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Circadian Rhythms Behind Interviewers' Approaches: The Time-Of-Day Effect in Police Interviews With Children

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ABSTRACT

Police interviews with children are often the only source of evidence about an abuse. Circadian rhythms are known to affect cognitive processes, but the effect they may have on the quality of police interviews is unknown. Data comprised 102 transcriptions of police interviews with children. Transcripts were rated for effective interviewing approaches, that is approaches following guidelines. Time of day was examined as a predictor of interviewers effectiveness related with the type of approaches interviewers used, for example, open-ended questions. Interviewer effectiveness declined as the day progressed, but only for the less skilled interviewers. Highly skilled interviewers were unaffected by the time-of-day. The identification of time-of-day as a possible risk factor which reduces the quality of interviews is of great importance.

1 | Introduction

Circadian rhythms concern the periodic fluctuations of physiological functions within a 24-h period, for example, alertness, body temperature (Collinson et al. 2020). There is a relationship between circadian variations and cognitive processes, particularly processes like attention, working memory and executive function (Valdez et al. 2014). Data generated from laboratory and field settings suggest a decline in some cognitive processes during the night and in the early hours of the morning, while cognitive improvement is observed during the day (Morris et al. 2017). Although there is research about the relationships between circadian rhythms and cognitive processes, previous researchers have not considered the possible relationship between circadian rhythms and the quality of police investigative interviews with children. The present work is original because it considers for the first time how physiological factors related to the time of the day might affect investigative interviewing.

1.1 | Assessing the Quality of Investigative Interviews With Children

Child abuse is common. For example, in England and Wales there were 73,260 child sexual abuse cases in 2019 (Office for National Statistics 2020). In Cyprus one in five children may have been victims of sexual abuse (Karayianni et al. 2017). The main and often only evidence about the abuse comes from children's own testimonies. Indeed, children's testimonies were the only source of evidence for the police and prosecution in 67% of cases in the USA (Block and Williams 2019) and in 95% of child abuse cases in Cyprus (Kyriakidou 2011). As police have to rely solely, or mainly, on investigative interviews to solve child sexual abuse cases, it is important that all possible measures are taken to ensure the most accurate testimonies from the children.

Front-line interviewers, prosecution and defense lawyers describe good investigative interviews as ones that obtain as

much information about the abusive event as possible, and do so using suitable question types (Krähenbühl 2008; Kyriakidou 2011). This is because the type and phrasing of questions and the interviewer's interaction with the child can affect children's responses and may sometimes result in children giving unreliable details (Dale et al. 1978; Lamb et al. 2011). We refer to each of the interviewers' questions or interactions with a child during an interview as an '*approach*'.

Amongst effective approaches, 'open-ended' prompts (e.g., 'Tell me everything that happened from the beginning to the end.') encourage children to start talking or elaborating on topics, and these topics may often generate enough reliable details for investigations (Dale et al. 1978; Lamb et al. 2011). But field studies have shown the percentage of open-ended prompts in investigative interviews range from 3% of all approaches in Norway (Baugeryd et al. 2020) or 4% in Indonesia (Sumampouw et al. 2019) to 37% in Australia (Hamilton et al. 2016).

Amongst less effective approaches, '*suggestive*' prompts (e.g., 'He yelled at you, didn't he?') imply an answer or offer details that have not already been mentioned by the child and may elicit unreliable details from the child (Dale et al. 1978; Lamb et al. 2011). '*Option-posing*' prompts (e.g., 'You saw the man with the white t-shirt, right?') present details not previously mentioned by children and do so in the form of focused questions (e.g. yes/no questions). Such prompts can lead to the introduction of false testimony from a child (Lamb et al. 2011). The field studies mentioned above found that suggestive and option posing prompts were 11% of all approaches used in Australia, 44% in Norway and 49% in Indonesia.

Situational factors in forensic settings include circumstances related to the context of the interview such as the interviewer's working hours. For example, interviewers' approaches toward children become less effective when interviews are conducted toward the end of an interviewer's shift or when the interviews are conducted outside of the interviewer's normal working hours (Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis 2020b). Interviews commenced during interviewers' early duty shifts had significantly more 'appropriate' and 'neutral' approaches than interviews commenced at the end of interviewers' shift or outside interviewers' normal working hours. 'Appropriate' approaches were echo-statements (repeating children's exact words), facilitators (e.g., hmm), TED (e.g., tell me), and any questions including how/what/who/why. 'Neutral' approaches were Echoing which used wh-questions, any questions including when/where/which and TED expressions stated as yes/no questions for example, Can you tell me about it? 'Inappropriate' approaches used within the interviews remained the same across all working conditions. 'Inappropriate' approaches were choice questions, leading questions, and yes/no questions.

Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis (2020b) argued that 'appropriate' approaches may involve more cognitive resources when used because they are not naturally used. This is due to their absence from our daily conversations which mainly rely on 'inappropriate' approaches. Thus, when a situation, such as working hours affect concentration, 'appropriate' approaches can be affected by that situation. There was no explanation provided by the authors why 'neutral' approaches might also be affected by interviewers' working hours.

But such studies have not considered time of the day as a situational factor when assessing the performance of interviewers. We investigate whether 'appropriate' and 'neutral' approaches could be impacted by further situational factors such as the time of the day.

