

Child Neuropsychology

A Journal on Normal and Abnormal Development in Childhood and Adolescence

ISSN: 0929-7049 (Print) 1744-4136 (Online) Journal homepage: <https://www.tandfonline.com/loi/ncny20>

Executive functions in homeless young people: Working memory impacts on short-term housing outcomes

Charlotte E. Fry, Kate Langley & Katherine H. Shelton

To cite this article: Charlotte E. Fry, Kate Langley & Katherine H. Shelton (2020) Executive functions in homeless young people: Working memory impacts on short-term housing outcomes, Child Neuropsychology, 26:1, 27-53, DOI: [10.1080/09297049.2019.1628930](https://doi.org/10.1080/09297049.2019.1628930)

To link to this article: <https://doi.org/10.1080/09297049.2019.1628930>



© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



[View supplementary material](#)



Published online: 24 Jun 2019.



[Submit your article to this journal](#)



Article views: 564



[View related articles](#)



[View Crossmark data](#)



OPEN ACCESS



Executive functions in homeless young people: Working memory impacts on short-term housing outcomes

Charlotte E. Fry^a, Kate Langley^{a,b} and Katherine H. Shelton^a

^aSchool of Psychology, Cardiff University, Cardiff, UK; ^bMRC Centre for Neuropsychiatric Genetics and Genomics, School of Medicine, Cardiff University, Cardiff, UK

ABSTRACT

Most homeless young people have experienced multiple adversities, with potential implications for the development of Executive Functions (EFs), higher-order cognitive processes important for adaptation. EFs have been identified as putative contributors to the capacity to exit homelessness, however, little research has investigated EFs in homeless young people. To address gaps in current knowledge, this study compared executive function performance between homeless and housed young people. Relationships between EFs and short-term housing outcomes were also explored. Sixty-eight homeless young people (16–19 years) and 37 age-matched housed young people participated in this study. Computerized EF tasks spanned the domains of working memory, set shifting/flexibility, planning, impulsivity/risky decision making, selective attention/inhibition, and verbal fluency. Homeless young people demonstrated worse performance than housed youth on several EF tasks, particularly working memory and impulsivity/risky decision making. Working memory predicted progression into more independent accommodation; those with longer working memory spans were twice as likely to have progressed to more independent housing rather than maintained their current housing status after six months. Poorer EFs are associated with youth homelessness and also with an individual's ability to progress towards independence. As such, EFs should not continue to be overlooked by researchers and service providers. Emerging adulthood, as a sensitive period for EF development, is an opportune time for intervention to increase the likelihood of positive housing outcomes in homeless young people.

ARTICLE HISTORY

Received 1 November 2018

Accepted 31 May 2019

KEYWORDS

Executive functions; working memory; homeless; youth; housing

Some of the most basic universal human rights include the right to shelter and food, the right to live in safety, the right to education, and the right to be treated equally without discrimination (United Nations, 1948). For many homeless young people, the reality is very different, and these young people represent one of the most vulnerable groups in society. Worldwide estimates indicate that there are over 100 million young people living on the streets (Thomas de Benitez, 2007); more recent estimates in the United

CONTACT Charlotte E. Fry  FryC1@cardiff.ac.uk  School of Psychology, Cardiff University, Tower Building, 70 Park Place, Cardiff CF10 3AT, UK

 The supplementary data for this article can be accessed at <https://doi.org/10.1080/09297049.2019.1628930>.

© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

States indicate 1 in 10 18–25 year olds and 1 in 30 13–17 year olds experienced some form of homelessness in the space of a year (Morton, Dworsky, & Samuels, 2017), and in the United Kingdom, best estimates suggest that more than 150,000 young people present as homeless each year (Centrepont, 2015). Homeless youth can be considered a distinct group from homeless adults and families, and include those who have run away, those who have been kicked out of home, and those aging out of foster care or released from prison, some or all of whom may have spent time on the streets (Toro, Dworsky, & Fowler, 2007). Despite the diverse backgrounds of homeless young people, ultimately what qualifies them as homeless is their lack of non-transitory, appropriate, and safe accommodation in which they can live and call “home”.

There is likely to be a complex interaction of structural and individual factors that contribute to or else maintain youth homelessness (e.g., Bramley & Fitzpatrick, 2017). Whilst research into associations between homelessness and individual level factors, such as substance abuse, risky behavior, trauma, and coping have been studied (e.g., Bender, Yang, Ferguson, & Thompson, 2015; Bousman et al., 2005; Dashora, Erdem, & Slesnick, 2011; Greene, Ennett, & Ringwalt, 1999; Kidd, 2003; Milburn et al., 2017; Nyamathi et al., 2010; Rice et al., 2013), the crossover between the cognitive and neuropsychological fields and the literature on homeless young people is in its infancy, with skills in the cognitive domain often overlooked (Fry, Langley, & Shelton, 2017; Parks, Stevens, & Spence, 2007). The paucity of research at this scholarly intersection exists despite the fact that adolescence and emerging adulthood represent key periods of development for cognitive skills and abilities, especially those related to frontal lobe function like executive functions (e.g., Selemon, 2013).

Executive functions

Executive functions are considered to be higher-level cognitive processes that often interact with lower-level cognitive processes, and work in a goal-directed way to allow us to adapt to novel situations or circumstances (Alvarez & Emory, 2006; Best & Miller, 2010; Diamond, 2013; Gilbert & Burgess, 2008; Huizinga, Dolan, & van der Molen, 2006; Miyake & Friedman, 2012; Zelazo & Carlson, 2012). They are important for everyday life, especially education and employment, and have been found to predict many developmental outcomes, as well as to predict risky behavior in adolescents/emerging adults (Diamond, 2013; Jurado & Rosselli, 2007; Miyake & Friedman, 2012; Pharo, Sim, Graham, Gross, & Hayne, 2011; Zelazo & Carlson, 2012).

There are some indications that cognitive difficulties, and EF difficulties in particular, could impact housing-related outcomes for homeless young people. Cognitive impairments, including EFs such as planning, can adversely affect independent living, presenting barriers to accessing services and exiting homelessness (Backer & Howard, 2007). These difficulties can be perceived by services and landlords as non-compliant behaviors and lead to problems maintaining suitable accommodation, as well as increase vulnerability to using substances and compound risk for homelessness in care leavers, those that have left residential and/or foster care (Backer & Howard, 2007). Despite the potential impact on outcomes for homeless groups, cognitive impairment is rarely assessed by services, as the focus tends to fall on more immediate needs, such as problematic substance use (Solliday-McRoy, Campbell, Melchert, Young, & Cisler, 2004). In homeless young people, a recent

study found that having cognitive difficulties in addition to psychiatric disorder(s) was associated with being less likely to earn enough money to live independently (Saperstein, Lee, Ronan, Seeman, & Medalia, 2014).

In addition to evidence that executive functions continue to develop in late adolescence and early adulthood, there are a number of factors that may disrupt or impact on executive function development that are likely to relate to homeless young people's experiences. Two major factors that are commonly experienced by homeless young people and have been linked to executive function development are maltreatment/early life stress and poverty. Across a range of ages, maltreatment was related to poorer executive functioning and working memory (DePrince, Weinzierl, & Combs, 2009; Masson, Bussi eres, East-Richard, R-Mercier, & Cellard, 2015; Wenzel & Gunnar, 2013), and familial trauma explained unique variance in EF performance after controlling for anxiety, socioeconomic status, and potential brain injury (DePrince et al., 2009). Childhood maltreatment was also found to predict poorer executive functioning in adulthood (Nikulina & Widom, 2013). More broadly, early life stress is associated with executive function difficulties (among other cognitive difficulties) and the protracted development of the prefrontal cortex renders it particularly vulnerable to the effects of early adversity (Pechtel & Pizzagalli, 2011).

Young people living in poverty have demonstrated worse performance on executive function and working memory tasks than their relatively better off counterparts, and socioeconomic status has been associated with executive function and working memory across a broad range of incomes (Farah et al., 2006; Noble, McCandliss, & Farah, 2007). The relationship between poverty and school achievement was also found to be mediated by executive functioning (Lawson & Farah, 2017). In their review of socioeconomic status and its effects on brain development, Hackman and Farah concluded that socioeconomic status was an important predictor of executive function, and even when performance was equivalent, there were differences in brain function (Hackman & Farah, 2009).

