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# Episodic future thinking in 3- to 5-year-old children: The ability to think of what will be needed from a different point of view

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ABSTRACT

Assessing children's episodic future thinking by having them select items for future use may be assessing their functional reasoning about the future rather than their future episodic thinking. In an attempt to circumvent this problem, we capitalised on the fact that episodic cognition necessarily has a spatial format (Clayton & Russell, 2009; Hassabis & Maguire, 2007). Accordingly, we asked children of 3, 4, and 5 to chose items they would need to play a game (blow football) from the opposite side of the table on which they had never before played. The crucial item was the box that was needed by children to reach the table from the other side. Over four experiments, we demonstrated that, while children of 3 perform poorly on future questions and children of 5 generally perform quite well, children of 4 years find a question about what they themselves will need to play in the future harder to answer than a similar question posed about another child. We suggest that this result is due to the 'growth error' of over-applying newly-developed Level 2 perspective-taking skills (Flavell et al., 1981), which encourages the selection of non-functional items. The data are discussed in terms of perspective-taking abilities in children and of the neural correlates of episodic cognition, navigation, and theory of mind.



## 1. Introduction

Tulving (2005) coined the term 'chronesthesia' in order to capture the fact that both when we re-visit the past in episodic memory and envision the future in episodic future thinking (Atance & O'Neill, 2001) we consciously 'travel through time' while remaining in the present. If this mental time travel is indeed a unitary capacity, then one would expect re-experiencing and pre-experiencing – we shall borrow the useful term *prospection* for the latter (Buckner & Carroll, 2007; Gilbert & Wilson, 2007; Suddendorf & Corballis, 2007) – to develop at around the same time. However, in assessing both the development of episodic memory and that of prospection the researcher is dogged by a similar problem. Just as it is one thing successfully to remember a piece of information and quite another thing to recollect, qua re-experience, the picking up of this information, so one must draw a clear distinction between correctly making judgments about, and acting in terms of, future states and needs and actually projecting oneself into a future scenario – prospection. The first kind of capacity is informational and the second is phenomenological. Suddendorf and Corballis (2007) give an explicit analysis of the parallels between episodic memory and prospection in these terms.

Students of episodic memory development have dealt with the issue of how to distinguish between episodic recollection and semantic remembering in a number of ways. Perner, for example, has taken the difference between free recall (episodic) and cued recall (semantic) performance as a measure of episodic memory (Perner & Ruffman, 1995), and has made a similar contrast between the episodic and the semantic in terms of the distinction between memory for directly-experienced events and for ones that

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were experienced indirectly via a video recording (Perner, Kloo, & Gornik, 2007a). But how does one draw a distinction between successfully knowing about the future and prospecting it? This is the central issue that this paper addresses.

In the first place, we need to distinguish between studies in which the child's general future-oriented behaviour is assessed and those that at least have the potential for telling us about prospection, given that behaviour can be future-orientated without the agent actually envisioning any future state. In the first category fall studies of planning (Carlson, Moses, & Claxton, 2004) and of prospective memory (Guajardo & Best, 2000). Of course, the capacities just mentioned may indeed involve prospection; but they need not do so *prima facie*.

As for potential tests of prospection, experimental measures can be divided into three kinds. First, there are those studies that ask children questions about what they would and would not do tomorrow (Busby & Suddendorf, 2005). However, while children may indeed be using prospection to produce their answers, the questions can be answered on the basis of what they know about the future (though see Quon and Atance (2009), for a recent attempt to empirically distinguish between these possibilities). Second, there are tasks that require children to choose appropriately for a future motivational state when this conflicts with their current motivational states. In this domain, Atance and Meltzoff (2006) have shown that children between 3 and 5 years tend to predict future food preferences in terms of their present motivational state, saying for example, that tomorrow they will prefer water to pretzels because they are currently thirsty, having just eaten a lot of pretzels, which they generally prefer to water. That they should do this suggests that they find it difficult to imagine themselves in different motivational state in the future. There was little evidence for development across these ages. Also in this motivational category fall delay-of-gratification tasks in which children are invited to accept a smaller treat in the present in order to gain a bigger one in the future. Children might do this at age 4 (Mischel, Shoda, & Roderiguez, 1989) but individual differences are substantial (Carlson & Moses, 2001). The clear drawback to these two motivational procedures is that, in them, the ability to project mentally into the future is confounded by demands for executive inhibition. Needless to say, many of the tasks we give children in which they have to make a decision in which some options are more attention-grabbing than others (such as the task to be reported here) make executive demands; but in the case of the tasks just mentioned it would appear to be a primary requisite.

The third kind of study that at least has the potential for being a test of prospection are studies in which children have to select items for future use. The present study falls within this category, in fact. Proposals of this kind were simultaneously published by Tulving (2005) and by Suddendorf and Busby (2005), the latter authors backing up the idea with an experimental study. In fact, the general proposal was first made by Suddendorf (1994) in an unpublished Masters thesis.

Tulving's inspiration sprang from an Estonian folk tale about a small girl who dreamed one night about attending a party where a delicious-looking chocolate pudding was being served, which she was unable to taste as she had no spoon. The next night, on retiring to bed, she placed a spoon under her pillow. We shall refer to tasks of this kind as employing a 'spoon-test' methodology. Similarly, Suddendorf and Busby (2005) argued that if children can select items for a future need then they should, compared to a control group, be more likely to take items with them into a room in order to alleviate future boredom. In this 'rooms task', there were two rooms, one containing a puzzle board minus the puzzle pieces ('empty' room) and the other containing a number of items including puzzle pieces ('active' room). At issue was the question of whether children would take puzzle pieces from the active to the empty room to alleviate anticipated boredom. In the control group there was no puzzle board in the empty room. At around 4–5 years children did indeed select puzzle pieces as an insurance against future boredom more often than did control children. Loosely comparable procedures have been employed with apes (Mulcahy & Call, 2006; Osvath & Osvath, 2008); though note that in this case the animals received multiple trials. Note also that, while the present study employs something comparable to the spoon test procedure, we use verbal methods, asking the children what they or another child will need.

A further study by Atance and Meltzoff (2005) has addressed similar issues, although in this case the 3-, 4-, and 5 year olds were presented with stories and pictorial scenes designed to evoke thoughts about thirst, cold, and hunger. The children were then asked to imagine themselves in these scenarios (e.g., a snowy mountain) and point to one item on a picture card that they would need in that scenario. The items could be functional (e.g., a winter coat for cold) or non-functional but semantically associated (ice cubes for cold). Across scenarios, 5 year olds selected the functional items more than did the 3 and 4 year olds. Moreover, in a number of scenarios, 3- and 4 year olds chose the non-functional but semantically-associated items just as frequently as they chose the functional items. Atance and Meltzoff (2005) proposed that children develop the ability to anticipate future needs before age 5, but that this ability is not fully mature and is prone to error in certain situations, particularly those where the available options are semantically associated with the scenario.

There is, however, an interpretive problem with the spoon-test methodology which, as adumbrated earlier, derives from the fact that it does not necessarily test for children's ability to imagine themselves in a future scenario. That is to say, their choices may be based on impersonal reasoning and functional knowledge. For example, the child's decision to take puzzle pieces with her into the room could have been based on no more than reasoning of the kind: "Anybody left alone in that room will need puzzle pieces, so I'll pick some up." All that is required for this kind of reasoning is the general semantic or 'script-like' knowledge that board games cannot be played without the relevant pieces. This is to be distinguished from imaging oneself playing the game in the prospective 'theatre' (Suddendorf & Corballis, 2007) of the mind's eye. Similarly, in the Atance and Meltzoff (2005) study the child may simply be reasoning "What is needed in cold weather is a warm coat, so I shall pick that." Imaginative projection is not required in these cases.

