TASIT-S Part B Sincere	12.52 (3.63)	13.71 (2.83)	12.82 (3.87)	11.13 (3.30)
TASIT-S Part B Sarcasm	18.40 (2.18)	18.12 (2.77)	18.50 (2.12)	18.41 (1.78)

Note: All analyses conducted using age as continuous variable.

Statistical analyses

All analyses were conducted using JASP (version 0.11.1) (JASP Team, 2020). All data were inspected for outliers and all were deemed acceptable. Age, Education level, Sex (male as reference group for regression analyses), and the three general cognitive test variables, Matrix Reasoning, Similarities, and Digit Span Total were included in regression models predicting either emotion from the mini-SEA, or sincere, or sarcasm subscores of the TASIT-S. Standardized Beta is reported throughout to indicate size of the effect. All analyses were conducted using age as a continuous measure. For descriptive purposes and for baseline comparisons for clinical applications, we present descriptive data across three age-groups.

Results

A summary of demographic and cognitive test scores is presented in Table 1. Linear regression models were fitted for emotion recognition, and sincere and sarcasm accuracy. Age, sex, education, Matrix Reasoning, Similarities, and Digit Span Total were included as predictors in all models.

Emotion recognition

The model examining the emotion recognition component of the mini-SEA was significant, $F(6,186) = 8.04$, $p < 0.001$, with a model fit of $R^2 = 0.21$. Both Female Sex (Beta = 0.34, $p < 0.001$) and better performance on the Digit Span (Beta = 0.19, $p = 0.007$) were significant predictors of better emotion recognition. Age (Beta = −0.003, $p = 0.97$), Education (Beta = 0.14, $p = 0.06$), Matrix Reasoning (Beta = 0.03, $p = 0.73$), and Similarities (Beta = 0.12, $p = 0.11$) were all nonsignificant.

Sincere

The model examining the sincere recognition component of the TASIT-S (Part B) was significant, $F(6,161) = 2.89$, $p = 0.01$, with a model fit of $R^2 = 0.10$. Both younger age (Beta = −0.23, $p = 0.003$) and higher Matrix Reasoning scores (Beta = 0.18, $p = 0.03$) were significant predictors of greater accuracy for correctly judging sincere exchanges. Sex (Beta = 0.04, $p = 0.61$), Education (Beta = −0.06, $p = 0.45$), Similarities (Beta = −0.07, $p = 0.42$), and Digit Span (Beta = −0.03, $p = 0.75$) were all nonsignificant. The significant relationship between age and recognition of sincere exchanges is displayed in Fig. 1.

Sarcasm

The model examining the sarcasm recognition component of the TASIT-S (Part B) was not a significant fit, $F(6,161) = 2.10$, $p = 0.06$. It should be noted that although the overall model just failed to reach significance, age was not a significant predictor (Beta = −0.08, $p = 0.33$). The nonsignificant relationship between age and the recognition of sarcastic exchanges is displayed in Fig. 2.

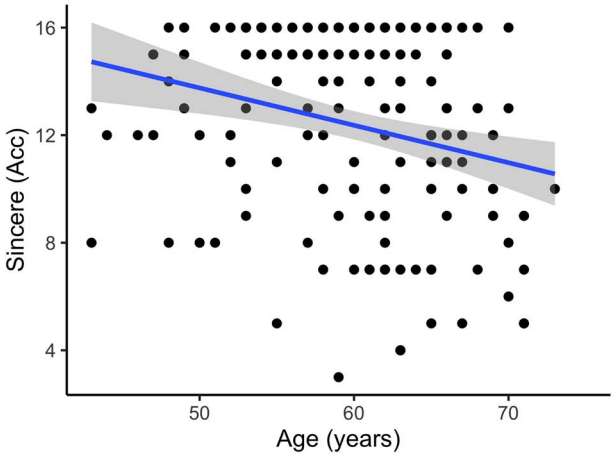

Fig. 1. Accuracy for sincere exchanges was negatively associated with age. The blue line represents the line of best fit and the shaded grey area represents the 95% confidence interval.