1.2 | Circadian Rhythms

Kleitman (1933) and Kleitman et al. (1938) observed that reaction times, and accuracy in cognitive tasks (such as card sorting, mirror drawing, code transcription and multiplication speed) were related to body metabolism resulting in better performance in the afternoon, and poorer performances early in the morning and late at night. Kleitman (1963) suggests that variations in behavior and cognition are linked with circadian rhythms (Colquhoun 1981).

Other researchers have shown that circadian rhythms can affect attention (Valdez et al. 2005), executive functions (Walsh et al. 2014), sensory perception (Kwon and Nam 2014), time perception (Kuriyama et al. 2003), arithmetic calculations (Jasper et al. 2009; Loeb et al. 1982), verbal reasoning (Monk and Carrier 1998), and logic, memory, and other reasoning (Folkard and Monk 1980; Gerstner and Yin 2010).

When controlling variables such as the complexity of a task, participants' age and chronotype (a person's tendency to sleep at certain times) the link between circadian rhythms and other factors also applies to decision making, driving simulation tasks, motivation, shopping and work performance (e.g. Collinson et al. 2020).

In laboratory settings, biological measures (e.g. body temperature, heart rate) have been used as indices of circadian rhythms. Low body temperatures may be related to sleepiness and tiredness (Morris et al. 2017; Ramírez et al. 2012). Ramírez, et al. noted the body temperature of eight participants for 24 h from 10:00 a.m. The participants' performance was measured with a Stroop test. Performance on color naming and shifting were associated with circadian rhythms based on the participants' body temperatures. Low body temperatures were correlated with greater sleepiness, tiredness and poorer performance. Other researchers have found that only some components of attention show circadian variations (Valdez et al. 2010) and have concluded that biological changes do not necessary imply cognitive changes, because not all areas of the brain are affected equally (Valdez et al. 2014).

For example, when considering the Neuropsychological Model of Attention (Cohen 2014), attention comprises of tonic alertness (general alertness throughout the day), phasic alertness (instant alertness to specific stimulus), selective attention (focus on some information while ignoring distractions or irrelevant information) and vigilance attention (focus on a task while maintaining this focus with time). Reactions to psychometric tests measuring tonic alertness, phasic alertness and selective attention have shown circadian variations while reactions to

psychometric tests measuring vigilance attention remain unaffected by circadian variations in adults (Valdez et al. 2005).

It is unclear which precise types of attentions interviewers rely on mostly during an investigative interview. Conducting an investigative interview, is a complex task expected to require all four components of attention. As some parts of attention are affected, it may be that only some parts of interviewers' behavior are affected, perhaps, only 'appropriate' behaviors may be impacted (Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis 2020b). Studies of attention have not been applied in real life forensic settings, such as measuring interviewers' biological metrics prior to an investigative interview. The present study will help understand whether this is something that should be considered in relation to forensic investigations.

In field studies, time-of-day is used as an index of circadian rhythms (Collinson et al. 2020; Pope 2016). Pope (2016) examined how time-of-day affected the productivity of two million students in the USA (based on their GPA and learning performance in test scores). Students learned more in the morning than later in a day, with a consistent decline in performance from morning to afternoon classes. Morris et al. (2017) found a decline in cognitive processes during the night and the early morning hours, while an improvement was found during the day. A model was put forward by Valdez et al. (2014) who proposed that cognitive processes are low from 07:00 to 11:00, improve between 11:00 to 14:00, decline between 14:00 to 16:00, improve between 16:00 to 22:00 and are at their lowest levels between 22:00 to 07:00. Despite the findings that time-of-day can affect performance this variable has been neglected in psychological research (McGrath and Kelly 1986; McGrath and Tschan 2007). As noted earlier, the effects of time-of-day on police interviews has not been examined before.

1.3 | The Present Study

Circadian rhythms may affect police interviewers behaviors because interviewers are often required to work early mornings, evenings and night shifts. In the present study we looked at how the performance of police interviewers was affected in relation to the time-of-day. Our analyses examined, in transcriptions of investigative interviews, whether the starting time of an interview was a predictor of the interviewers' performance. Our hypothesis was that time-of-day would be a predictor of interviewers' approaches (Morris et al. 2017; Pope 2016; Valdez et al. 2014). In particular, we expected that the usage of 'appropriate' approaches may be susceptible to the time of the day compared to other types of approaches (Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis 2020b).

But considering the complexity of conducting an investigative interview, we were uncertain whether particular times of the day would show different quality of interviews (e.g. poor interviews from 07:00 to 11:00, improved interviews between 11:01 to 14:00, poor interviews between 14:01 to 16:00, improved interviews between 16:01 to 22:00 (as suggested by Valdez et al. 2014) or whether only late shifts would produce problematic interviews (as suggested by Pope 2016). All different time periods were initially considered while accepting the possibility that some time slots might not have any interviews in them.

The present study relies on secondary, double-anonymized data extracted from Cyprus Police Force between 2017 and 2018. Identifiable information was removed during data collection, and each transcript was initially assigned a numerical code. Subsequently, these numerical codes were replaced with pseudonyms (e.g., C1), thus, the data underwent a two-stage anonymisation process prior to our analysis. The national police training on police interviews with children from 2005 to 2018 integrated trainings from Israel, the UK and the US and included various interviewing models such as the Achieving Best Evidence (ABE), the National Institute of Child Health and Human Development (NICHD) protocol, and the Preparation and Planning, Engage and Explain, Account, Closure, and Evaluate (PEACE) model. Within the Cyprus police, at the time of this research project, there was a group of police officers who were identified as particularly skilled interviewers, as defined by Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis (2020a), therefore this group of interviewers was considered separately, and will be referred to as the highly skilled or 'HS' group. The other interviewers will be referred to as the regular interviewers or 'RI' group.