How might one distinguish empirically between selecting an item for a future need on the basis of functional reasoning and doing so by prospection? We suggest that this can be done by exploiting the fact that episodic memory – *and indeed episodic cognition more generally* – essentially involves egocentric spatial representation. To explain this claim we shall briefly précis the case for a 'perspectival' interpretation of episodic memory made by Clayton and Russell (2009), generalising this to episodic cognition, so as to include prospection.

1. If episodic cognition amounts to re-experiencing (Tulving, 1999, p. 13) and pre-experiencing (Atance & O'Neill, 2001), then these two will inherit the necessary features of experience itself.
2. Following Kant (1781/1998) in the Transcendental Aesthetic section of the *Critique of Pure Reason*, all objective experience (where 'objective' can include bodily feelings) necessarily has spatial and temporal formats. That is, space and time are 'a priori' in the sense of being necessary for experience, rather than products of it. The spatial content refers to the perspectival spatial relation between subject and objects (egocentric relations such as left/right, up/down). For Kant, the temporal element refers to succession versus simultaneity (of elements within an event); but as these must be *bound* to the spatial element, the temporal element inherits this perspectival quality.
3. Accordingly, if we wish to assess whether or not subjects, such as a children, are engaging in episodic cognition then we must gauge the extent to which they are representing the spatial perspective of the past or future self in an episode.

Consider, in illustration, what we would naturally count as a case of memory in the sense of re-experiencing. If somebody says that he can remember the scoring of the winning goal in a soccer match but cannot recall whether he saw the goal from side-on, from behind the goal-mouth or from the far end of the pitch, from the back of the stadium or near the front, then we would be inclined to deny that this was a case of episodic recall. (If recall is ever reported from a third-person point of view, as some adult cases in Nigro and Neissser (1983), then it is either an imaginative reconstruction, or the original experience was of self-as-observed, something one would expect not to find in young children.) Similarly, if somebody says that she can envision "in my mind's eye" her dinner with John *tomorrow night* but is agnostic about whether she will be sitting *vis-à-vis* or side-by-side him then we would tend to say that, despite what the speaker claims, this cannot be a case of episodic future thinking.

This leads to the following empirical claim about children's performance in spoon-task situations. If children are really envisioning a future state of the self within a scenario, then they will not only be able to select items they need in that scenario but will be able to select items they need to use from a particular spatial location within that scenario. Moreover, in order to ensure that they are not performing this spatial projection task by duplicating their present spatial position, it needs to be the case that they have to project to, and select an item needed at, a position at which the item has never been used. (Compare the case in which somebody prospects seeing a goal scored from their usual seat in the stadium, which can be done from memory, with the case in which this is done from a position in which the individual has never before sat.)

Before we give the specifics of such a task a caveat has to be entered. The claim is not being made here that if children pass a task of this kind then they must necessarily be doing so by prospection. As will be seen, the claim is rather that, when combined with different kinds of question, such as task can yield significant clues about whether a-personal, functional reasoning or prospection is being used.

The task we used is called the Blow Football task. Blow football is a form of table soccer in which each of two players defends a goal on one side of a table and attacks the opponent's goal on the other side. The ball is a ping-pong ball and each player projects it by blowing through a drinking-straw. The prototypical experimental situation was this. Our blow football table was such that only one side of it was reachable by a preschool child without standing on a yellow box. Children stood on this box *before* playing. The side on which the box was needed was the blue side and the reachable side was red. The child plays the game with the experimenter, with the child standing at red and experimenter at blue. After this, the child is asked to pick, from 6 items, which two he or she will need when she/he returns to play the game again the next day from the *blue* (unreachable) side. See Fig. 1 for a schematic illustration. There were two functional items (the yellow box and the straw) and four non-functional ones (such as a doll referee). The ball was always present. We included the straw as a functional item for two reasons: (1) to ensure the child

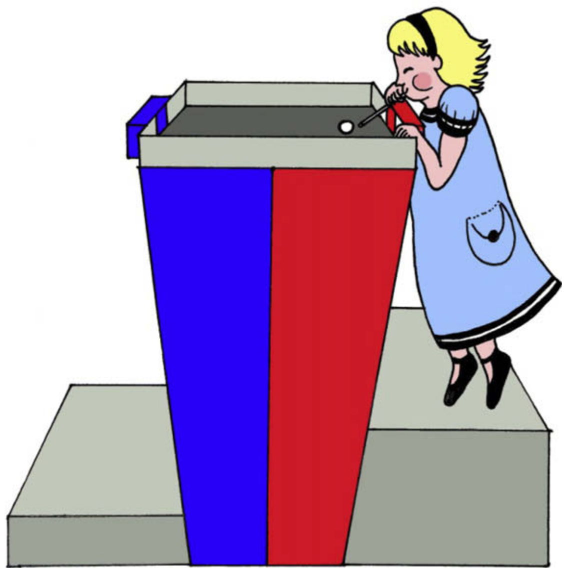

**Fig. 1.** A schematic representation of a child playing on the red side. Drawing by Sanne de Wit.

was choosing items to *play* the game and not merely to reach the table or make the table-platforms symmetrical; (2) to make a child's being correct by chance less likely.

If a child correctly chooses the straw and box, then, while it is possible that this was done by prospection, that interpretation is by no means mandatory, as the task will inevitably be passable by purely functional reasoning such as 'anybody who plays on the blue side will need the box'. However, it is possible to discover something about whether prospection is being used here by comparing children's answers to self-projection future questions with their answers to *other*-projection questions (e.g., "What would another little girl just like you need...?"). This is because the essence of prospection is projection of the *self* towards a future state and not merely thinking functionally about that state insofar as it would make functional demands on anybody. If the answers do not differ, then the appropriate conclusion is that there is no evidence for prospection in children of this age. However, if there is a difference in difficulty in one direction or another then it is likely that the *achieved* (self condition superior) or *inadequately attempted* (other condition superior) act of prospection is playing a role.

We tested children between 3 and 5 years because, as the previous literature review suggests, it is within this age range that future-orientated thinking and behaviour seems to develop. Moreover, in an extensive analysis using a number of tasks (item selection for the future, delay of gratification, planning, prospective memory) Atance and Jackson (2009) confirmed that it is within these ages that significant development takes place.

Finally, in order to ensure that it is their being asked about future states that is challenging the children, and not the perspective-taking or other demands of the task, our first study included conditions in which children are questioned about the present and the past. In any event, perspective-taking of the kind required here is generally taken to be within the capacity of children within the age-range studied, with 3 year olds being above chance in Newcombe and Huttenlocher's (1992) task in which children had to project themselves to different locations and report on the positions of landmarks (left–right, etc.) in relation to their body at these new locations. For reviews see Newcome and Huttenlocher (2000) and Newcombe and Huttenlocher (2006).

We shall report four experiments:

(1) to confirm that children of 3–5 years can pass the Blow Football task when (a) the self-projection question is about the present and (b) the 'other' question is about the past not the future, with these conditions crucially having in common their not being about the future;
(2) directly to compare performance on self- and other-projection *future* questions at all three ages;
(3) given the outcome of Experiment 2, to do the same as (2) for age 4 only;
(4) to ask whether the self-other differences in 4 year olds that emerged in (3) were specific to questions about the future, or whether the same would be found with self-other questions framed in the present tense.

## 2. Experiment 1

In this experiment the aim was to determine whether the blow football task can be passed by children between 3 and 5 years when the challenge to project the self into the future is *not* required. What 'passing' the task at a certain age amounts to is that, at this age, the number of children choosing correctly the two functional items from the six is greater than chance.

Two conditions were run, with children at each of 3, 4, and 5 years. In one of our conditions, the children were asked to say which two of the six items they needed to play the game from the blue (unreachable) side "right now." This is the *present-self* condition. In the second condition, the idea was to determine whether children in this age range can indeed answer the question from the point of view of other children when they did not have to do this for a future state. In this case we framed the question in the past tense as being about "another little girl/boy" who played the game "yesterday." We chose the past tense because it was reasoned that 'other' questions could more naturally be employed in a past than a present context. This is the *past-other* condition. (Data from a present-other condition will be reported in a later study.)