Both maltreatment and poverty represent factors that can impact negatively on the development of executive functions and associated brain regions. Given the increased likelihood of early adversity and a lack of economic resources in homeless young people, it is likely that there is also vulnerability for sub-optimal development of executive functions. However, little is known about EF in homeless young people; the evidence is mixed as to whether EF performance is worse than in housed young people, and studies that have considered EF have either covered limited EF domains or combined scores to give an EF composite score (Fry et al., 2017). This is problematic because EF domains, while related, are also separable (e.g., Miyake & Friedman, 2012; Miyake et al., 2000). This means important differences in performance between EF domains could be missed. Not understanding these difficulties could be problematic for implementing effective interventions or adaptations to services for young people's specific EF-related needs. The limited previous work has identified working memory and selective attention as difficulties for homeless young people, whereas findings for overall EF performance and IQ differ between studies (Fry et al., 2017).

Potential implications

Adolescence and emerging adulthood may represent a time when adverse environmental influences may have a particularly negative impact, but there are also opportunities

during this period for intervention and training (Casey, Tottenham, Liston, & Durston, 2005; Knoll et al., 2016; Masten, 2014). Indeed, executive functions have demonstrated improvements with practice, coupled with concurrent changes in brain structure and function (e.g., Masten, 2014; Zelazo & Carlson, 2012). Although there are some questions as to whether training generalizes to other tasks and domains (see e.g., Shipstead, Redick, & Engle, 2012), attempts to train executive functions have been found to benefit disadvantaged young people, with improvements not only in the trained task, but also in untrained tasks and in academic achievement more broadly (e.g., Holmes & Gathercole, 2014; Jolles & Crone, 2012). While a recent study attempted to demonstrate feasibility for a cognitive skills training intervention, including EF, in homeless young people (Medalia, Saperstein, Huang, Lee, & Ronan, 2017), substantial loss of participants through the course of the study made it difficult to draw conclusions about the effectiveness of the intervention. As such, there have been promising developments in this field, but the question still remains as to whether EF interventions that work for homeless youth can be developed and whether these can contribute to improving young people's outcomes.

The present study

Adolescence and emerging adulthood represent sensitive periods of development that may provide opportunities as well as vulnerabilities, and have been identified as key periods of development for executive functions and related brain regions. For this reason, we recruited young people in transition between adolescence and emerging adulthood, aged 16–19 years. Executive functions are higher-level cognitive functions that are crucial for being able to adapt to new situations, and are likely to be important for obtaining and maintaining accommodation, as well as everyday living. To examine the importance of executive functions for homeless young people, we also aimed to explore the possibility that executive functions could predict short-term housing outcomes in the homeless group. Executive functions are closely linked to frontal lobe function and connectivity. One of the most prominent theories of executive functions envisages them as distinct but related constructs, and this seems to be consistent with the evidence. Executive functions that are influenced by emotion and motivation have been distinguished from those that are more logical and rational (Happaney, Zelazo, & Stuss, 2004; Zelazo & Carlson, 2012), and these “hot” executive functions are considered more representative of everyday decision making (e.g., Chan, Shum, Touloupoulou, & Chen, 2008; Happaney et al., 2004; Zelazo & Carlson, 2012). Accordingly, a range of tasks were included in the current study, tapping both “hot” and “cool” executive functions.

The current study addresses several gaps in the literature insofar as it assessed a broad range of executive function domains, included an age-matched comparison group, and used analytic techniques consistent with the conceptualization of EFs as both related and separable (Miyake & Friedman, 2012; Miyake et al., 2000), in addition to considering how executive functions impact on homeless young people's lives, specifically short-term housing outcomes. Previous investigation of associations between EFs and outcomes that are pertinent to homeless young people is particularly scant; to our knowledge, Saperstein et al. (2014) is the only example. In Saperstein's paper, there was no indication as to rates of cognitive and EF impairment in homeless young people *without* psychiatric disorders, as

this was not assessed (Saperstein et al., 2014). As such, this is an area that, despite its potential importance, is in great need of examination. Consequently, the aims of this paper were to:

- (1) Compare executive function performance in homeless young people with that of a comparison group of housed young people, noting similarities and differences in domains of strengths and difficulty.
- (2) Test whether executive function performance would predict housing outcome at least six months later in homeless young people.

Methods

This study was approved by the Cardiff University School of Psychology Research Ethics Committee. The research process comprised a pilot phase to optimize the methodology (details available from corresponding author) and the main study phase. Data collection spanned three sites to enable access to homeless and housed young people.

Participants

Homeless group

We recruited 76 unaccompanied homeless young people through a youth homelessness charity based in Wales. All participants were living in temporary accommodation at the time of testing. To be eligible to access supported housing services, young people must be legally homeless. All of the housing projects and staff were contacted to see if they had any potentially interested service users on a rolling basis between February 2016 and November 2016. After excluding eight individuals who had consumed excessive substances or alcohol in the preceding 24 hours, were ill at the time of testing, or were both color-blind and dyslexic, the total sample consisted of 68 homeless young people. Participants were aged between 16 and 19 years, with a mean age of 17.5 ($SD = 0.82$). There were more males than females (62% male); one participant identified their sex as “Other”.

Housed group

We recruited 37 young people without experience of homelessness. Twenty five participants were recruited from a local further education college that offered a broad spectrum of qualifications from traditional University access courses (A-Levels) to vocational courses. Recruitment was supported by the Enrichment Team at the college, who helped with advertising and coordinating participants. Text and email reminders were used to maximize attendance. The remaining 12 participants were recruited from a local high school, whose catchment area included more deprived areas of the city. Recruitment at the school was managed by one of the teachers, who contacted tutors and booked interested students into timeslots, and chased up non-attendance. In total, there were 37 young people (16–19 years) in the housed group. Participants had a mean age of 17.1 ($SD = 1.16$), there were marginally more females than males (54% female), and one participant classified their sex as “Other”. Demographic information and background characteristics for both groups can be found in [Table 1](#).

Table 1. Demographic profiles of the homeless and housed groups.

		Homeless Group N (%)	Housed Group N (%)
Age	Mean (<i>SD</i>)	17.5 (0.82)	17.1 (1.16)
Sex	Male	42 (61.8)	16 (43.2)
	Female	25 (36.8)	20 (54.1)
	Other/Prefer not to say	1 (1.5)	1 (2.7)
Ethnicity	White	61 (89.7)	28 (75.7)
	Mixed	2 (2.9)	1 (2.7)
	Asian	1 (1.5)	3 (8.1)
	Black	2 (2.9)	4 (10.8)
	Other	2 (2.9)	1 (2.7)
First language	English	64 (94.1)	28 (75.7)
	Welsh	0 (0.0)	2 (5.4)
	Filipino	1 (1.5)	0 (0.0)
	Oromo (Ethiopia)	0 (0.0)	1 (2.7)
	Polish	1 (1.5)	1 (2.7)
	Portuguese	0 (0.0)	1 (2.7)
	Romanian	1 (1.5)	0 (0.0)
	Spanish	1 (1.5)	0 (0.0)
	Tigrinya (Eritrea)	0 (0.0)	2 (5.4)
	Turkish	0 (0.0)	1 (2.7)
	Arabic & Kurdish	0 (0.0)	1 (2.7)
Substance past 24 hours (light/regular) ¹	Yes	14 (20.6)	0 (0.0)
	No	54 (79.4)	37 (100.0)
Alcohol past 24 hours (less than 3 drinks) ²	Yes	3 (4.4)	0 (0.0)
	No	65 (95.6)	37 (100.0)
Past month main Accommodation	Supported housing	64 (94.1)	0 (0.0)
	Family or friends' place	2 (2.9)	1 (2.7)
	On the streets	1 (1.5)	0 (0.0)
	Foster care	1 (1.5)	1 (2.7)
	Private rented	0 (0.0)	1 (2.7)
	At home	0 (0.0)	34 (91.9)
	Remembered having one-to-one support and /or extra time at school	24 (35.3)	17 (45.9)
Highest level of education ³ (see footnote for explanation)	Unsure	6 (8.8)	0 (0.0)
	No	38 (55.9)	20 (54.1)
	Not yet attained any qualifications	10 (14.7)	2 (5.4)
	1–4 GCSEs any grades or equivalent	32 (47.1)	11 (29.7)
	5+ GCSEs grades A*-C or equivalent	22 (32.4)	22 (59.5)
	2 + A levels or equivalent	3 (4.4)	2 (5.4)
Experience of ever living in foster care	Other	1 (1.5)	0 (0.0)
	Yes	32 (47.1)	5 (13.5)
	Unsure	1 (1.5)	0 (0.0)
	No	35 (51.5)	32 (86.5)
Contact with Criminal Justice System	Yes	39 (57.4)	1 (2.7)
	Unsure	1 (1.5)	0 (0.0)
	No	28 (41.2)	36 (97.3)
Regular substance use (at least once a week)	Yes	21 (30.9)	1 (2.7)
	No	47 (69.1)	36 (97.3)
Regular alcohol use (at least once a week)	Yes	9 (13.2)	2 (5.4)
	No	59 (86.8)	35 (94.6)
FAS-II score	Mean (<i>SD</i>)	4.4 (2.3)	5.4 (1.9)
Total N		68	37

¹Anyone with heavier than regular use and/or polysubstance use within the 24 hours prior to testing was excluded.