The skilled interviewers were identified through a nationwide assessment of all active interviewers in 2016 (Kyriakidou 2016). In total 47 interviewers were assessed on 80 interviews that they had conducted. The assessment was made on nine criteria: (a) the number of words interviewers used based on children's age, (b) how relevant were the topics discussed to the investigation, (c) the question types used, (d) how interviewers referred to topics already discussed for example, using identical words with the child's words, or paraphrasing, (e) how many details an interviewer requested in each question, (f) how many useful details for the investigation each interviewer gained, (g) how the interviewer handled the topics discussed e.g., was the interviewer focusing on what the child said? Or was the interviewer focusing on far earlier topics mentioned? And (h) how appropriate was the language used. The skilled interviewers scored high on all nine criteria, meaning that their interviews were above the average performance of other colleague interviewers. The skilled interviewers performance was considered outstanding and suitable based on the recommended police guidelines and relevant research.

2 | Methods

2.1 | Sample

The transcriptions analyzed in this study were part of a sample of data randomly extracted in 2017 and 2018 from the Cyprus police database. The police database included many investigative interviews of vulnerable interviewees from which we randomly chosen 102. This was the same database used in previous studies but analyzed here for different research purposes (Kyriakidou et al. 2020a, 2020b). This was the secondary dataset we used. This random sample of 102 transcripts was

initially selected from the available police transcripts due to practical time constraints as data collection was limited to few months and could only take place during police working hours, with officers present. Transcripts were randomly chosen from a larger pool, allowing for the analysis of as many cases as feasible within the given timeframe. This included an analysis of 102 transcriptions of investigative interviews with children who had made allegations of sexual abuse between 2005 and 2018. Ethical approval was obtained from the University of the first author and from the Cyprus Police Headquarters.

They were five interviewers qualified as highly skilled 'HS' (Kyriakidou 2016). The other interviewers were in the regular interviewers 'RI' group. There were 42 (41.2% of the sample) investigative interviews conducted by the HS group of interviewers, and 60 (58.8%) conducted by the RI interviewers. All districts of Cyprus were represented in the sample in proportion to their population, Nicosia ($n = 49$), Limassol ($n = 25$), Larnaca ($n = 15$), Paphos ($n = 7$), Ammochostos ($n = 6$).

The starting time of the interviews ranged from 09:20 to 20:59. On average the interviews by the HS interviewers started at 13:21 (SD = 2:33) and interviews by the RI interviewers started at 14:00 (SD = 2:59). There was no difference in the time that interviews started between the two groups ($F(1) = 1.282$, $p = 0.260$). Mean duration of interviews was 0:32 min (SD = 0:21). There was no difference in the duration of interviews conducted by the HS and the RI interviewers ($F(1) = 0.210$, $p = 0.648$). Children's ages ranged from 5- to 17-years-old ($M = 12.01$ years; SD = 3.17), with no difference in the children's age for those interviewed by the HS and the RI interviewers ($F(1) = 1.85$, $p = 0.668$).

There were no significant variations of the children's age in each of the four time periods compared ($F(3, 98) = 1.104$, $p = 0.351$). Children's age, in years, within each time-category (07:00 a.m.–11:00 a.m.; 11:01 a.m.–14:00 p.m.; 14:01 p.m.–16:00 p.m.; 16:01 p.m.–22:00 p.m.) had mean ages of 12.09 (SD = 3.2), 11.39 (SD = 3.4), 12.8 (SD = 2.8), 11.8 (SD = 3.1) respectively. All children were typically developed with no additional support needs or disabilities, and all investigations concerned sexual abuse allegations. No further information was noted about the children or about the cases because such information was not needed for the present study. All interviewers, within both the HS and RI group, had received the same training and all had specialized in interviewing children.

Twenty-two interviews were conducted between 07:00 a.m.–11:00 a.m.; 33 interviews were conducted between 11:01 a.m. 14:00 p.m.; 26 were conducted between 14:01 p.m.-16:00 p.m., and 21 interviews were conducted between 16:01 p.m.–22:00 p.m.

2.2 | Coding of Transcriptions

Based on previous studies (Kyriakidou et al. 2020a, 2020b) interviews were categorized into 12 general items, each representing a distinct type of approach. Within these items, a total of 18 specific approaches were identified, reflecting the ways interviewers interacted with children. For 11 items, a single approach was coded for example, item 1 'echo-statement' addressed repetition. Item 4 (wh-approaches) encompassed seven distinct subtypes of questions based on different *Wh*-words for example, what, as shown in Table 1. Thus, they were 12 items which included in total 18 approaches. Forensic analysts have coded question types in a number of ways (Oxburgh et al. 2010). For example, the NICHD protocol for interviewing children considers five approaches for interviewing children (Baugerud and Johnson 2017). These five approaches have an important role in evaluating the implementation of the NICHD protocol and they frame its coding system, but as our study had a different purpose, we used a coding system to combine important elements the NICHD protocol with other coding systems.