### 2.1. Method

#### 2.1.1. Participants

The majority of participants in this and all studies came from middle-class backgrounds. Parents and children were recruited by telephone and in person from a number of nurseries, church groups, schools, day-care centres, and play-groups, in a city in the east of England.

Thirty-six preschool children (21 boys, 15 girls) performed in the *present-self* condition. Children were divided into three groups ($n = 12$ per group) according to age: 3 year olds (mean age = 43.0 months; range of 3;2 to 3;11), 4 year olds (mean age = 51.9 months; range 4;0 to 4;8), 5 year olds (mean age = 63.6 months; range 5;0 to 5;11). Three children were eliminated and replaced from this condition for the following reasons: refusal to participate or parent interference during questioning ($n = 1$), recruitment error ($n = 1$), experimenter error ($n = 1$).

Thirty-six preschool children (19 boys, 17 girls) took part in the *past-other* condition. Children were allocated to three groups ($n = 12$ per group) according to age: 3 year olds (mean age = 41.7 months; range 3;0 to 3;11 months), 4 year olds (mean age = 53.1 months; range 4;1 to 4;10), 5 year olds (mean age = 66.0 months; range 5;1 to 5;10). Two children were eliminated and replaced from this condition for the following reasons: repeatedly pointing to all the items on the picture card ($n = 1$), experimenter error ($n = 1$).

#### 2.1.2. Apparatus

All test sessions in were filmed using a Panasonic (AG-6200) VHS or Phillips Hard Disk (7260H) recording system, in a developmental laboratory with remotely-controlled cameras. The main testing apparatus was a specially-constructed blow football table. See Fig. 1.

One side of the table was painted blue, and the other red. The tabletop was 70 cm long × 65 cm wide. The height of the table was 105 cm. The height of the table made it impossible for 3-, 4-, and 5-year-old children to see the top without aid, so each side was equipped with a platform affixed to the floor on which children could step. The platform on the red side was high enough for children to view the tabletop, but the one on the blue side was not. The platform on which the player stood on the red side was 60 cm long × 60 cm wide × *38* cm high. The equivalent platform on the blue side was 60 cm long × 60 cm wide × *10* cm high. The functional items that were necessary to play blow football from the blue side, in addition to the ball, were a straw (to blow the ball) and the yellow box (60 cm long × 60 cm wide × *28* cm high, to see the tabletop on the blue side). The non-functional items that were not necessary to play blow football were a cardboard referee, a stuffed animal spectator, a team badge necklace, and a pair of football boots. The child wore the team badge round his or her neck, the spectator and the referee were set on the tabletop during the game, and the boots were placed in plain view near the table.

### 2.1.3. Procedure

Once children seemed comfortable in the lab, the experimenter told them that they were going to play a game called blow football. They were then lead from the interview area to the testing area. The child's mother or other caretaker was present throughout. In the testing room, the caretaker was asked to stand on the blue side (unreachable side) while the child was asked to step up onto the yellow box which was placed next to the table, so he or she could view the tabletop.

Once child and the caretaker were in their respective positions, the experimenter said, "We're going to play a game called blow football, and the point of the game is to take our straw [experimenter showed the child the straw] and use it to blow the ball [experimenter showed the child a coloured ping-pong ball] into the other team's goal, like this [experimenter blew the ball into the goal]."

The experimenter continued by explaining to the child what each of the functional and non-functional items did. "There's a bunch of cool things with this game. This is the referee [experimenter showed the child each item in turn]; he watches the game. This is the spectator; she watches the game. These are some football boots that make the place look really cool. This is our straw, which blows the ball, and this team badge makes you look really cool [experimenter hung the team badge around the child's neck]. Now when two people blow the ball it looks like this."

The caretaker and the experimenter then played the game for at least a minute to stimulate the child's interest, and to make it clear that the point of the game was to blow the ball into the opponent's net. Afterwards, the child was given the caretaker's straw and was told to take the caretaker's position on the blue (unreachable) side. The child was given the opportunity to play the game on this side but immediately realised that it was impossible to reach the tabletop. The experimenter then said "Oh, you can't reach on this side. I know! This yellow box will help you see on the blue side." The experimenter then placed the box on the low platform. The child stepped up onto the box, which allowed the child to view the tabletop. At this point, the experimenter excused himself briefly "to check something in the other room," surreptitiously taking the ball with him. This was done to ensure that the child had experience using the box to view the tabletop on the blue side without actually playing the game on that side.

When the experimenter re-entered the room, he told the child that everything was okay in the other room and that they were now going to play blow football. Before the game began though, the child was told "Blue is my favourite colour, and I really want to play on this side, so can you go over to the red side and play?" All children readily agreed to this request, and once the child was standing on the red side, the experimenter removed the yellow box from the low platform on the blue side and said, "I'm going to move this yellow box because I'm tall enough and don't need it to play." The yellow box was returned to its place next to the table. The child and the experimenter then played blow football. The duration of the game varied between children, depending on their interest and ability. The child always won.

Immediately following the game, the child was congratulated and asked to step down from the red side. Each child was asked the test question next to the table with all of the functional and non-functional items being placed directly in front of them on the yellow box. The child was then shown a laminated card (43 cm long × 31 cm high) containing pictures of all the functional and non-functional items. He or she was then asked one of two test questions and invited to point to two items on the card. The reason why the children were directed to photographs of the items rather than to the items themselves was in order to give each of the items equivalent visual salience, given that the originals were of widely varying sizes.

*Present-self*:

> "We're going to play blow-football one more time, but you're going to play on this side, the blue side by the window. As well as the pitch and the ball and the goals, point to the two things you have to have to play blow-football right now on this side, the blue side?"

*Past-other*:

> "Yesterday, a little girl/boy [depending on child's gender] just like you played blow football on this table. When she played, she was on the blue side, the far side by the window. As well as the pitch and the ball and the goals, point to the two things you think the little girl had to have to play blow football on the blue side?"

This was a forced choice question insofar as the child had to choose two different items only. If a child picked the same one twice, he or she was asked to choose another item. If the child began pointing to additional items, he or she was stopped, and the experimenter asked the question again. If the child did not select two items at this point, he or she was excluded from the data. The items the child pointed to were marked, and afterwards, parents were paid £8 and given a VHS cassette or DVD of their child's performance. Children were thanked for their help and provided with the materials to play blow football at home.

*Correct conjoint choices and statistical analysis.* In order to pass the test question, a child had to make the correct conjoint choice of both functional items (i.e., straw, box). The probability of passing the test question (i.e. correct conjoint choice of both functional items) solely by chance is 2/30.[1] The converse of this probability is the probability that a child would fail the test question (i.e. missing one or both functional items; 28/30). The two values (pass = 2/30, fail = 28/30) were used as the expected values in a 2 (pass, fail) $\times$ 1 (condition) *Pearson Chi Square* $\chi^2$ goodness-of-fit test to assess whether more children in this condition passed the test question than would be expected by chance. A 3 (3 years, 4 years, 5 years) $\times$ 2 (pass, fail) contingency test was used to determine whether there was a significant relationship between age and performance. To assess whether more children in each age group were making correct conjoint choices than would be expected by chance, a series of 2 (pass, fail) $\times$ 1 (age group) goodness-of-fit tests were run. Finally, multi-dimensional chi-squares were carried out to determine whether there were any significant differences in performance between age groups. In all analyses, Alpha was set at 0.05. For tests with a *p*-value close to significance the exact *p*-values are reported. Performance (pass, fail) was analysed in this way for this and all subsequent experiments.