²Anyone who had consumed more than 3 alcoholic drinks within the 24 hours prior to testing was excluded. ³ GCSEs = General Certificates of Education, which represent secondary qualifications taken around age 16 in the UK; 5 or more GCSEs grades A*-C typically represents the level students would need to attain to progress into further education (college or sixth form), and is used as a benchmark for schools; A Levels are further education qualifications typically attained at age 18, through college or sixth form, that confer eligibility to apply for bachelor's degree programs at universities in the UK; there are also equivalent vocational qualifications of a similar level, e.g. Level 3 is equivalent to A Level (for further information, please see <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>). FAS-II = the Family Affluence Scale 2nd edition (Currie et al., 2008).

Initially, all young people who had reported taking substances in the 24 hours prior to testing were going to be excluded, but this approach quickly became unfeasible due to approximately a third of participants in the homeless group reporting that they were using cannabis regularly (see Table 1). The strategy was adjusted so that those who reported heavier than usual cannabis use during the preceding 24 hours and those who reported polysubstance use were excluded. The participants retained in the sample were those that had used cannabis only (no other substances) in the previous 24 hours, in amounts that did not exceed their typical weekly use.

Materials

We asked participants about themselves and their experiences, including school, foster care, criminality, and substance use. This interview section included questions previously used with homeless young people (Hodgson, 2014). We also asked about handedness, vision, and screened for color-blindness to assess potential barriers to and/or differences in participants' performance. To assess executive function, we used tests from the Psychology Experiment Building Language (PEBL, tests listed below; Mueller & Piper, 2014), and Letter and Category Fluency (Tombaugh, Kozak, & Rees, 1999). We also assessed IQ using the two-subtest version of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999), as it is well-validated, brief and gives an indication of full scale IQ (FSIQ; Canivez, Konold, Collins, & Wilson, 2009; Psychological Corporation, 1999). A brief questionnaire measure was used as an indicator of socioeconomic status.

BCST-64

The Berg Card Sort Test was identical to the well-known Wisconsin Card Sort Test™ (Grant & Berg, 1948). The short 64-card version was used, which has been shown to yield similar results to the full 128-card version – strong correlations were found on all performance measures between the 64 card and 128 card version of the PEBL BCST in a recent study ($r = .77$ to $.87$; Fox, Mueller, Gray, Raber, & Piper, 2013). This test assesses shifting and flexibility. Four stimulus cards represented four piles, each differing in color, shape, or number. Participants sorted cards into one of the piles and were informed whether their choice was correct or incorrect based on the current rule. The rule changed after ten consecutive correct sorts, with 64 trials in total. The measure of interest was the number of perseverative errors made, that is, the number of times participants continued to sort according to the previous rule.

Corsi

This implementation of Corsi Blocks (Backwards) used the rules and set-up proposed by Kessels (Kessels, van Den Berg, Ruis, & Brands, 2008; Kessels, Van Zandvoort, Postma, Kappelle, & De Haan, 2000) to assess spatial working memory. Nine blue squares in a set arrangement appeared on the screen. The squares would light up in a sequence, ranging from two to nine blocks in length. Participants then clicked on the squares in the reverse order to the order in which they were presented. The inter-stimulus and inter-trial intervals were 1000 ms. Each length had two sequences: if both were incorrect, the test was terminated. There were three practice trials. The measure

used was block span (length of the last correct sequence). Corsi Blocks was originally developed by Corsi (1972), and has been widely used since. Comparisons between a computerized version and the standard version revealed no significant difference in backward span (Claessen, Van Der Ham, & Van Zandvoort, 2015).

Iowa Gambling Task

This test was an implementation of Bechara's Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994) to assess impulsivity and risky decision making. Participants started with \$2000 of "borrowed" money and were told the aim was to try to win as much money as possible by selecting decks of cards. Every time a deck was selected, money was won and sometimes lost. The only "hint" was that some of the decks were worse than others and that avoiding the bad decks was the best way to win. The game ended after 100 trials. The "safe" decks (C and D) gave less in winnings (\$50) but losses were also small, that is, they yielded a net gain. The "risky" decks (A and B), however, gave more in winnings (\$100) but losses were also greater, that is, they yielded a net loss. The measure used was response preference (i.e., the number of times participants selected from "safe" minus "risky" decks).

Stroop

Selective attention and inhibition were assessed using a color-word Stroop paradigm. A fixation cross was present for 1000 ms, then words appeared on the screen (for a maximum of 3000 ms) in different colors: red, blue, green, and yellow. The words could also be the words "red", "blue", "green", or "yellow". Participants had to press buttons (1–2–3–4 on the keyboard, marked with colored stickers) corresponding to the color the word was written in, ignoring the word itself, as quickly and accurately as they could. It is a well-replicated effect that reaction times are slower when the colors and words are incongruent than when the colors and words match, as there is interference (e.g., MacLeod, 1991). There were 24 practice trials, and 144 trials in total with a break halfway through. The measure of interest was interference (congruent – incongruent RTs, ms). We also checked the proportion correct for congruent, incongruent, and neutral trials to ensure participants were able to do the task.

Tower of London

The implementation of the Tower of London (ToL) task was that used in Phillips, Wynn, Gilhooly, Della Sala, and Logie (1999) Set A. It is often used to index planning and problem solving ability. There were three rods and five colored disks presented in an arrangement which participants had to replicate in as few moves as possible. There were eight trials in total; the minimum number of moves required to solve the problem increased over the trials (3, 5, 5, 7, 7, 9, 9, 10). Trial 5 did not exactly match trial 5 of Phillips and colleagues (Phillips et al., 1999); this trial was excluded, leaving seven trials. The task would not move on to the next trial until the current trial was complete. The measure used to index planning was average time before first move (ms). We also looked at the correlation between average time before first move (planning time, ms) and total number of moves made over the minimum possible moves (48 for seven trials). Planning time was adjusted for total time, to reduce any potential impact of participants being generally slow, and this adjusted planning time was negatively

correlated with the number of moves over the minimum required to solve the problem in both groups (Homeless: $r(66) = -.534, p < .001$; Housed: $r(35) = -.633, p < .001$). It should be noted that for a total of 14 participants, the calculation of planning time (average time taken before first move) did not include the first trial, and in contrast to Phillips et al. (1999), participants were not explicitly instructed to plan.

Fluency

We assessed verbal fluency using a letter fluency task (F, A, S) and a category fluency task (animal naming). Participants had one minute to say as many words as they could think of beginning with the letter F (then A and S, respectively). Proper nouns were not permitted, and both repetitions and attempts to use words that had the same stem scored only for the first instance of the word. Any word, including colloquial words, which appeared in the Oxford English Dictionary that did not violate these rules was accepted. For the category fluency task, participants had one minute to name as many animals as they could think of. Any animal was accepted, including those that were magical/imaginary or extinct (Strauss, Sherman, & Spreen, 2006).