2.3 | Interrater Reliability

Due to the sensitive nature of the interviews, coding was conducted only inside police departments. Access to the transcriptions was given for July-August 2017 and for April-May 2018. Coding was carried out by two coders. The coding process followed a structured, multi-step approach. First, the coders were trained and practiced on mock interview transcripts until the initial coding reached 100% agreement between the coders. Second, the actual coding of the study transcripts was conducted. Transcripts were reviewed line-by-line, and each interviewer utterance was assigned a code corresponding to one of the 18 approaches. Coders focused on both the linguistic structure (e.g., open-ended vs. closed questions) and the functional purpose of the utterance (e.g., facilitating elaboration vs. leading the child) (Oxburgh et al. 2010). Throughout this stage, coders regularly consulted the coding guidelines and held periodic meetings to address any uncertainties. Twelve percent of the transcripts were jointly coded. Reliability in the identification of the 12 interviewers' approaches was high with Cohen's kappa ranging from 0.87 to 0.98. Any disagreements were resolved by discussion.

2.4 | Categorizing Interviewers' Approaches

Regression was a suitable test to examine the starting time of an interview as a predictor of the 18 approaches used by interviewers. To reduce the risk of Type I error in running 18 independent regression tests (Brunner and Austin 2009) we categorized the coded 18 approaches into three groups, '*appropriate*', '*neutral*', and '*inappropriate*'. But, in the case of any significant regression outcomes, we explored each of the 18 approaches in follow up analyses (MANOVA, correlation) to gain a fuller understanding of how interviewers' behaviors may have been affected by the time-of-day. Based on functional and linguistic similarities, the 18 approaches in Table 1 were merged and organized into 13 approaches, as follows: *appropriate* (four approaches), *neutral* (four approaches), and *inappropriate* (five approaches).

TABLE 1 | Coding of interviewers' approaches.

Approach	Definition	Example
1. Echo-statement	Repeating children's exact words without rephrasing them as questions	Child: *He was tall.* Interviewer: *Tall.*
2. Facilitators	Vague sounds Encouragement	*Hmm.* *Okay.*
3. TED	Open-ended approaches including the words '*tell*', '*explain*' and '*describe*' phrased as sentences.	*Explain it to me.*
4. Wh-approaches 4.1. How 4.2. What 4.3. When 4.4. Where 4.5. Which 4.6. Who 4.7. Why	Approaches including the aforementioned words that could be phrased as questions or statements.	*What happened?* *Tell me what happened.*
5. Echo-wh	Repeating children's exact words by adding a wh-approach into the repetition.	Child: *He was tall.* Interviewer: *How tall*?
6. Yes/no-TED	Approaches including the words '*tell*', '*explain*' and '*describe*' but phrased as yes/no questions.	*Can you tell me more about it?*
7. Yes/no-wh	Approaches including wh-approaches but phrased as yes/no questions.	*Can you explain how she looked?*
8. Choice	Approaches offering two or more choices phrased as questions. These refocused the child's attention on something that was already mentioned.	*Was it yellow or blue?*
9. Echo-choice	Repeating children's exact words by adding a choice approach into the repetition.	Child: *He disappeared.* Interviewer: *He disappeared or left the room?*'
10. Echo-yes/no	Repeating children's exact words as a yes/no question.	Child: *He was tall.* Interviewer: *Was he tall?*
11. Leading	Leading or suggesting approaches phrased as statements or questions. These could have included a key detailed introduced by the interviewer first or been a tag question. They could also be phrased as any type of approach e.g. TED, choice.	*He was tall, wasn't he? Tell me how tall he was* (when the child had not mentioned how tall he was).
12. Yes/no	Approaches phrased as questions by giving only one choice. These refocused the child's attention on something that was already mentioned.	Did you go to the beach?

2.4.1 | Appropriate

The '*appropriate*' group of approaches were those that were likely to obtain reliable details from children. This group included four approaches. These were the more open approaches: (a) echo-statements, (b) facilitators, (c) TED, and (d) How/What/Who. This categorization was similar to the categorization used in Kyriakidou et al. (2020a, 2020b), but our coding deviated from that categorization because we considered a '*why*' approach as a '*neutral*' approach instead of an appropriate approach. We coded '*why*' approaches as neutral because there has been no agreement on whether such approaches are appropriate or inappropriate ones (Westcott and Kynan 2006). The '*echo-statements*', '*facilitators*' and '*TED*' (tell, explain, describe) approaches identified here were similar with the '*invitations*' and '*cued invitations*' utterances used in the NICHD protocol.

2.4.2 | Neutral

The '*neutral*' group included approaches for which there is no clear agreement among researchers as to whether the approaches are open (e.g. Korkman et al. 2006) or specific (e.g. Rischke et al. 2011). This group included four approaches. Identifying these approaches as neutral ensured that they did not interfere with approaches that have been marked as open/appropriate or specific/inappropriate by most analysts of investigative interviewers (Oxburgh et al. 2010). The neutral group included: (a) echo-wh, (b) When/Where/Which/Why, (c) yes/no-TED, and (d) yes/no-wh. The '*Wh-approaches*' and '*echo-wh*' used here were similar to the '*directive*' utterances in the NICHD coding. The presence of '*yes/no-TED*' approaches (e.g. *Can you tell me more about it?*) and '*yes/no-wh*' (e.g. *Can you tell me where this happened?*) approaches in the current analysis were distinct items in contrast to other coding systems. Other

coding systems have defined these as open (Korkman et al. 2006), or sometimes as specific approaches (Rischke et al. 2011). Coding '*yes/no-TED*' and '*yes/no-wh*' approaches separately establish a more distinct measurement of the '*TED*' and 'yes/no-wh' approaches.