In addition to the data on conjoint selections we shall also report the results of this and all subsequent experiments in terms of whether children made any functional selections at all: choosing no functional items, choosing one of them, or choosing neither. While we shall base our discussion of the data principally on the incidence of children selecting the box to play from the far side (i.e., selecting both the box and the straw) these data can throw light on ambiguities, in addition to fleshing out necessary detail.

### 2.2. Results

#### 2.2.1. Children making correct conjoint choices

*Present-self*: Fig. 2 shows the proportion of children in each age group in the present-self condition who made the correct conjoint choice of the straw and the box. Overall in this condition, more children made the correct conjoint choice of both functional items than would be expected by chance: $\chi^2(\mathrm{df} = 1,\ n = 36) = 41.14,\ p < 0.001$. As there was no relationship between age and performance [$\chi^2(\mathrm{df} = 2,\ n = 36) = 0.75$, n.s.], individual comparisons between age groups were not carried out. Of the 12 children in each age group, 42% (5/12) of 3 year olds, 25% (3/12) of 4 year olds, and 33% (4/12) of 5 year olds made the correct conjoint choice. A series of goodness-of-fit tests revealed that, at each age, more children selected the conjoint choice of both functional items than would be expected by chance: 3 year olds, $\chi^2(\mathrm{df} = 1,\ n = 12) = 23.62,\ p < 0.01$; 4 year olds, $\chi^2(\mathrm{df} = 1,\ n = 12) = 6.48,\ p < 0.05$; 5 year olds: $\chi^2(\mathrm{df} = 1,\ n = 12) = 13.71,\ p < 0.01$.

*Past-other*: Fig. 3 shows the proportions of children in each age group making the correct conjoint choice of the straw and the box in the past-other condition. Overall, more children made the correct conjoint choice than would be expected by chance ($\chi^2(\mathrm{df} = 1,\ n = 36) = 70.87$, $p < 0.001$). Of the 12 children in each age group, 42% (5/12) of 3-, 4-, and 5 year olds made the correct conjoint choice. Goodness-of-fit tests showed that more children in each age group selected the conjoint choice of both functional items than would be expected by chance: $\chi^2(\mathrm{df} = 1,\ n = 12) = 23.62,\ p < 0.01$.

### 2.3. Overall functional choices

In Table 1A are presented the same data broken down in terms of whether the children chose no functional items, chose one of then, or chose both. It will be seen that, in both tasks the incidence of selecting no functional items was relatively low. The distribution of the data diverged significantly from chance in both the present-self [$\chi^2(\mathrm{df} = 2,\ n = 36) = 7.00,\ p < 0.05$] and in the past-other conditions: [$\chi^2(\mathrm{df} = 2,\ n = 36) = 16.15,\ p < 0.001$.

### 2.4. Discussion

This experiment unambiguously confirmed that even children as young as three are able to pass the blow football task when (a) the question is posed in the present tense and (b) when the 'other' question does not concern a future state. This clears the way for a comparison between performance on a future-self and a future-other condition.

## 3. Experiment 2

### 3.1. Method

#### 3.1.1. Participants

Seventy-two children aged between 3;0 and 5;11 took part in this experiment. Thirty-six children (15 boys, 21 girls) were allocated to the *Future-self* condition. These children were separated into three groups ($n = 12$ per group) according to age: 3 year olds (mean age = 42.2; range 3;0 to 3;11), 4 year olds (mean age = 52.8 months; range 4;0 to 4;11), 5 year olds (mean age = 65.3 months; range 5;0 to 5;11). Eleven children were eliminated and replaced from this condition for the following reasons: refusal to participate or parent interference ($n = 4$), repeatedly pointed to all the items on the picture card ($n = 2$), too tall for the apparatus ($n = 1$), experimenter error ($n = 4$).

Thirty-six children (20 boys, 16 girls) were allocated to in the *Future-other* condition. Children were separated into three groups ($n = 12$ per group) according to age: 3 year olds (mean age = 40.4 months; range 3;1 month to 3;11), 4 year olds (mean age = 53.2 months; range 4;1 to 4;11),

[1] The probability of passing the test question was calculated in the following way. As there were two functional items and four non-functional items involved in the game (total items, $n = 6$), the probability that a child would choose a functional item on his/her first choice is 2/6 (i.e. two functional items out of six total items). The probability that a child would then choose the other functional item on his or her second choice is 1/5 (i.e. one functional item out of the remaining five items). These two probabilities are multiplied together to produce the probability that a child would pass the test question by choosing both functional items solely by chance (i.e. $2/6 \times 1/5 = 2/30$).

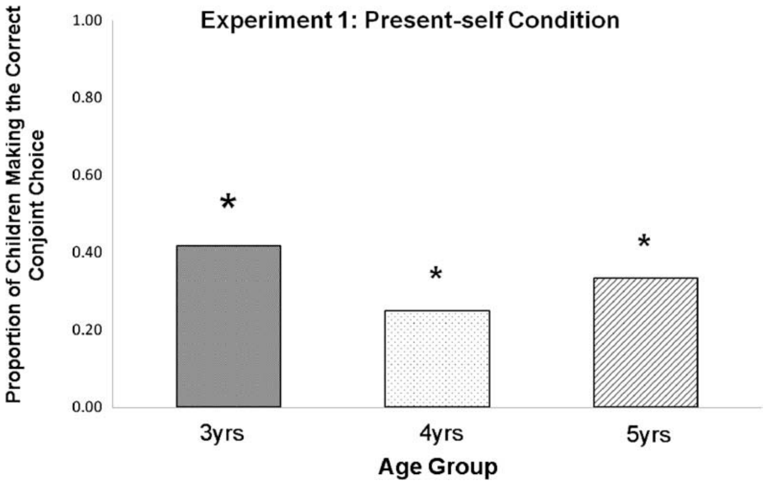


**Fig. 2.** The proportions per age-group of children selecting the two functional items, straw and box in the present-self condition. Twelve children per group. The asterisk means better-than-chance performance.


**Fig. 3.** The proportions per age-group of children selecting the two functional items, straw and box in the past-other condition. Twelve children per group. The asterisk means better-than-chance performance.

5 year olds (mean age = 65.6 months; range 5;0 to 5;11). Eight children were eliminated and replaced in this condition for the following reasons: refusal to participate, or parent interference during questioning ($n = 2$), too tall for the apparatus ($n = 1$), experimenter error ($n = 5$).

*3.1.2. Apparatus*

This was the same as in Experiment 1.

*3.1.3. Procedure*

The only differences between the procedures for this experiment and for Experiment One resided in the test questions, and in the fact that the children in the future-self condition did indeed return to play the next day, as they had been told they would. The future-self question was:

> "Tomorrow, you're going to come back and play blow football. When you play tomorrow, you're going to be on the blue side, the far side by the window. You won't be able to use all these things because other people use this room, and I'm going to bring them home tonight. So, as well as the pitch and the ball and the goals, point to the two things you want me to save for you so you can play blow football properly on the blue side tomorrow?"