Family Affluence Scale version II (FAS-II)

The Family Affluence Scale (FAS-II) is a brief, resource-based measure of socioeconomic status (SES) that can be completed without requiring information from parents (Currie et al., 2008). FAS-II focuses on material objects and experiences that young people may or may not have had (e.g. vehicle ownership). Across countries, the country-level FAS-II was found to be strongly associated with Gross Domestic Product (GDP) and with health outcomes (Boyce, Torsheim, Currie, & Zambon, 2006). UNICEF adopted the FAS-II as an indicator of child material well-being (United Nations Children's Fund, 2007). While the FAS-II was the best available measure of likely poverty for our study, it does have some drawbacks in that it relies on material object ownership, which can vary according to what households may choose to spend their limited income on. However, it remains a better measure of SES when working with young people who do not necessarily have contact with parents than parental income and occupation, which are often used instead (e.g., Bradley & Corwyn, 2002).

Housing outcome

To assess housing outcome, we secured participants' permission to access data held on the charity's monitoring database. Data was retrieved for all participants, with at least 6 months between cognitive testing and identification of outcomes. Possible housing outcomes were divided into three categories: those that had undesirable outcomes or had regressed to less stable accommodation, those that had stayed at the same level or "maintained", and those that had moved on or "progressed". Outcomes within the "maintained" category included: remained in tenancy, moved to another housing project, and moved to a different provider with a similar level of support. Outcomes that were coded as "progressed" were: secured new tenancy, moved to University, moved to accommodation with a lower level of support, moved in with family, and relinquished to family, friends, or private rented. Outcomes categorized as "negative" included: in custody, evicted, no fixed abode, and in Local Authority emergency accommodation (considered less stable). As only a minority of participants were coded as having a "negative" outcome ($n = 6$), these young people were

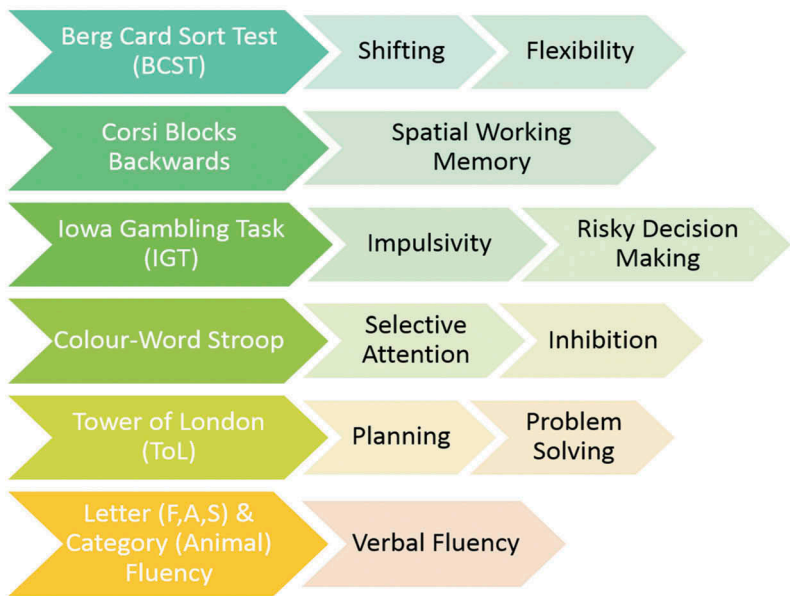
profiled separately. Decisions regarding coding of outcomes were discussed with charity staff to establish how they would consider participants’ outcomes, and any queries were resolved on a case-by-case basis by consulting further information recorded in the database.

Procedure

The order of tasks was counterbalanced around the IQ task, which always appeared in the middle. In our pilot testing, young people reported the IQ task to be the most challenging, as it was the least interesting, so it was strategically placed before the midway break. Tasks were given in one of seven different orders to avoid fatigue and order effects. [Figure 1](#) summarizes the EF tests and corresponding domains. The PEBL EF tests were administered on a laptop using PEBL. Screenshots from the PEBL EF tasks can be found in [Figure 2](#). The WASI was administered in the standard way by the experimenter, except that the stimuli were presented on the screen (using PowerPoint slides) rather than in a booklet. The fluency stimuli were also presented in this manner. Responses and scoring for the non-PEBL tasks were recorded using paper record forms. The Family Affluence Scale-II was completed using pen and paper by the participants themselves, unless they had indicated they wanted the researcher to read the questions out and record responses for them. All participants were given this option in case of reading difficulty. Participants were excluded if it was clear they did not understand the task after completing practice trials.

Statistical analysis

The main technique used was Multivariate Analysis of Variance (MANOVA). IQ was not included in the main analysis because it is unclear what the relationship between IQ and



5.3. EF tasks and corresponding domains.

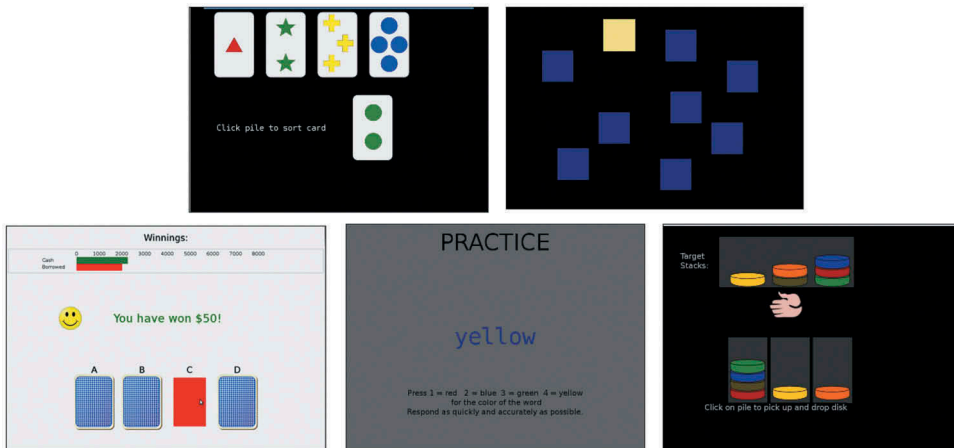


Figure 2. Screenshots of PEBL EF tasks (retrieved from <http://pebl.sourceforge.net/wiki/>).

EFs looks like, and therefore it is not known exactly what would be “accounted for” by including it as a covariate (Dennis et al., 2009). However, as it is very common to control or match for IQ, especially in the neurodevelopmental literature, IQ was included as a covariate in the subsequent MANCOVA sensitivity analysis. Each MANCOVA contained one covariate: IQ, socioeconomic status (as assessed by the FAS-II), or highest level of education attained so far. Any outliers were winsorized and variables were transformed where parametric assumptions had been violated. Variables that had violated parametric assumptions were transformed according to the violation, as recommended by Tabachnick and Fidell (2014). Most had moderate positive skew so a square-root transformation was applied, some had more severe positive skew and were thus log-transformed, and one variable was negatively skewed to a moderate degree so was reflected, then square-root transformed. Skew and kurtosis were within 1SD of the mean ($z = 0$, $z = 3$, respectively, for normal distributions) after transformation.

A One-Way MANOVA was used to test whether the homeless and housed groups differed in their performance on tests of EF, the DVs in this analysis were: number of perseverative errors (BCST-64, sqrt), backwards block span (Corsi), response preference (risky vs. safe decks, IGT), interference (congruent vs. incongruent RTs, Stroop, reflect and sqrt), time taken before first move corrected for total time taken (ToL, sqrt), letter fluency (sqrt), and category fluency. No post-hoc comparisons were conducted as there were only two groups in the IV. Pillai's Trace (V) is the statistic quoted for all MANOVA and MANCOVA analyses due to its relative robustness and the discrepancy in group sizes (Field, 2009; Tabachnick & Fidell, 2014). Follow-up univariate ANOVAs were used to assess group differences on each DV. In order to assess any group differences on a combination of DVs (representing the underlying dimension of EF), discriminant function analysis was also used to follow-up the omnibus MANOVA, as recommended by Field (2009) and Barton, Yeatts, Henson, and Martin (2016).

Whether EFs were associated with later housing outcomes was examined using binomial logistic regression. For the logistic regression analysis, all variables were mean-centered

prior to analysis (Aiken & West, 1991). Participants with negative outcomes ($n = 6$) were not included in the analysis, and four additional participants were missing data on one or more variables, so were also excluded from the logistic regression analysis. The total number of participants included in the logistic regression analysis was 58.