2.4.3 | Inappropriate

The '*inappropriate*' group consisted of approaches that were likely to obtain unreliable details from children and were typically phrased as specific approaches: (a) choice, (b) echo-choice, (c) echo-yes/no, (d) leading, and (e) yes/no. This categorization was identical with Kyriakidou et al. (2020a), (2020b). The '*leading*' approaches identified here were the same as the '*suggestive*' utterances in the NICHD coding. The combination of the '*yes/no*' and '*choice*' approaches used here were the same as the '*option-posing*' utterances in the NICHD coding. Considering each approach ('*yes/no*', '*choice*') separately helped to identify variations in their use. Discrete features of our coding system were the inclusion of '*echo-choice*' and '*echo-yes/no*' which were added for a more detailed analysis of echolalia in interviewers' approaches. We also differentiated '*yes/no*' approaches from other approaches. Other systems code these approaches alongside echo-yes/no approaches or choice questions (as option posing) (Andrews et al. 2015). Our distinct coding of yes/no approaches considered the presence of clarifications throughout interviews on topics that had already been mentioned, such as the ground rules or the description of a suspect. Six- to nine-year-olds are more likely to disclose details of a suspect following such approaches (Wyman et al. 2017) and children seven- to 12-years-old find yes/no questions easier to answer (Brunacher et al. 2019). Nonetheless, asking young children yes/no questions is usually avoided, because young children tend to agree with the interviewer without providing any further elaboration (Fritzley and Kang 2003).

Overall, our coding method was comparable with other coding systems that have been used to assess the quality of interviewers' approaches. For example, the tell, explain, describe *TED* approaches, '*wh-approaches*', '*choice*' approaches, '*yes/no*' approaches and '*facilitators*' used here were the same as Myklebust and Bjørklund's (2010) coding system for '*open questions*', '*identification*', '*selection*', '*yes/no*' and '*facilitators*' respectively.

The number of times each approach was used during an interview was noted.

2.5 | Analysis

To explore how time of day may have affected interviewers' approaches our statistical analyses took the following steps. First, with regression analysis we tested whether interviewers' group (HS or RI) predicted interviewers' approaches. This was to determine whether analyses should be conducted separately on each group (if the interviewers' group predicted interviewers' approaches), or could be conducted all interviewers irrespective of group.

Second, we used regression analysis to test if time-of-day was a predictor of interviewers' approaches. For significant outcomes, we explored whether time-of-day was a predictor of interviewers' approaches by looking at how different times of day affected interviewers' performance using Multivariate Analysis of Variance (MANOVA). We assigned interviews into one of four time-categories (07:00 a.m.–11:00 a.m.; 11:01 a.m.–14:00 p.m.; 14:01p.m.–16:00 p.m.; 16:01 p.m.-22:00 p.m.) based on Valdez et al. (2014). We also considered how interviews toward the end of the day might be affected, using correlational analyses. Given the lack of previous research into time-of-day and interviewing children, we did not make specific hypotheses about the outcome of these analyses.

3 | Results

3.1 | Details of Approaches Used by the Interviewers

For the 102 transcriptions the mean number of appropriate approaches made by interviewers was 138.32 (SD = 99.66), the mean number of neutral approaches was 22.16 (SD = 14.34), and the mean number of inappropriate approaches was 85.86 (SD = 65.11).

3.2 | Normality Test

To test the normality of the approaches we used a Shapiro-Wilk test as it provided better power than other normality tests (Ghasemi and Zahediasl 2012; Steinskog et al. 2007). None of the 13 approaches, (a) echo-statements, (b) facilitators, (c) TED, (d) How/What/Who, (e) echo-wh, (f) When/Where/Which/Why, (g) yes/no-TED, (h) yes/no-wh, (i) choice, (j) echo-choice, (k) echo-yes/no, (l) leading, and (m) yes/no, was normally distributed (for each variables $p < 0.001$). None of the three categories of approaches were normally distributed: 'Appropriate' W (102) = 0.137, $p < 0.01$; '*neutral*' W (102) = 0.136, $p < 0.01$; and '*inappropriate*' (W (102) = 0.204, $p < 0.01$).

3.3 | Transformation

A logarithm transformation was used to transform the data to meet the assumptions of Regression analysis, MANOVA and Pearson correlation. Logarithm transformation was the most suitable for our dataset which was measured variables, and had a stronger transformation with a major effect on the data distribution shape compared to other transformations (Cox 2005).

Variables with significance values ranging from $p = 0.207$ to $p = 0.855$ were transformed. The transformation failed to transform '*Yes/no-TED*' ($p = 0.007$), '*Yes/no-wh*' ($p = 0.027$) or '*Echo-choice*' ($p < 0.001$). These three variables were excluded from the regression analysis, and a Spearman correlation (if needed) was used to assess them. The new categories of '*neutral*'

approaches and '*inappropriate*' approaches did not include these three variables - see Table 2 for the categories of approaches analyzed in the present study.