The test question in the future-other condition was as follows:-

> "Tomorrow, a little girl just like you will play blow football on this table. When she plays, she will be on the blue side, the far side by the window. As well as the pitch and the ball and the goals, point to the two things

**Table 1**
Percentages of children in each group making any functional selections, in all experiments.

| | Selecting neither | Selecting one | Selecting both |
|---|---|---|---|
| *A. Experiment 1* | | | |
| Present-self | | | |
| 3 years | 25 | 33 | 42 |
| 4 years | 8 | 67 | 25 |
| 5 years | 17 | 50 | 33 |
| Past-other | | | |
| 3 years | 0 | 58 | 42 |
| 4 years | 8 | 50 | 42 |
| 5 years | 0 | 58 | 42 |
| *B. Experiment 2* | | | |
| Future-self | | | |
| 3 years | 42 | 58 | 0 |
| 4 years | 58 | 42 | 0 |
| 5 years | 17 | 50 | 33 |
| Future-other | | | |
| 3 years | 50 | 33 | 17 |
| 4 years | 17 | 50 | 33 |
| 5 years | 50 | 25 | 25 |
| *C. Experiment 3* | | | |
| 4 years future-self | 69 | 25 | 6 |
| 4 years future-other | 19 | 37 | 44 |
| *D. Experiment 4* | | | |
| 4 years present-self | 25 | 43 | 32 |
| 4 years present-other | 12 | 56 | 32 |

you think the little girl will have to save to play blow football properly on the blue side tomorrow."[2]

## 3.2. Results

### 3.2.1. Children making correct conjoint choices

*Future-self*: Fig. 4 shows the proportion of children in each age group in the future-self condition who saved the correct conjoint choice of the straw and the box. It will be noted that none of the 3 and 4 year olds saved the correct items. Overall in this condition, children did not save the correct conjoint choice above chance levels: $\chi^2(\mathrm{df} = 1, n = 36) = 1.14$, n.s. However, there was a significant relationship between age and performance: $\chi^2(\mathrm{df} = 2, n = 36) = 9.00$, $p < 0.05$. Comparisons between the age groups revealed that there was no significant difference in performance between 3- and 5 year olds, or 4- and 5 year olds: $\chi^2(\mathrm{df} = 1, n = 24) = 4.80$, $p = 0.09$, in both cases. A goodness-of-fit test showed that more 5 year olds (4/12; 33%) saved the correct conjoint choice than would be expected by chance: $\chi^2(\mathrm{df} = 1, n = 12) = 13.71$, $p < 0.01$.

*Future-other*: Fig. 5 shows the proportion of children in the Future-other condition selecting the correct conjoint choice for the imagined child. It can be seen that this time, some of the 3 year olds were correct. Overall, more children selected the correct conjoint choice than would be expected by chance: $\chi^2(\mathrm{df} = 1, n = 36) = 19.44$, $p < 0.001$. As there was no significant relationship between age and performance [$\chi^2(\mathrm{df} = 2, n = 36) = 0.88$, n.s.], comparisons between the age groups were not carried out. Of the 12 children in each age group, 17% (2/12) of 3 year olds, 33% (4/12) of 4 year olds, and 25% (3/12) of 5 year olds selected the correct conjoint choice. Goodness-of-fit tests revealed that more 4 year olds [$\chi^2(\mathrm{df} = 1, n = 12) = 13.71$, $p < 0.01$] and more 5 year olds [$\chi^2(\mathrm{df} = 1, n = 12) = 6.48$, $p < 0.05$] passed the test question than would be expected by chance. However, three-year-olds were not performing above chance levels: $\chi^2(\mathrm{df} = 1, n = 12) = 1.92$, n.s.

## 3.3. Comparison between future-self and future-other

Fig. 6 shows children's performance on the test question in the future-self and future-other conditions. Overall, there was no significant difference in performance between the two conditions [$\chi^2(\mathrm{df} = 1, n = 72) = 2.34$, n.s.], and none of the age groups performed better in one condition than they did in the other: age 3, $\chi^2(\mathrm{df} = 1, n = 24) = 2.18$, n.s.; age 4, $\chi^2(\mathrm{df} = 1, n = 24) = 4.80$, $p = 0.09$; age 5, $\chi^2(\mathrm{df} = 1, n = 24) = 0.20$, n.s.

It is fair to say, however, that there was a trend for performance on the future-other condition to be superior. A total of four children (all 5 year olds) passed the future-self condition. In contrast, nine children (two 3 year olds, four 4 year olds, and three 5 year olds) passed the Future-other condition. Moreover, at age 4 there was a non-significant trend ($p < 0.09$) towards superior performance in the Future-other condition.

Finally, the difficulty imposed by questions about the future is brought into clear relief by comparing the performance of 3 year olds on the two future-oriented questions (24 children, Experiment 2; 2 passed) against the 24 3 year olds performing on the two non-future questions (present-self and past-other; 10 passed) in Experiment 1. This was a significant difference: $\chi^2(\mathrm{df} = 1, n = 48) = 7.20$; $p < 0.01$. The effect of the future questions on children older than 3 was clearly more complex, and will be explored in subsequent experiments.

## 3.4. Overall functional choices

In Table 1B are presented the distribution of the data in terms of whether children chose neither, one, or both of the functional items. There was no significant difference between the distributions of choices in the future-self and the future-other groups: $\chi^2(\mathrm{df} = 2, n = 72) = 2.72$, $p > 0.05$. However, in view of the results of the above conjoint analysis we also compared self-other performance at age 4 only. The distributions differed significantly [$\chi^2(\mathrm{df} = 2, n = 24) = 6.86$, $p < 0.05$], with 'other' performance being superior.

## 3.5. Discussion

One conclusion that one can draw from this experiment is that introducing a future-planning element into the test question results in many children in this age-range failing

[2] It will be noted that the question in the future-self condition contained an additional sentence explaining why all the items could not be used the next day. This potentially confounding factor will be addressed in the next experiment.


**Fig. 4.** The proportions per age-group of children selecting the two functional items, straw and box in the future-self condition. Twelve children per group. The asterisk means better-than-chance performance.

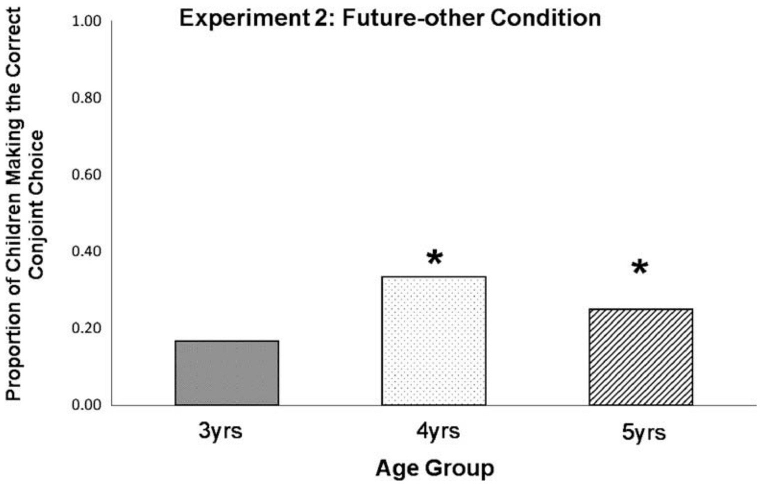


**Fig. 5.** The proportions per age-group of children selecting the two functional items, straw and box in the future-other condition. Twelve children per group. The asterisk means better-than-chance performance.

to choose the target items. However, the answer to the question that actually generated the study was ambiguous. This was the question of whether there would be a difference in difficulty between the future-self and the future-other conditions. In terms of the usual statistical criteria, there was no difference. However there was a trend, at age 4 at least, for the future-other condition to be easier. We concluded that this trend was sufficiently strong to merit a further condition comparison within the 4-year-old children only. Additionally, it may be recalled that the self-other difference was significant when the data were analysed in terms of overall functional choices.

This comparison study was warranted for another reason. It will be recalled that the future-self condition contained an extra sentence, which had been included in order to justify the restriction on choice of items. It is possible that the additional length was responsible for the observed trend towards greater difficulty in the future-self condition. Consequently, in our comparison between future-self and future-other we balanced the questions more thoroughly for length and complexity.

Finally, a self-other comparison at age 4 was warranted for more theory-driven reasons. As 4 is the middle age of the sample, it is possible that this is an illuminating, transition age, such that children below this age generally find the future questions too challenging, children above this age are performing above chance, but that at this intermediate age they are highly sensitive to the way in which future-planning questions are framed. This sensitivity may throw light on the developmental process. In order to investigate the possibility thoroughly we increased the age-group size from 12 to 16 children.