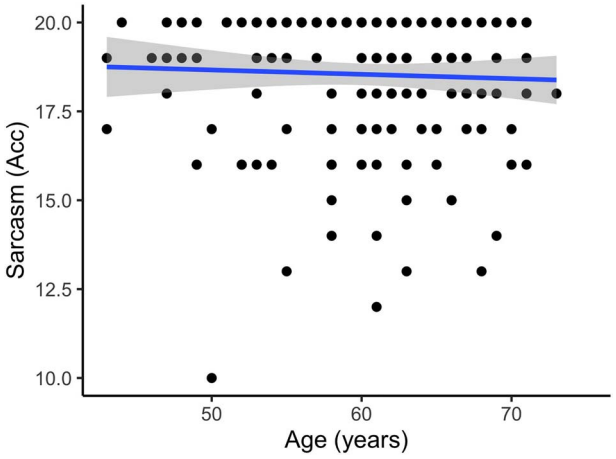

Fig. 2. Accuracy for sarcastic exchanges was not associated with age. The blue line represents the line of best fit and the shaded grey area represents the 95% confidence interval.

Discussion

Advanced age is associated with reduced social cognitive ability (Henry, Phillips, Ruffman, & Bailey, 2013; Martin et al., 2019; Sullivan, Ruffman, & Hutton, 2007). In this study, we assessed age-related differences on two tasks, commonly used clinically to assess social functioning, in a sample of middle to older adults. We also investigated the role of sex, education level, and general cognitive functioning in age-related differences for the two social cognitive measures. Our findings show that increased age was associated with greater difficulty in accurately detecting sincere exchanges between actors. Although fluid intelligence predicted accuracy for sincere exchanges, this did not account for the age-related difference. Emotion recognition was not associated with age but performance was superior in females and those who performed better on the auditory verbal attention task. Sarcasm detection showed no age-related difference and was not associated with demographic factors or general cognitive functioning.

The observed difference in sincere but not sarcastic exchanges is consistent with previous findings using the shorter TASIT-S (McDonald et al., 2018) and in contrast to previous studies using the longer version (Phillips et al., 2015). It has been previously suggested that sincere exchanges require greater cognitive capacity to select between the greater number of possible interpretations, whereas sarcastic exchanges are explicit and unambiguous (McDonald et al., 2018). The notion that sincere exchanges require the ability to select is in line with research showing that selection ability declines with age (Madden, Sale, & Robinson, 2019) and that selection impairments are associated with the left lateral prefrontal cortex (e.g., Robinson, Blair, & Cipolotti, 1998; Robinson, Shallice, Bozzali, & Cipolotti, 2010; Robinson, Shallice, Bozzali, & Cipolotti, 2012;

Robinson, Shallice, & Cipolotti, 2005), which is a region shown to decline in older adults (e.g., Kievit et al., 2014). With regard to sarcastic exchanges, others have suggested that the detection of sarcasm requires significant contributions from cognitive processes such as ToM, empathy, emotional recognition, and decision-making (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005). Our finding of an association between fluid intelligence and accuracy for sincere but not sarcastic exchanges supports the claim that the sincere exchanges are cognitively more demanding in the short version of the TASIT. However, it is important to note that age-related differences in performance remained with fluid intelligence included in the model. Therefore, age-related differences on accuracy for sincere exchanges does not simply reflect differences in general cognitive functioning. It is also possible that deciphering sincere exchanges when presented alongside an approximately equal number of sarcastic exchanges is more cognitively demanding than what would be expected in real-life exchanges, where the default position is likely to be that the utterance is sincere until otherwise determined with the aid of the cognitive systems labelled earlier.