Missing data

There were no more than 5% missing data on any one variable. Little's MCAR test (Little, 1988) indicated that it was highly unlikely that data were systematically missing, and could be treated as if missing completely at random, $\chi^2(56, N = 105) = 57.14, p = .43$.

Results

There were no significant associations between group and sex or age ($\chi^2(1) = 2.469, p = .116$; $t(55.9) = 2.011, p = .049$), but the groups did differ in terms of their socio-economic status ($t(102) = -2.185, p = .031$). However, the magnitude of the difference was small (Homeless group: $M = 4.39, SD = 2.30$; Housed group: $M = 5.35, SD = 1.86$). The housed group also demonstrated better performance on the IQ measure than the homeless group ($t(103) = -3.045, p = .003$), and tended to have achieved a higher level of education ($\chi^2(1) = 6.198, p = .013$). There were more young people whose first language was not English in the housed group, likely as a result of the diverse student populations within the education establishments we targeted for recruitment ($\chi^2(1) = 5.909, p = .015$). Yates' continuity correction was applied to all 2×2 chi-square analyses. Descriptive statistics for EF performance and IQ can be found in Table 2.

Comparison of executive function performance

An overall significant difference between the groups in EF performance was found using Pillai's Trace ($V = .241, F(7, 93) = 4.224, p < .001$), as summarized in Table 4. The housed group outperformed the homeless group on several EF tasks, including: shifting/flexibility, working memory, impulsivity/risky decision making, selective attention/inhibition, and planning. There were no differences between the groups on the verbal fluency tasks. With Bonferroni correction for the number of ANOVAs conducted, significant differences remained between the groups on working memory and impulsivity/risky decision making ($p < .007$).

Follow-up discriminant function analysis revealed one discriminant function that explained 100% of the variance, canonical $R^2 = .241$, and significantly differentiated the homeless and housed groups, $\Lambda = 0.759, \chi^2(7) = 26.363, p < .001$. The frequency distribution of discriminant scores is presented in Figure 3. Performance on the IGT ($r = .558$) and visuospatial working memory span ($r = .511$) were the highest loading variables on the discriminant function, accounting for 31% and 26% of the variance in the composite variable, respectively. An independent samples t -test on the centroid mean discriminant function scores confirmed that they were significantly different for the homeless and housed groups, $t(99) = -5.610, p < .001$. These results were consistent with those of the omnibus MANOVA.

Table 2. Descriptive statistics for EF performance and IQ by group.

EF measure	Group	
	Homeless <i>M (SD)</i>	Housed <i>M (SD)</i>
Perseverative Errors (BCST64)	8.0 (3.1) Range: 3.0 to 16.0	7.1 (4.0) Range: 1.0 to 19.0
Block Span (Corsi)	5.27 (1.35) Range: 1.00 to 8.00	6.14 (1.59) Range: 2.00 to 8.00
Deck Preference (IGT)	−0.064 (0.218) Range: −0.540 to 0.600	0.067 (0.196) Range: −0.340 to 0.560
Interference (ms, Stroop)	−90.8 (65.6) Range: −273.8 to 22.71	−60.2 (44.7) Range: −209.5 to 15.1
Planning Time (ToL)	0.044 (0.010) Range: 0.020 to 0.070	0.049 (0.014) Range: 0.020 to 0.090
Letter Fluency (F,A,S)	27.0 (10.8) Range: 8.0 to 53.0	29.7 (10.6) Range: 12.0 to 63.0
Category Fluency (Animal)	16.9 (4.6) Range: 9.0 to 28.0	16.9 (5.8) Range: 7.0 to 31.0
IQ		
Full Scale IQ (WASI, 2 subtest)	82.4 (13.2) Range: 55 to 115	91.6 (17.4) Range: 55 to 118

Homeless group performance was substantially worse than norms across most domains (see Fry, 2018). IQ performance was > 1SD below the mean.

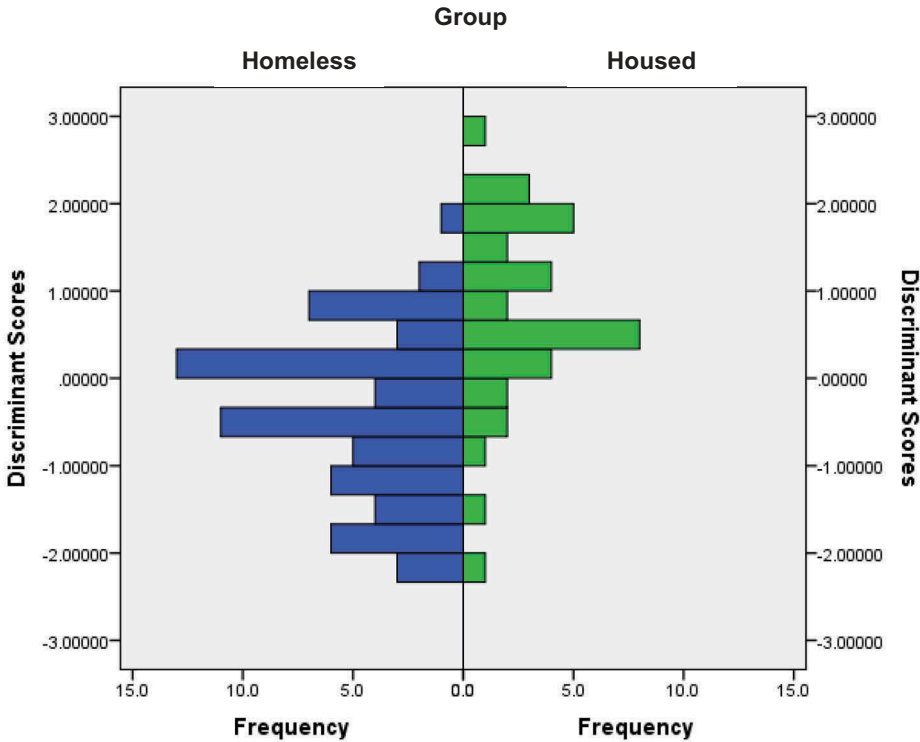


Figure 3. Frequency distribution of discriminant scores across the homeless and housed groups. This illustrates that for the homeless group the majority of discriminant scores are negative and for the housed group they are mostly positive, meaning the analysis was able to discriminate fairly well between the two participant groups based solely on their EF performance.

Sensitivity analysis

To explore how potential contributory factors may have affected the results, the analyses were re-run including these factors as covariates in separate MANCOVAs. IQ was the only significant covariate; SES and highest level of education so far were not significantly affecting the combined DV (EF performance). With IQ included in the analyses, there was still a significant difference between the groups on EF, though a moderate reduction in effect size, $V = .183$, $F(7, 92) = 2.947$, $p = .008$, as illustrated in Table 4. EF performance on each task adjusted for IQ is described in Table 3.

Executive functions and housing outcome

Working memory was positively associated with housing outcome in the homeless group, that is, those with larger working memory spans were more likely to have progressed ($r_{pb}(59) = .281$, $p = .028$). To test whether working memory predicted housing outcome, predictors were entered into logistic regression. The logistic regression model was significant ($\chi^2(1) = 8.59$, $p < .01$), explained 18.8% (Nagelkerke R^2) of the variance in housing outcome, and correctly classified 67.2% of cases. Working memory significantly predicted housing outcome, with those who had longer working memory spans twice as likely to have progressed rather than maintained (OR = 2.01, 95% CI [1.17, 3.45]). Performing a median split on the working memory variable divided working memory span between those with spans of five or less, and those

Table 3. Descriptive statistics (transformed) for EF performance by group with IQ as a covariate.

	Group	
	Homeless $N = 65$	Housed $N = 36$
EF measure	M_{adj} (SE)	M_{adj} (SE)
Perseverative Errors (BCST64, sqrt)	2.73 (0.07)	2.63 (0.09)
Block Span (Corsi)	5.39 (0.17)	5.94 (0.24)
Deck Preference (IGT)	-0.06 (0.03)	0.06 (0.04)
Interference (Stroop, reflect & sqrt)	10.24 (0.38)	8.81 (0.52)
Planning Time (ToL, sqrt)	0.21 (0.00)	0.22 (0.00)
Letter Fluency (F,A,S, sqrt)	5.23 (0.11)	5.17 (0.15)
Category Fluency (Animal)	17.51 (0.56)	16.10 (0.76)

Table 4. MANOVA, follow-up, and sensitivity analyses.