The normality of the transformed data was, for '*appropriate*' W (96) = 0.987, $p = 0.474$, for '*neutral*' W (96) = 0.982, $p = 0.198$, and for '*inappropriate*' W (96) = 0.984, $p = 277$.

3.4 | Interviewers' Group as a Possible Predictor of Interviewers' Approaches

Linear Regression showed that the interviewers' group (highly skilled HS or regular interviewers RI) was a significant predictor of the use of '*appropriate*' approaches, F (1,100) = 15.340, $p < 0.01$ with an R^2 of 0.133; of '*neutral*' approaches, F (1,94) = 7.372, $p = 0.008$ with an $R^2 = 0.073$; and of '*inappropriate*' approaches, F (1,100) = 7.438, $p = 0.008$, with an R^2 of 0.069. The mean use of each approach by each group of interviewers is shown in Table 3. A one-way MANOVA was conducted to examine whether there were any differences between the mean number of each approach based on interviewers' group. Significant group differences were found for the use of '*appropriate*' approaches (F (1, 94) = 14.75, $p < 0.01$, partial $\eta^2 = 0.14$), the use of '*neutral*' approaches (F (1, 94) = 7.37, $p = 0.008$, partial $\eta^2 = 0.07$), and the use of '*inappropriate*' approaches (F (1, 94) = 6.113, $p = 0.015$, partial $\eta^2 = 0.06$).

The HS group were more likely to follow the recommended police guidelines than the RI group. As the interviewers in the two groups addressed children differently, we explored any time-of-day effects separately for each group.

3.5 | Time-Of-Day as Possible Predictor for Interviewers' Approaches

For the HS group: Time-of-day was not a predictor of HS interviewers' approaches. Linear Regression analysis showed that the starting time of an interview was not a predictor of the '*appropriate*' approaches used by the HS group, F (1,40) = 0.038, $p = 0.846$, with an R^2 of 0.001. The average use of '*appropriate*' approaches remained consistent from the start of the day ($M = 2.2$, SD = 0.25) to the end of the day ($M = 2.2$, SD = 0.21). The starting time of an interview was not a predictor of the '*neutral*' approaches used by the HS group, F (1,38) = 0.010, $p = 0.919$, with an R^2 of 0.017. The average use of '*neutral*' approaches remained consistent from the start of the day ($M = 2.1$, SD = 0.72) to the end of the day ($M = 2.2$, SD = 0.54). The starting time of an interview was not a predictor of the '*inappropriate*' approaches used by the HS group, F (1,40) = 0.576, $p = 0.442$, with an R^2 of 0.014. The average use of '*inappropriate*' approaches remained consistent from the start of the day ($M = 1.78$, SD = 0.28) to the end of the day ($M = 1.86$, SD = 0.23).

For the RI group: Time-of-day was a predictor of interviewers' appropriate and inappropriate approaches for the RI group. Linear Regression analysis showed that the starting time of an interview was a significant predictor of the '*appropriate*' approaches used by the RI group, F (1,58) = 12.449, $p = 0.001$, with an R^2 of 0.177. The starting time of an interview was not a predictor of the '*neutral*' approaches used by the RI group, F (1,54) = 2.396, $p = 0.127$, with an R^2 of 0.206. The starting time of an interview was a significant predictor of the '*inappropriate*' approaches used by the RI group (F (1,58) = 7.482, $p = 0.008$) with an R^2 of 0.114.

TABLE 2 | Categorization of approaches analyzed.

Appropriate	Neutral	Inappropriate
1. Echo-statement 2. Facilitators 3. TED 4. How/What/Who	1. Echo-wh, 2. When/Where/Which/Why	1. Choice 2. Echo-yes/no 3. Leading 4. Yes/no

TABLE 3 | Approaches based on interviewers' specialized status.

	Highly skilled			Regular interviewers		
	N	M	SD	N	M	SD
Appropriate	42	2.2	0.24	60	1.93	0.33
Neutral	40	2.02	0.26	56	1.63	0.78
Inappropriate	42	1.74	0.55	60	1.89	0.29

3.6 | Interviewers Approaches at Different Times of Day

As time-of-day was not a predictor of interviewers' approaches for the HR group, the HR group was excluded from further analysis. Further analysis was conducted to identify how the time of day predicted interviewers' approaches for the RI group. Each interview was assigned one of four time-categories (07:00 a.m.–11:00 a.m.; 11:01 a.m.–14:00 p.m.; 14:01 p.m.–16:00 p.m.; 16:01 p.m.–22:00 p.m.) based on Valdez et al. (2014). MANOVA was conducted to test if the mean use of '*appropriate*', '*neutral*' and '*inappropriate*' approaches deviated within each time-category for each group of interviewers.

For the RI group: a MANOVA found a significant difference between the mean of '*appropriate*' approaches within the four time-categories (F (3, 56) = 3.120; $p = 0.033$; partial $n^2 = 0.14$); no significant differences between the mean of '*neutral*' approaches within the four time-categories (F (3, 56) = 0.658; $p = 0.582$; partial $n^2 = 0.03$); and no significant difference between the mean of '*inappropriate*' approaches within the four time-categories (F (3, 56) = 2.413; $p = 0.076$; partial $n^2 = 0.11$). Multiple comparisons with Bonferroni tests showed significant differences in the mean of '*appropriate*' approaches used between the 07:00–11:00 and 16:01–22:00 group $p = 0.031$, 95%, C. I = 0.022, 0.72. The mean usage of '*appropriate*' approaches within the 07:00 to 11:00 group was 2.18 (SD = 0.25) and within the 16:01–22:00 group was 1.72 (SD = 0.38). No other significant differences were found.