In contrast to previous research with older adults using the TASIT-S (McDonald et al., 2018), we found no relationship between age and emotion recognition using the Mini-SEA. It should be noted that although our sample was of comparable size, our sample is a midlife cohort that extends to older adults. In this study we also controlled for education level, which may explain the discrepancy with previous research. Years of formal education has been identified as a moderator of age-related effects on emotion recognition (Goncalves et al., 2018) and should be considered when interpreting cross-sectional data between young and older adults. We also adopted a continuous model of age effects rather than creating age bins (e.g., 60–74 years). This approach allowed us to control for confounding effects and provide a linear fit using regression models. No age-related decline in emotion recognition ability supports previous research findings (Murphy, Millgate, Geary, Catmur, & Bird, 2019) and reinforces the need to control for confounding factors. The results strengthen evidence for the maintenance of certain cognitive abilities into advanced age, especially those involved in affective processing.

A further contrasting finding to previous research using the TASIT, was the superior performance of females on the emotion recognition task. A sex advantage for emotion recognition has been identified across a number of alternate emotion recognition tasks (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Hampson, van Anders, & Mullin, 2006; Saylik, Raman, & Szameitat, 2018; Schiffer, Pawliczek, Muller, Gizewski, & Walter, 2013) and the present findings are consistent with research showing a female advantage remains in later life (Abbruzzese, Magnani, Robertson, & Mancuso, 2019). As the mini-SEA and TASIT-S are designed to be used in clinical settings to document social cognitive decline, it is important to understand baseline sex differences in older adults. As dementia disproportionately affects women (Alzheimer's Association, 2020), through both living longer (Plassman et al., 2007) and for psychosocial reasons (Hasselgren et al., 2020), understanding sex differences will improve monitoring of cognitive decline in both sexes.

Our results apply to specific aspects of the TASIT-S, Mini-SEA, and the general cognitive function measures used. Future research is required to assess the relationship between other cognitive tasks, or domains, on social cognition as measured by the TASIT-S and the Mini-SEA. As our study adopts a cross-sectional design, longitudinal evidence is required to confirm age-related declines within individuals. Although the TASIT-S presents naturalistic social exchanges in the form of short video clips, the presentation of sarcastic statements alongside sincere statements in a controlled experimental manner, may increase the cognitive demand on determining whether an exchange is truly sincere. For example, investigating age-related changes in social inference using more naturalistic, ecologically valid, spontaneous social exchanges will likely provide novel insights into age effects on social cognition. This line of research should also consider social interaction rather than the passive viewing of social exchanges, in which the participant is simply observing rather than actively participating (Schilbach et al., 2013). As the cohort of older adults was drawn from the metropolitan area of Brisbane, Australia, it is overrepresented by Caucasians and those from a Western cultural background. As cultural upbringing influences social cognition (Vogeley & Roepstorff, 2009), future research will be required to assess the generalizability of age-related changes on the TASIT-S. It should also be noted that although our sample size is reasonable to assess age-related differences from middle to advanced age, larger sample sizes will be required to provide comprehensive norms for future clinical studies. Larger samples will be required to determine if age is related to differences in the recognition of specific emotions rather than the general emotion recognition index used in the present study. Such studies will be able to compute sensitivity for detecting each emotion and consider the effect of false positives. Future studies should also aim to identify the age-related brain-based changes that affect performance on the mini-SEA, TASIT-S, and other social inference tasks. For example, age-related differences have been identified within a broader social brain network (Kwak, Joo, Youm, & Chey, 2018), especially the dorsomedial prefrontal cortex (Moran, Jolly, & Mitchell, 2012), a region thought to be involved in the integration of different sources of social information (Ferrari et al., 2016; Martin, Dzafic, Ramdave, & Meinzer, 2017). However, to date, brain-based analysis has not focused on age-related differences on the TASIT-S or mini-SEA specifically.

In sum, age-related changes were identified for the identification of sincere exchanges that was independent from general cognitive functioning. No age-related effects were identified for emotion recognition, although a female advantage was identified. No age or sex effects were identified for the detection of sarcastic exchanges.

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Conflict of Interest

None declared.

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