	Pillai's Trace	F	df (hypothesis, error)	p	Partial η^2
MANOVA					
Group	.241	4.224	7, 93	.000	.241
ANOVA					
Perseverative Errors		4.939	1, 99	.029	.048
Block Span		8.220	1, 99	.005	.077
Deck Preference		9.806	1, 99	.002	.090
Interference		5.379	1, 99	.022	.052
Planning Time		5.109	1, 99	.026	.049
MANCOVA					
Group (IQ covaried)	.183	2.947	7, 92	.008	.183
IQ	.462	11.276	7, 92	.000	.462

Letter Fluency and Category Fluency were not significantly different between groups in follow-up ANOVAs.

with spans greater than five. The Odds Ratio was then calculated with housing outcome. Those with working memory spans of greater than five (i.e., six or more) were 2.5 times more likely to have progressed than maintained.

The six participants who had negative housing outcomes showed a diverse profile which is shown in the supplementary table. Although there are some interesting patterns, the size of the subgroup was too small to meaningfully analyze.

Discussion

Homeless young people tended to demonstrate poorer performance on EF tasks than their housed peers, as hypothesized. Impulsivity/risky decision making and visuospatial working memory were two key areas of difficulty, but there was also evidence of problems with shifting/flexibility, selective attention/inhibition, and planning. Neither type of verbal fluency appeared to pose difficulties for the homeless group compared to housed peers.

Although the groups were similar in age and sex, there were differences in IQ, SES, and highest level of education. In terms of SES, the difference was minimal and, through choosing educational institutions that were also accessed by homeless young people, we attempted to minimize the discrepancy between groups as best we could. The changes to results were minimal when these variables were included as covariates, with IQ having the only real impact on effect size. This is difficult to interpret, however, as it is not known how EFs and IQ relate to each other and what exactly is being removed when IQ is entered as a covariate (Dennis et al., 2009). The impact of including IQ, SES, and highest level of education was smaller than expected, considering the difference between groups on these variables and their associations with EF development. Perhaps their influence was diminished by our attempt to match the comparison group as closely as was practicable to the homeless group. Alternatively, it could be that meaningful differences in EF performance exist over and above these demographic factors. Follow-up discriminant function analysis revealed that the EF variables could be combined to create a function that significantly differentiated the homeless and housed groups, suggesting the groups were distinguishable using EF performance. Impulsivity/risky decision making and visuospatial working memory were the variables most highly related to the discriminant function, which is consistent with the findings from the main analysis.

The findings of this study are consistent with the small number of other studies with homeless young people, in terms of poorer performance on working memory, selective attention, and planning (Borges-Murphy, Pontes, Stivanin, Picoli, & Schochat, 2012; Pluck, Banda-Cruz, Andrade-Guimaraes, & Trueba, 2017; Saperstein et al., 2014). The results also lend support to an overall difficulty in EF performance (Saperstein et al., 2014), but are inconsistent with studies that found no differences in shifting or IQ performance (Dahlman, Bäckström, Bohlin, & Frans, 2013; Rafferty, Shinn, & Weitzman, 2004; Rohde, Noell, & Ochs, 1999). The results link well with the unity and diversity theory of executive functions, insofar as overall EF performance tended to be poorer in homeless young people, but there were also differences in performance across EF domains and performance in certain EF domains was particularly important in discriminating between the two groups (Miyake & Friedman, 2012; Miyake et al., 2000). Although EFs were likely still developing in the homeless group, use of an age-matched comparison enabled us to assess

EF performance relative to young people who were also likely to be experiencing a critical stage of EF development (e.g., Selemón, 2013).

Working memory was found to be the only predictor of housing outcome, that is, whether homeless young people maintained the type of accommodation they were already in or whether they progressed onto accommodation with less support. When looking at those with above average working memory, these young people were 2.5 times more likely to have progressed rather than maintained compared to those of average or below working memory span.

It is perhaps surprising that working memory emerged as the only predictor of housing outcome, as planning and impulsivity/risky decision making would have been considered more likely candidates. Whilst it is difficult to draw conclusions, it begs the question of why working memory would impact housing outcome. To answer this, a detailed examination of what working memory is proposed to do, and what functions it performs, is required. An important concept to start with is that working memory has a limited capacity for storage, and processing can be affected when this capacity is exceeded (Baddeley & Hitch, 1974; Holmes, Gathercole, & Dunning, 2010). Aside from the more obvious functions that working memory performs, it has also been proposed to manipulate and monitor information, reconstruct/reconfigure/integrate information from different sources, sustain goal-relevant processing, control attention, be involved in construction of mental models, reduce interference, and coordinate resources (Baddeley, 1992; Baddeley & Hitch, 1974; Engle & Kane, 2004; Gathercole et al., 2008; Holmes et al., 2010; Oberauer, 2009; Schmeichel, Volokhov, & Demaree, 2008; St Clair-Thompson, 2011). It is also thought to contribute to the regulation of emotions (Schmeichel et al., 2008). In turn, working memory is considered to impact a myriad of other abilities, including: planning/organizing, attention, learning, problem solving, maths, reading/literacy, reasoning, comprehension (e.g., of long complex documents), cognitive load, speed of processing, monitoring, mind wandering, general school achievement, failure to self-correct, and ability to hold down employment (Alloway, Gathercole, Kirkwood, & Elliott, 2009; Baddeley & Hitch, 1974; Evans & Fuller-Rowell, 2013; Gathercole et al., 2008; Holmes et al., 2010; Medalia & Revheim, 2002; Saperstein et al., 2014; Schmeichel et al., 2008; St Clair-Thompson, 2011). Collectively, working memory has a plethora of functions and affects a diverse range of abilities that are likely important in many areas of life.

The second point to consider when exploring why working memory might predict housing outcome, are the factors that affect young people's ability to exit homelessness. Although substantial work has been done examining social and familial factors affecting young people's entry and exit from homelessness, far less research has been conducted specifically on psychological factors affecting exit from homelessness in young people. Factors that have been identified so far include: availability of affordable housing, access to services, relationships with family/family conflict, maternal social support, experience of abuse, school/education, helpful/unhelpful peers, more stability (less moving between services), and legal issues/involvement in criminal activity (Mayock, Corr, & O'Sullivan, 2011; Milburn et al., 2009; Molino, 2007). If we expand for a moment to look at some of the factors associated with exiting homelessness more generally, including cognitive impairment, mental health, processing speed, previous independent living, and work experience (e.g., Burra, Stergiopoulos, & Rourke, 2009; Cobb-Clark, Herault, Scutella, & Tseng, 2016; Dworsky & Piliavin, 2000; Gabrielian

et al., 2015; Johnson, Scutella, Tseng, & Wood, 2015; Piliavin, Entner-Wright, Mare, & Westerfelt, 1996; Zlotnick, Robertson, & Lahiff, 1999), it is easy to see areas of overlap between these and those specific to young people and working memory functions. However, this discussion is merely illustrative; further research is needed to determine the nature of the relationship between working memory and housing outcomes, before considering potential mechanisms.

Those with negative outcomes represented a minority of the homeless sample, but some characteristics are not dissimilar to those of a subgroup of homeless young people identified by Hodgson and colleagues (Hodgson, Shelton, & van den Bree, 2015). Descriptions of these young people can be found in the supplementary table, however, as the group is so small, interpretation is severely limited. More work is needed with those at greater risk of negative housing outcomes.

In the current study, it was difficult to profile those who were falling through the cracks of services, as our sample was ostensibly supported and were arguably less likely to have negative outcomes than homeless young people not in contact with services. To be able to assess the similarities and differences between homeless young people across the range of positive, neutral, and negative outcomes, we would have needed to recruit from the street or more transient hostels. However, for young people as a group in the UK, this represents a challenge. Many are considered in priority need upon presentation to the Local Authority, meaning (at least in theory) that there are relatively few homeless young people living on the streets for extended periods of time (Mackie, Thomas, & Hodgson, 2012; Quilgars, Johnsen, & Pleace, 2008). Future work could consider recruiting those who are “hidden homeless”, for example staying on friends’ sofas, to represent a group of homeless young people not picked up by services, though this brings challenges in terms of definition, identification, and recruitment.