As there were significant differences regarding the usage of '*appropriate*' approaches between the 07:00–11:00 and

16:01–22:00 group for the RI group we explored how precisely '*Echo-statements*', '*Facilitators*', '*TED*' and '*How/What/Who*' might have been affected. One-way ANOVA shown that the means of '*Echo-statements*', '*Facilitators*' and '*TED*' were significantly different between the two-time groups, but '*How/What/Who*' approaches remained the same. Table 4 shows the lower mean usage of '*Echo-statements*', '*Facilitators*' and '*TED*' when interviews were conducted between 16:01 to 22:00 compared to the early morning group.

These results do not support the idea that different times of the day may affect the quality of interviews differently, but do suggest that later hours may produce fewer 'ideal' interviews. To test this further a correlation analysis was conducted for the use of appropriate approaches by the RI group.

3.7 | Correlational Relationships: Time-Of-Day and Interviewers' Approaches

For the RI group, Pearson correlation analysis showed a significant negative relationship between the time of the day and the use of '*appropriate*' approaches $r(58) = -0.420$, $p = 0.001$. These results reconfirm the idea that the later an interview was conducted the less 'ideal' it was. *Appropriate* approaches started with an average of $M = 2.1$ (SD = 0.31) in the early hours of the day and decreased to an average of $M = 1.7$ (SD = 0.38) in the later hours.

4 | Discussion

The present study evaluated the influence of time-of-day on interviewers' approaches (i.e., their questioning and interaction) in forensic interviews with children. To explore this in detail, we ran our analysis separately for specialized interviewers who focused on child interview work (the group labeled HS) and less specialized interviewers (the group labeled RI), because interviewers' group had an effect on their ability to gather evidence. Thus, controlling this was key in exploring any time-of-day effect. For the HS group there was no effect for time-of-day. For the RI group the time-of-day predicted their approaches. For the RI group their use of appropriate approaches declined as the day passed.

TABLE 4 | Means and ANOVA results for 'appropriate' approaches within the RI two-time groups.

	07:00–11:00		16:01–22:00			
Approaches	***M***	**SD**	***M***	**SD**	***F* (df)**	n^2
Echo-statements	1.45	0.39	0.99	0.39	7.63[a] (1,21)	0.27
Facilitators	1.84	0.26	1.26	0.42	13.65[b] (1,20)	0.41
TED	1.21	0.29	0.59	0.51	11.25[b] (1,20)	0.36
How/What/Who	1.46	0.35	1.28	0.35	1.45 (1,21)	0.06

[a] $p < 0.05$.
[b] $p < 0.005$.

As in other field studies which use time-of-day as an indicator of circadian rhythms (Blatter and Cajochen 2007; Collinson et al. 2020; Pope 2016) these results link circadian rhythms with the quality of police interviews conducted by less specialized interviewers. The specialist interviewers (the HS group) were not affected by the timing of the interviews which they conducted. But the less specialized interviewers (the RI group) were negatively affected, and the later they conducted interviews the less likely they were to follow the guidelines for interviewing children. In other words, time-of-day was a predictor of interviewers' approaches and in particular, the production of less ideal interviews during late hours for the less specialized interviewers.

The findings highlight differences between the *Highly Skilled* (HS) and *Regular Interviewer* (RI) groups in their use of interviewing approaches. The HS group consistently relied on *appropriate* approaches, aligning with recommended police guidelines. This group showed no significant variation in their use of *appropriate*, *neutral*, or *inappropriate* approaches throughout the day, suggesting a stable application of best practices regardless of time. In contrast, the RI group exhibited significant variability. Time of day was a significant predictor of *appropriate* approaches among RI interviewers, with fewer *appropriate* approaches used during later hours. Specifically, *appropriate* approaches such as *echo-statements*, *facilitators*, and *TED* decreased significantly between 16:01 and 22:00 compared to early morning hours. This suggests that RI interviewers may be more susceptible to factors such as fatigue or reduced focus over time, leading to less effective interviewing techniques. These individual differences underscore the importance of interviewer training and the potential impact of time-of-day effects on interview quality.

For the RI interviewers there was a decline in the use of appropriate approaches the later the interview was conducted during the day. This finding matches other field research which has shown that performance and decision-making change in a negative linear manner as time passes (Collinson et al. 2020; Pope 2016). For example, school performance declines later in the day with students performing best in the morning (Pope 2016). The correlational relationship we identified between time-of-day and appropriate approaches for the less specialized interviewers did not support previous laboratory research (Valdez et al. 2014). The previous research has shown peaks of cognitive performance between 11:00 and 14:00 as well as between 16:00 and 22:00 (Valdez et al. 2014). This may be because the present study was based on fieldwork and external variables in real life contexts may have impacted the findings. Because the present study was a field study, we could not test the full 24-h spectrum of a day for practical reasons. These meant we could not compare our results directly with the results from previous studies in experimental research settings.

4.1 | 'Appropriate' Approaches Were Affected in the RI Group

The interviews from the less specialist interviewers (the RI group) changed as the day progressed. As the day progressed, less specialist interviewers maintained the usage of '*neutral*' and '*inappropriate*' approaches, but used less '*appropriate*' approaches in their effort to gather evidence from children.