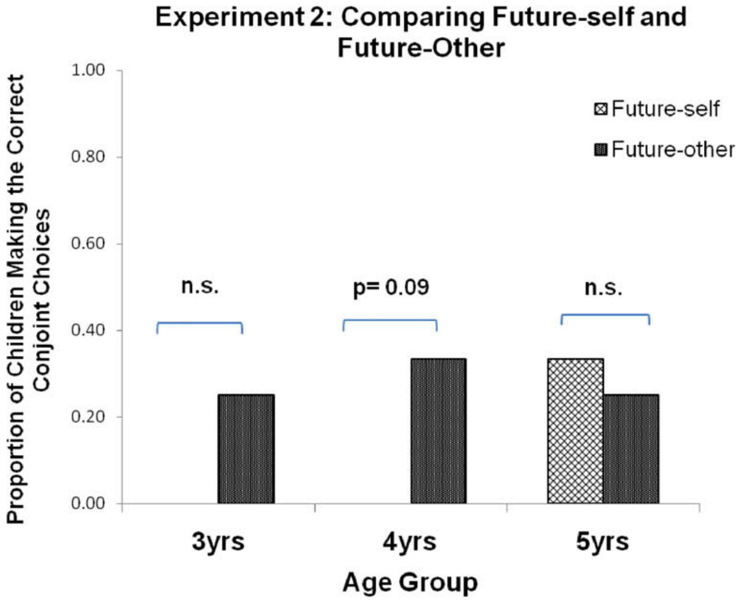


**Fig. 6.** A comparison of performance one the future-self and future-other conditions at all three age levels.

## 4. Experiment 3

### 4.1. Method

#### 4.1.1. Participants

Thirty-two 4-year-old children (15 boys, 17 girls) took part in Experiment 3. Children were randomly assigned to one of two groups: *future-self* ($n = 16$; mean age = 54.1 months; range of 4;1 to 4;10) and *future-other* ($n = 16$; mean age = 53.3 months; range 4;1 to 4;11). Six children were eliminated and replaced for the following reasons: refusal to participate or parent interference during questioning ($n = 3$), recruitment error ($n = 1$), experimenter error ($n = 2$).

#### 4.1.2. Apparatus

This was the same as in the previous two studies.

#### 4.1.3. Procedure

This was the same as in the previous experiments. The test questions were now as follows. Future-self test question:

> "Tomorrow, you will play blow football on this table. When you play tomorrow, you are going to be on the blue side, the far side by the window. As well as the pitch and the ball and the goals, point to the two things you will have to save to play blow football properly on the blue side tomorrow?"

The future-other test question was:

> "Tomorrow, a little girl/boy just like you will play blow football on this table. When she plays tomorrow, she is going to be on the blue side, the far side by the window. As well as the pitch and the ball and the goals, point to the two things the little girl/boy will have to save to play blow football properly on the blue side tomorrow."

### 4.2. Results

#### 4.2.1. Children making correct conjoint choices

Fig. 7 shows the proportion of children in the future-self and future-other groups who selected the correct conjoint choice on the test question. Of the 16 children in each group, 6% (1/16) in future-self group made the correct conjoint choice, and 44% (7/16) in the future-other group made the correct conjoint choice. Children in the future-self group were not passing the test question above chance levels [$\chi^2(\text{df} = 1, n = 16) = 0.00$, n.s.], whereas more children in the future-other group passed the test question than would be expected by chance: $\chi^2(\text{df} = 1, n = 16) = 35.36, p < 0.001$. There was a significant difference in performance between the two groups: $\chi^2(\text{df} = 1, n = 32) = 6.00, p < 0.02$.

#### 4.2.2. Overall functional choices

Table 1C shows these same data broken down in terms of whether children chose neither, one, or both functional items. The distribution of choices in the 'self' and 'other' groups proved to diverge significantly: $\chi^2(\text{df} = 2, n = 32) = 9.98, \ p < 0.01$.

### 4.3. Discussion

This experiment demonstrates clearly that children of 4 years of age find a future-self question more challenging than a future-other question. However before we can conclude that 4 year olds find it more difficult to work out what they themselves would require in the future on their own behalf than to work out what another child would require in a future episode on that child's own behalf, we need to check against the possibility that the difference we have found is not specific to self-versus-other questions about the *future*. That is to say, the group difference may reflect a difference in difficulty in self-versus-other

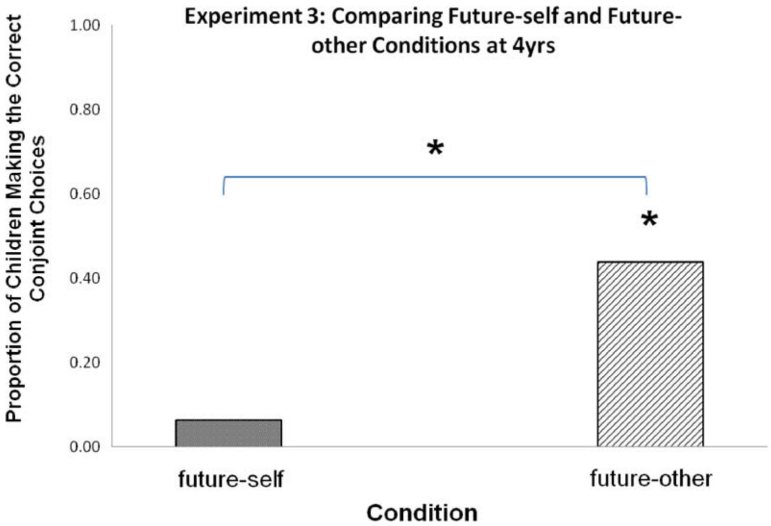


**Fig. 7.** A comparison of performance on the future-self and future-other conditions at age 4 only. The asterisk means better-than-chance performance or a significant difference between groups. Sixteen children per group.

questions more generally, in this situation. Consequently, in the final experiment, we compared self- and other-questions when they are asked in the *present* tense. Additionally, we compared the resulting data with the data from the experiment just reported on future questions. We felt that such a cross-experiment comparison was justified as Experiments 3 and 4 were carried out with a very similar population of children within weeks of each other.

## 5. Experiment 4

### 5.1. Method

#### 5.1.1. Participants

Data from 64 4-year-old children (34 boys, 30 girls) will be reported, with data from 32 of these being novel data. The future-self condition ($n = 16$) and the future-other condition ($n = 16$) were comprised of children who were asked these test questions in Experiment 3. An additional 32 4-year-old children were recruited and randomly assigned to either the *present-self* condition ($n = 16$, mean age = 54.1 months; range of 4;1 to 4;11) or the *present-other* condition ($n = 16$, mean age = 52.1 months; range of 4;0 to 4;8). Three children were eliminated from the 'present' conditions for the following reasons: refusal to participate or parental interference during questioning ($n = 1$), experimenter error ($n = 2$).

#### 5.1.2. Apparatus

This was the same as in the previous 3 experiments.

#### 5.1.3. Procedure

This was the same as before. The test questions for the present-tense questions were as follows:

*Present-self:*

"Right now, you will play blow football on this table. When you play now, you're going to be on the blue side, the far side by the window. As well as the pitch and the ball and the goals, point to the two things you will have to have to play blow football properly on the blue side now?"

*Present-other:*

"Imagine that a little girl/boy just like you will play blow football on this table right now. When she plays now, she's going to be on the blue side, the far side by the window. As well as the pitch and the ball and the goals, point to the two things the little girl/boy will have to have to play blow football properly on the blue side now"

### 5.2. Results

#### 5.2.1. Children making the correct conjoint choices

Fig. 8 shows the proportion of children in each condition who selected the correct conjoint choice. As we have seen, of the 16 children in each condition, 6% of children in the future-self, 44% of children in the future-other made the correct choices. However, 31% (5/16) of children in the *present*-self, and 31% (5/16) of children in the *present*-other condition made the correct conjoint choices. More children in the present conditions passed the test question than would be expected by chance: $\chi^2(\mathrm{df} = 1, n = 16) = 15.54$, $p < 0.01$, in both cases. The results of the hierarchical log linear model for a possible interaction between time (present/future) × perspective (self/other) were as follows: $\chi^2(\mathrm{df} = 1, n = 64) = 3.74$; $p = 0.05$ for two-tailed; $p = 0.02$, one-tailed. This means that it was specifically when the self-other comparison was to be made in the future case that the 'other' condition was easier. This also shows that, while the absolute difference between the performance of 4 year olds in future and non-future cases was not high (Figs. 2–5), the future question was nonetheless affecting performance interactively.