Strengths and limitations

This study was able to access a relatively large number of homeless young people because of the support of staff and service users at a housing charity. Though this was a cross-sectional design, we were also able to access data held for monitoring and evaluation purposes (with participants’ consent), and this meant we could trace participants’ housing outcomes for at least six months after testing. This highlights the value of collaboration with organizations working with vulnerable young people who are traditionally difficult to follow-up, gives the outcomes component of the study a quasi-longitudinal angle, and may represent a useful way to attempt follow-up with homeless young people in the future. Another strength of the work reported here was the recruitment of an age-matched comparison group. Studies with homeless young people rarely include a comparison groups, making it difficult to draw conclusions about performance relative to same age peers (Fry et al., 2017). This is particularly important for EFs as it is likely they are still developing. We tried as far as possible to recruit the comparison group from educational institutions that homeless young people also accessed, to avoid a large difference in socioeconomic status, and the resulting difference in scores on the Family Affluence Scale was minimal between groups. What differentiates this study from the scant previous studies investigating executive functions in homeless youth was the use of a broad range of tasks tapping a diverse range of

EF domains and the investigation of relationships between EF domains and short-term housing outcomes.

There are some overarching limitations of the research that need to be noted. The sample size was not as large as had been hoped, due to difficulties with recruitment of the comparison group. A number of pupils taking part had English as a second language – 94% had English as their first language in the homeless group compared to 76% in the housed group – and this may have impacted the findings somewhat. However, running analyses without participants whose first language was not English did not substantially alter the results. The majority of our participants were in mainstream education and, though we asked about Special Educational Needs, many were unsure whether this applied to them.

Another limitation relates to the classification of housing outcomes. It was difficult in some cases to determine whether a reported housing outcome was positive, neutral, or negative. For example, while custody was an unambiguous negative outcome, moving in with friends and moving out of area were ambiguous. To try and get a more accurate picture, we considered housing outcome and accommodation variables together, and consulted with charity staff to discuss how they would view any ambiguous outcomes. Although there were some common characteristics, the EF profiles of these participants were diverse, potentially indicating that they are a heterogeneous group. To get a better idea of how EFs and mental health relate to negative housing outcomes we would have needed to recruit from more transient hostels or from the street, which was not possible in the current study.

In addition, the period of follow-up for short-term housing outcomes may seem arbitrary. Although all participants had at least six months between testing and follow-up, we did not look at how long homeless young people had been in supported accommodation prior to testing. However, the majority of our participants had experienced a period of vulnerability (as can be seen from their main accommodation in the past month in [Table 1](#)). To be accepted into supported accommodation, such as that provided by Llamau, young people would have to have presented as homeless or be leaving foster care/residential care, and some may have had a period of sofa surfing at family and/or friends' houses before presenting as homeless. As this is often a transient population, it is likely that delaying follow-up any longer than six months might have resulted in losing contact. The six-month period also aligns with service monitoring processes within the organization, which generated the data we used. However, we appreciate that future research may consider using more clinically meaningful variables such as total length of time homeless.

The homeless group, particularly, often reported regular cannabis use. It could have been the case that the difference between groups was not as stark as it seemed, as the homeless group felt able to be more honest than the housed group, who were tested in an educational setting and may have been fearful of the consequences of revealing substance use. There were a substantial number of participants in the homeless group who had reported using cannabis in the 24 hour period before testing in keeping with their usual use, which had potential implications for EF performance. Cannabis has been found to have differential acute, short, and long-term effects on some areas of EF (Broyd, van Hell, Beale, Yücel, & Solowij, 2016; Crean, Crane, & Mason, 2011; Fernández-Serrano, Pérez-García, & Verdejo-García, 2011). However, neither substance use during the 24 hours

prior to testing, nor regular substance use, were related to performance on any of the EF tasks in the homeless group.

There was considerable heterogeneity within our single sample of homeless young people, in terms of backgrounds and experiences that may account for the variability in EF performance within the group. In other words, it may be that instead of a single group of “homeless young people”, there were smaller subgroups with factors in common that demonstrated similar EF performance to each other, yet were distinct from other subgroups. Taking this into consideration, it may have been informative to perform a cluster analysis to identify potential subgroups and their characteristics based on EF performance, determining what characterizes those with few or no EF problems, those with some EF problems, and those with severe EF problems. This may be a useful analytic approach for future work on EF with homeless young people.

There is evidence of links between EF and psychopathology (see e.g., Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lönnqvist, 2008; Wagner, Müller, Helmreich, Huss, & Tadić, 2015), and high rates of psychiatric disorder have been identified in homeless young people (see e.g., Hodgson, Shelton, & van den Bree 2014; Hodgson, Shelton, van den Bree, & Los, 2013). It is therefore unfortunate that we were not able to obtain information pertaining to psychiatric diagnoses in our sample, as mental health difficulties may have contributed to the derived findings. The interplay between mental health problems and cognitive functioning is an important avenue for future research in the study of experiences of homelessness among young people.

Finally, it must be noted that owing to the gaps in knowledge in this area, most of the work reported in this paper was exploratory in nature. It has been noted throughout where findings would not have survived Bonferroni correction for multiple testing, however, Bonferroni can often be overly conservative and correct excessively (e.g., Field, 2009). The results from this study are intended to spur additional investigation.

Implications for practice

There remains a focus on mental health, substance use, physical health, and risky sexual behavior in homeless youth, which are an appropriate focus of intervention (along with immediate needs for shelter and safety; e.g., Fry et al., 2017; Solliday-McRoy et al., 2004). However, this study has demonstrated that both researchers and services should also give consideration to cognitive functioning, and EF in particular. As adolescence and emerging adulthood have been identified as sensitive periods in EF development, this represents an ideal opportunity for services to consider supporting homeless young people with EF skills. It is likely that housing outcome is just one area that is influenced by EF, and future work could explore its broader impact, not only in homeless young people, but also in young people from other adverse backgrounds, to assess if EF is related to adversity more generally.

Housing First approaches (Atherton & McNaughton Nicholls, 2008; Busch-Gertseema, Edgar, O’Sullivan, & Pleace, 2010; Tsemberis, Gulcur, & Nakae, 2004) are becoming increasingly popular as an approach to reducing homelessness. The idea behind the original Housing First model (Tsemberis et al., 2004) was that homeless people would be offered their own housing, no matter their needs, and tailored intensive support would

be put in place to increase the likelihood of them maintaining their own accommodation. Our findings suggest that the Housing First approach may benefit from consideration of strategies or techniques to enhance EF (e.g. Backer & Howard, 2007; Holmes et al., 2010; Medalia & Revheim, 2002). Some suggestions as to how this could be realized include adapting the surroundings (e.g., using memory aids around the house), encouraging use of strategies (e.g., using flow charts/diagrams or imagery), and direct training, such as that used as part of wider programs with homeless people (e.g., BrainWise; Welsh, Gorman Barry, Jacobs, & Beddes, 2018).

Future directions

The investigation of cognitive functioning more broadly is still in its infancy in vulnerable groups such as homeless young people (Fry et al., 2017). To our knowledge, this is the first study in the UK to examine cognitive functioning in homeless young people, and the first in the world to explore potential relationships between cognitive functioning and short-term housing outcomes. The focus on EF means that there is more work to be done to fully investigate the profile of cognitive functioning (e.g., attention, learning, memory) in this group of vulnerable young people. To strengthen the conclusions of this study, future research could focus on the link between EFs and housing outcome in homeless young people, designing a study that assessed EF domains while in hostel or supported accommodation and a follow-up EF assessment to compare to baseline after a set period of time, ideally a year or more. This would be challenging to accomplish, relying on keeping in contact with young people, but follow-up has been successful in the past with this group (Hodgson, Shelton, & van den Bree, 2014; Hodgson et al., 2015). There would have to be careful selection of tests and alternate forms of certain tests would need to be used to avoid practice effects. This would give some insight as to whether EFs improve with more independent living, which would presumably offer more opportunities to use and hone EF skills. Ultimately, if the results were replicated, given more promising findings recently in training EF (Holmes & Gathercole, 2014), the next step would be to investigate whether approaches that address EF challenges can be developed in homeless youth, and whether these could be used as a means to improve outcomes.