Having interviews with fewer '*appropriate*' approaches can affect the quality of a police interview (Ministry of Justice 2022).

Other researchers have noted that '*appropriate*' approaches were influenced by interviewers' working hours, again in a negative manner, but '*inappropriate*' approaches remained the same (Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis 2020b). They suggested that '*appropriate*' approaches are cognitively more difficult to generate than others. The more cognitively difficult an approach is, the more it is likely to be affected by situations impacting cognition (Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis 2020b). This may be why '*appropriate*' approaches are affected by interviewers' working hours (Kyriakidou, Blades, Cherryman, Christophorou, and Kamberis 2020b) and the time-of-day. '*Appropriate*' approaches may require more cognitive effort by interviewers because they are less often used in everyday interactions (Stivers 2012). As these approaches are less often used, generating '*appropriate*' approaches within an interview may therefore require more cognitive resources (e.g. further focus and attention by the interviewer) compared to other approaches.

A contribution of the present study is the distinction between highly skilled interviewers and regular interviewers which showed a difference in these two groups behaviors. When a skill is mastered, it has developed its own strong neural activity patterns surrounding the performance of that mastered skill; thus, the cognitive resources required to deliver that mastered skill are reduced (Gaser and Schlaug 2003; Oby et al. 2019). The less specialist interviewers may have found it challenging to maintain the usage of '*appropriate*' approaches under more difficult circumstances (e.g., different times of day) which affected their cognitive skills because they had not fully mastered such approaches. This may explain why '*appropriate*' approaches were the only approaches which were affected in the RI group; less specialist interviewers may have relied more heavily on those cognitive skills which are influenced by situational factors to generate '*appropriate*' approaches.

This same reasoning can explain why all approaches used by highly skilled interviewers were unaffected. Specialist interviewers, who are more likely to have mastered the use of '*appropriate*' approaches, do not require as many cognitive resources as the less specialist interviewers. Therefore, the specialist interviewers were less likely to be disrupted by external factors like the time of day, hence their consistent performance.

These results show that Kleitman (1933) has a selective effect upon investigative interviewing; meaning there is a partial impact of circadian rhythms on interviewers, at least on the less skilled interviewers. This selective effect of circadian rhythms on interviewers' performance is supported by laboratory studies which have shown a selective effect of circadian rhythms on executive functioning (Kleitman et al. 1938; Valdez et al. 2005, 2010). Laboratory studies provide clues that only some components of attention are affected and not all areas of the brain are equally affected by circadian variations (Valdez et al. 2014; Valdez et al. 2005, 2010). For example, the susceptibility of tonic alertness, phasic alertness and selective attention to circadian variations may have partially impacted the less skilled interviewers performance. Future forensic laboratory studies could be carried out to identify which cognitive functions are affected during interviewing based on the results of this study and Valdez et al. (2005, 2010, 2014).

4.2 | Limitations

Like other similar field studies, we used time-of-day as an indicator of circadian rhythms (Collinson et al. 2020; Pope 2016) so the link between the performance studied and circadian rhythms was indirect. Complementary experimental studies could build on the present work to make this link direct. e.g., biological measures such as interviewers' body temperature and heart rate during the interview process as well as sleep pressure, shift, and individual differences would provide direct measures of circadian rhythms.

As this study utilized secondary data, it was not possible to determine which interview protocols (e.g., NICHD, ABE, PEACE) were followed in each transcript, limiting analysis of protocol-specific variations. Using transcripts limited our ability to capture non-verbal cues, such as tone, pauses, and body language, which are important for understanding the dynamics of the interviews. This may have influenced how interviewer performance and interactions were interpreted.

Due to the anonymous database, we could not identify the number of interviews conducted by each interviewer. It is possible that some interviewers may have contributed more than one interview to our sample. Moreover, as this study was based on secondary data which did not note children's replies, it is unclear how children's responses affected interviewers' approaches for example, a child providing short responses or not collaborating may have affected an interviewer's approaches. Despite these limitations, our research shows the presence of a selective effect of circadian rhythms on interviewers' performance.

5 | Conclusions

These results extend Kleitman's Theory (1933, 1938) to the field of investigative interviews. This theory can help us identify previously ignored factors that interfere with interviewers' ability to gather evidence. There is a selective effect of circadian rhythms on the quality of work performance in investigative interviews, at least for less specialist interviewers.

This work demonstrates the importance of situational factors in police interviews with children for managerial teams within criminal investigation departments. If possible, police forces should try to avoid interviewing children at the end of the day. We also suggest that interviewers have the opportunity to go on improving their skills, so that as many as possible can reach the standard of the highly skilled interviewers in this study, because the highly skilled interviewers were not affected by the time of day. Future research into the quality of police interviews should consider the timing of the interviews when analyzing and reporting data, and should include information about the time of day in the details about the study's procedure.

The reliance on investigative interviews to gain evidence in most child sexual abuse cases puts pressure on police and front-line interviewers to take all possible measures to obtain the best testimonies from child victims. The identification that time of day is a risk factor in the quality of some interviews has practical implications for police training and should be noted in the guidance and manuals for police interviews with children.

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Ethics Statement

Ethical approval to conduct the initial study which generated these secondary data was P59645 by Coventry University Ethics Committee in 2017. The permission to conduct this study within the police premises was sent to the Editor-in-Chief.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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