#### 5.2.2. Overall functional performance in the 'present' groups

Table 1D presents the data from the two, novel 'present' groups broken down in terms of whether neither, one,

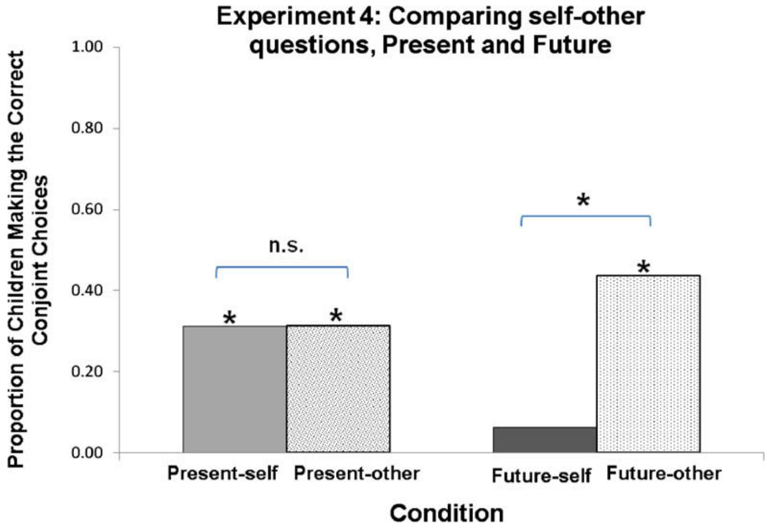


**Fig. 8.** A comparison of performance on the future-self and future-other conditions at age 4 only, plus a similar comparison for a present-self and present-other condition. The asterisk means better-than-chance performance or a significant difference between groups. Sixteen children per group.

or both functional items had been selected. The distributions did not differ significantly: $\chi^2(\mathrm{df} = 2,\ n = 32) = 0.91$, $p > 0.05$.

### 5.3. Discussion

These data show that self-directed questions are not *generally* more difficult than other-directed questions, as there was no difference in difficulty when they were asked in the present tense. We cannot, of course, make such a comparison for questions asked in the past tense, because a past-self question is a memory question. Otherwise, the question would have had to have been posed in a subjunctive/counterfactual form of 'What items would you have needed...?" In this case the linguistic challenges are substantial.

Moreover, while cross-experiment comparisons should be interpreted with extreme caution and while it was only when a one-tailed test was used that the interaction between self/other and future/present was clearly significant, it is fair to conclude that there was a difference between the future and present conditions, insofar as only in the former case was a self-directed question more challenging.

## 6. General discussion

The age of 4 years emerges from this study as a pivotal age in the development of episodic future thinking, and in this regard it is broadly in line with results of the studies reviewed in the Introduction, despite the numerous differences between these studies and the present one. Moreover, age 4 is also a good candidate for being the period when episodic memorial abilities come on stream (Hamond & Fivish, 1991; Perner, Kloo, & Stöttinger, 2007b; Perner & Ruffman, 1995; Suddendorf & Corballis, 1997, 2007; Tulving, 2005; Wheeler, Stuss, & Tulving, 1997). All this tends to bear out Tulving's (2005) proposal that each is a facet of a single 'chronesthesic' capacity.

We will thoroughly discuss how and why age 4 emerged as a pivotal age. But first we need to consider why the performance of the 3-year old children was generally poor in the future conditions. Our assumption is that children as young as this lack prospective abilities; but might it not be the case that their performance is better explained in terms of linguistic shortcomings than in terms of difficulties with prospection? This seems unlikely, as children of 3 can generally understand the future tense when the auxiliary 'will' is used (Fraser, Bellugi, & Brown, 1963; Harner, 1976; Herriot, 1969; Lovell & Dixon, 1967). Indeed Harner found that 3 year olds understood the past and future tenses equally well in her study, and that a number of 2 year olds could comprehend the form. Where their shortcomings lie is with the use of explicitly future forms in spontaneous speech (Gerhardt, 1985; Gee & Savasir, 1985) and with marking 'aspect' in the future tense (Harner, 1981); that is, marking whether an action is discrete ('He'll swim') or continuous ('He'll be swimming'). Following Lyons (1968), Harner (1981) interprets the relatively slow development of futurity in speech in terms of the fact that the auxiliary 'will' in English does not have a purely future-facing semantics, but one that is partly modal. But even if some of the children were interpreting the 'will' in 'will have to save to play blow football' as meaning something like 'could' or, more plausibly, 'should/must' it is not at all clear why this should have impaired their performance. That said, it would be of interest to examine performance when modal-obligatory forms, and indeed forms like 'is gonna have...', are used in the instructions.

To return now to the pivotal age 4, it is clear that it emerged from this study as being pivotal in a somewhat ambiguous and counter-intuitive sense. That is to say, 4 year olds find it easier to work out which objects another child will need in the future to act successfully from a position 180°-removed from the familiar one than to work out the objects that they themselves will need from the other side of the table. Given their relative success on the present-self and the past-other conditions, one might suggest that 4-year-old children in the future-other condition are discounting the temporal element of the question and answering it as if it were not about the future at all. Why might they do this? Perhaps children of four interpret questions about what somebody else will need in the future in an untensed, purely functional manner because considering some other, notional child's future needs requires an imaginative effort and investment that thinking about one's own future needs does not (see Harris (1991), on the defaults that have to be overridden in this kind of simulation of another's situation). So they focus simply on what is needed and ignore the tense.

Meanwhile, this implies that when children of 4 are asked about what they themselves will need they do indeed *try*, at least, to think about the future episodically, as this is something they have become able to do on their own account. But what makes them go wrong? A possibility worth exploring is that children at age 4 do indeed engage in prospection – imagining themselves in a different position in this case – but that they do so in a way that leads to error. They are, as it were, doing the right kind of thing but not well enough. That is to say, the children may actually be envisioning playing the game from the blue side and in so doing 'see' the equivalent of what they saw from the red side, *including referee, spectator, and so forth*. What this encourages is ignoring the functional requirement of actually playing successfully.

This account is, of course, a rich interpretation of the data. A thinner interpretation would be that no prospection is taking place at this age, or that, if it is, our technique is not sufficiently sensitive to reveal it. On this view, the reason for the greater success in the future-other condition is that asking about what another child would need diverts the child from his or her own personal preferences (e.g., for proudly-worn team badge) and the contingent lures (e.g., to the colourful and jolly spectator doll). However such an account struggles to explain why similar differences were not found at ages 3 and 5. By contrast, the present account applies naturally to an intermediate age and makes implicit reference to a ubiquitous developmental phenomenon – the growth error (Strauss, 1982). When a growth error takes place the child may over-apply an ability that has recently been acquired, with the result that performance gets worse before it gets better. This happens, for example, when children become able to take a top-down, theory-driven attitude to a problem, making them neglect the bottom up constraints (Karmiloff-Smith, 1986). The present account falls within this explanatory domain, and against it the thinner interpretation is post hoc.

A second sceptical reaction to these data would mean questioning whether a self-other difference on the future question is informative in itself, arguing that when self and other questions are compared in developmental research it may simply be the case that sometimes self is harder, sometimes other is harder, and sometimes they are equally difficult. But this is certainly *not* the pattern that is seen to emerge when first and third person performances are compared for the core developmental tasks. The almost inevitable result is one of no difference. Not only is performance on false belief tasks consistently equivalent across first and third person (Wellman, Cross, & Watson, 2001, for a meta-analysis), so too is that on intention-reporting tasks (e.g., Phillips, Baron-Cohen, & Rutter, 1998; Russell & Hill, 2001; Russell, Hill, & Franco, 2001); while even performance on executive tasks such as the DCCST can be equivalent between first and third person (Jacques, Zelazo, Kirkham, & Semcesen, 1999). Additionally, in the present study we report the lack of a self-other difference when the question is posed in the present tense. What is more, those who take a 'simulation' theory position on the development of theory of mind and cognate abilities (on which Harris, 1991) would tend to predict the opposite result, of first person being easier. The outcome of Experiment 3 stands, then, in sharp relief.

Next, if there is indeed a form of growth error occurring at the age of 4 years in which children's envisioning of their own future perspective leads them to neglect the functional demands of the question, why should this occur at age 4? One answer would be that 4 years marks the beginning of what John Flavell called a 'Level 2' appreciation of visual experience (Flavell, Everett, Croft, & Flavell, 1981). On the basis of numerous studies, Flavell proposed that Level 1 children below the age of 4 can conceive of *what* another person can see (e.g., a picture of a turtle or only the turtle's shell), while Level 2 children can additionally conceive of *how* it looks to others given their spatial perspective (e.g., as lying on its back). Analogising to the present task, the 4 year old children presented with a question about what they will need to play from the other side of the table tend to apply their new capacity and represent to themselves *how* playing the game will look from that position, rather than simply *what* will be visible, and rather than *what* will be needed to play it. In other words, in Level 2 perspective-taking tasks children of 4 will imagine how something looks from a point of a view they do not share – indeed from one 180° different in the 'turtle' experiment – and in future-self questions they will imagine how the $180^0$ different position will indeed look to them, *including the non-functional items*.

This spurs the question of why the same process does not occur when the present tense is used (Experiment 4). Either this shows that our Level 1/Level 2 analysis is limited, or it suggests that envisioning is something that children – and perhaps adults too – are more likely to engage in when they are expected to step out of the present tense. This is not an unmotivated proposal, given that if a question is untensed there is no implicit 'invitation' to imaginatively consider alternative, open-ended scenarios.

One way in which the present account could be tested is through examining the relation between performance on Level 2 perspective-taking tasks and the commission of the proposed growth error at age 4. Here one might employ a within-subjects design in which each child performs on both the future-self and the future-other condition on different occasions as well as on Level 2 tasks and cognate theory-of-mind and spatial reasoning tasks. Would children who perform well on Level 2 tasks be those who are more likely to be worse on the future-self than on the future-other condition? Whether or not this somewhat counter-intuitive prediction is confirmed, there is surely good reason to examine the relation between Level 2 perspective-taking and episodic cognition more generally.

We turn now to the neuroscientific implications of this result and of the approach to past and future episodic thinking that generated the study. A survey of recent imaging and neuropsychological work and of the theoretical positions they have inspired reveals at least two clear outcomes. First, there is considerable overlap in the brain regions recruited when participants are asked to recall episodes and envision future events (Addis, Wong, & Schacter, 2007; Okuda et al., 2003; Szpunar, Watson, & McDermott, 2007). Second, and more relevantly, there is a high degree on commonality in the brain regions seen to be activated when the following four kinds of tasks are presented to participants: episodic recollection, prospection, third-person theory of mind, and navigation. Given our core emphasis on the spatial roots of episodic cognition, we shall consider the inclusion of the last mentioned – navigation.

The network in question is distributed over the hippocampus, the parahippocampal gyrus, retrosplenial cortex, the posterior parietal cortex and the ventro-medial pre-frontal cortex, these areas being involved in past and future episodic cognition, third-person theory of mind, navigation, and spatial abilities more generally (see immediately subsequent references). Whatever the core cognitive element in this network turns out to be, it is necessary to point out that we, at least, have no commitment to the inclusion of theory of mind on this list, for it is not clear that mentalising, even of the third-person variety, must have a spatial element. A spatial element is present in the classic "Maxi" false belief scenario (Wimmer & Perner, 1983), but it is not a general feature of theory-of-mind tasks. Indeed Gallagher and Frith (2003) argue that the anterior paracingulate cortex is uniquely associated with theory of mind. The posterior cingulate, meanwhile, is implicated in autobiographical memory for people (Maddock, Garrett, & Buonocore, 2001).

Turning, then, to the question of the core cognitive element of these abilities and of this network, two conflicting approaches have emerged to date. Buckner and Carroll (2007) argued that what all of these capacities essentially require, and therefore what this network essentially computes, is what the authors call 'self projection'. They accept that, on the face of it, navigation "is perhaps the most tentative candidate for being related to the other three" (p. 50), but argue that it should be included by virtue of shared functional properties – it involves alternative locations or personal viewpoints – and shared functional anatomy (Aguirre & D'Esposito, 1997; Maguire et al., 1998).

The approach of Hassabis and Maguire (2007) is set explicitly in opposition to that of Buckner and Carroll, insofar as the former propose 'mental scene construction' as the key component process, putting this at the core where Buckner and Carroll located self-projection. Insofar as scene construction involves evoking a spatial context for any episodic performance, whether past or future, the approach of Hassabis and Maguire sits naturally with the Kant-inspired 'perspectival' approach to episodic cognition presented in Clayton and Russell (2009) and sketched in the Introduction. As they say, "remembering what you did last Saturday night is nearly always accompanied by complex mental imagery of that event played out within a spatial context – likewise if you cast your mind forwards to what you might be doing next Saturday evening" (pp. 299–300).

If it is indeed the case that both past and future episodic thinking contain an essentially spatial element, might it be the case that one of the two is the more spatially dependent? One answer forthcoming from a survey of the neuro-imagining literature is that it is future episodic tasks that are the more heavily spatial. On the one hand, Addis et al. (2007) report that when participants were asked to construct a past autobiographical event or envision a plausible future event from verbal cues, both tasks activated the left hippocampus, but that only the envisioning task activated the right hippocampus significantly. Meanwhile, a study by Maguire et al. (1998), in which participants had to navigate their way through a virtual-reality town, had shown specific and strong activation of the right hippocampus when the task was to work out the location of places and then navigate between them. It might be said that this result is what one would expect given that navigation is an inherently future-oriented activity. But navigation frequently involves the ability to return to base, which might be thought to be past-oriented, especially if dead-reckoning (Newcome & Huttenlocher, 2000, Chapter 2) of some kind is being used. In any event, another reason for proposing a greater loading on spatial ability in the future case is that here the imagined space must be actively constructed by the individual, in contrast to episodic memory when it is perhaps possible for a spatial context to be more passively evoked by objects (as in deferred imitation tasks, for example) or verbal cues. Indeed there is a sense in which an episodic memory image is something that we are caused to have *in the way we have it* (on which Hoerl (2001) and Martin (2001)); whereas this cannot be said of an image of a future state insofar as it is typically constructed for a purpose and with many degrees of freedom. Viewed in the light of Suddendorf and Corballis's (2007) 'theatre' metaphor of mental time travel, in the case of episodic memory one is essentially a member of the audience (though only in the sense that one does not control the action, on our view); but in the case of prospection one must be a 'director' (these authors' term) in addition; and a director must block the moves of the actors in mental space and set up the scene.

It might be objected that navigation is a far cry from simply envisioning oneself doing something from a novel position, as the children had to do in our study. But in both cases one might project oneself into a different location to consider how things might look and what can practically be done from that point. Our conjecture is that 4 year olds do the former at the expense of the latter. In any event, and irrespective of whether our growth-error account turns out to be well founded, there would seem to be clear benefit in taking a spatial as well as a conceptual (e.g., Perner et al., 2007b) approach to episodic cognition, not only for developmental but also for philosophical and neuroscientific reasons.

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