Given the prevalence of psychiatric diagnoses reported in homeless young people and the likely contribution to both overall functioning and moving towards stability (see e.g., Castro et al., 2014; Edidin, Ganim, Hunter, & Karnik, 2012; Hodgson et al., 2014, 2013), it is important for future research to consider psychological functioning alongside cognitive functioning, and EF in particular, to better understand their interaction. There are also potentially interesting interactions to explore with regards to education, IQ, and EF that were not possible in the current study.

Conclusions

This paper compared EF performance between homeless and housed young people, and explored whether EFs predict short-term housing outcomes in the homeless group. It is the first study in the UK to examine cognitive functioning in homeless young people, and one of the first in the world to explore the impact of EFs on housing-related outcomes for young people.

Homeless young people demonstrated worse EF performance than housed young people across a range of EF domains, with working memory and impulsivity/risky decision making representing areas of particular difficulty. However, good working memory predicted progression into more independent accommodation, such that those with longer working memory spans were twice as likely to have progressed rather than maintained. This suggests that working memory can be both an area of vulnerability and an asset for homeless young people. Recent evidence suggests that training working memory can result in improvements in other areas of functioning and can be particularly beneficial for disadvantaged youth. Although promising, it remains to be seen if these findings can be applied to homeless youth. As adolescence and emerging adulthood have been identified as sensitive periods in EF development, future work should focus on answering the question of whether we can develop approaches to improving EF in homeless young people, which positively impact their ability to increase their independence and ultimately move into their own accommodation.

Acknowledgments

The authors would like to acknowledge the funding provided by the Economic and Social Research Council (ESRC) and Llamau that made this work possible. We would also like to thank Dr. Lisa Evans, Dr. Nick Maguire, and Dr. Catherine Jones for their comments on earlier versions of this article. In addition, we would like to extend our gratitude to the placement students who assisted on the project: Rachel Brown, Joshua Smithers, Charlotte Deeley, Mariam Afifi, Chloe Sayer, Amy Smith, and Bethan Phillips. We really appreciate the support provided by Lisa Jones and Naomi Alderson in the recruitment of the housed group, and are indebted to Sam Austin, Deputy Chief Executive at Llamau, for her continued support. Finally, the biggest thanks of all go to the young people who kindly gave up their time to participate, without whom none of this would be possible.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This study formed part of Charlotte E. Fry's PhD studentship which was jointly funded by the Economic and Social Research Council (Grant number: ES/J500197/1) and Llamau, a charity supporting homeless young people across Wales; Economic and Social Research Council [ES/J500197/1]; Llamau [507790].

ORCID

Charlotte E. Fry  <http://orcid.org/0000-0002-1221-1281>

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage Publications Inc.
- Alloway, T. P., Gathercole, S. E., Kirkwood, H., & Elliott, J. (2009). The cognitive and behavioral characteristics of children with low working memory. *Child Development*, 80(2), 606–621.

- Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: A meta-analytic review. *Neuropsychology Review*, 16(1), 17–42.
- Atherton, I., & McNaughton Nicholls, C. (2008). 'Housing First' as a means of addressing multiple needs and homelessness. *European Journal of Homelessness*, 2, 289–303.
- Backer, T. E., & Howard, E. A. (2007). Cognitive impairments and the prevention of homelessness: Research and practice review. *The Journal of Primary Prevention*, 28(3–4), 375–388.
- Baddeley, A. (1992). Working memory. *Science*, 255, 556–559.
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *Psychology of learning and motivation* (pp. 47–89). New York, NY: Academic Press Inc.
- Barton, M., Yeatts, P. E., Henson, R. K., & Martin, S. B. (2016). Moving beyond univariate post-hoc testing in exercise science: A primer on descriptive discriminate analysis. *Research Quarterly for Exercise and Sport*, 87(4), 365–375.
- Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, 50, 7–15.
- Bender, K., Yang, J., Ferguson, K., & Thompson, S. (2015). Experiences and needs of homeless youth with a history of foster care. *Children and Youth Services Review*, 55, 222–231.
- Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development*, 81(6), 1641–1660.
- Borges-Murphy, C. F., Pontes, F., Stivanin, L., Picoli, E., & Schochat, E. (2012). Auditory processing in children and adolescents in situations of risk and vulnerability. *Sao Paulo Medical Journal*, 130(3), 151–158.
- Bousman, C. A., Blumberg, E. J., Shillington, A. M., Hovell, M. F., Ji, M., Lehman, S., & Clapp, J. (2005). Predictors of substance use among homeless youth in San Diego. *Addictive Behaviors*, 30(6), 1100–1110.
- Boyce, W., Torsheim, T., Currie, C., & Zambon, A. (2006). The family affluence scale as a measure of national wealth: Validation of an adolescent self-report measure. *Social Indicators Research*, 78(3), 473–487.
- Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, 53(1), 371–399.
- Bramley, G., & Fitzpatrick, S. (2017). Homelessness in the UK: Who is most at risk? *Housing Studies*, Published online ahead of print. doi: 10.1080/02673037.2017.1344957.
- Broyd, S. J., van Hell, H. H., Beale, C., Yücel, M., & Solowij, N. (2016). Acute and chronic effects of cannabinoids on human cognition: A systematic review. *Biological Psychiatry*, 79(7), 557–567.
- Burra, T. A., Stergiopoulos, V., & Rourke, S. B. (2009). A systematic review of cognitive deficits in homeless adults: Implications for service delivery. *The Canadian Journal of Psychiatry*, 54(2), 123–133.
- Busch-Gertseema, V., Edgar, W., O'Sullivan, E., & Pleace, N. (2010). *Homelessness and homeless policies in Europe: Lessons from research*. Brussels: European Commission.
- Canivez, G. L., Konold, T. R., Collins, J. M., & Wilson, G. (2009). Construct validity of the Wechsler abbreviated scale of intelligence and wide range intelligence test: Convergent and structural validity. *School Psychology Quarterly*, 24(4), 252–265.
- Casey, B. J., Tottenham, N., Liston, C., & Durston, S. (2005). Imaging the developing brain: What have we learned about cognitive development? *Trends in Cognitive Sciences*, 9(3), 104–110.
- Castaneda, A. E., Tuulio-Henriksson, A., Marttunen, M., Suvisaari, J., & Lönnqvist, J. (2008). A review on cognitive impairments in depressive and anxiety disorders with a focus on young adults. *Journal of Affective Disorders*, 106(1), 1–27.
- Castro, A. L., Gustafson, E. L., Ford, A. E., Edidin, J. P., Smith, D. L., Hunter, S. J., & Karnik, N. S. (2014). Psychiatric disorders, high-risk behaviors, and chronicity of episodes among predominantly African American homeless Chicago youth. *Journal of Health Care for the Poor and Underserved*, 25(3), 1201–1216.
- Centrepont (2015). Youth homelessness databank: Beyond statutory homelessness. Retrieved from <https://centrepont.org.uk/what-we-do/the-youth-homelessness-databank/>

- Chan, R. C., Shum, D., Toulopoulou, T., & Chen, E. Y. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology*, 23(2), 201–216.
- Claessen, M. H., Van Der Ham, I. J., & Van Zandvoort, M. J. (2015). Computerization of the standard Corsi block-tapping task affects its underlying cognitive concepts: A pilot study. *Applied Neuropsychology: Adult*, 22(3), 180–188.
- Cobb-Clark, D. A., Herault, N., Scutella, R., & Tseng, Y. P. (2016). A journey home: What drives how long people are homeless? *Journal of Urban Economics*, 91, 57–72.
- Corsi, P. M. (1972). Human memory and the medial temporal region of the brain. *Dissertation Abstracts International*, 34, 819B.
- Crean, R. D., Crane, N. A., & Mason, B. J. (2011). An evidence based review of acute and long-term effects of cannabis use on executive cognitive functions. *Journal of Addiction Medicine*, 5(1), 1–8.
- Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., & Richter, M. (2008). Researching health inequalities in adolescents: The development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Social Science & Medicine*, 66(6), 1429–1436.
- Dahlman, S., Bäckström, P., Bohlin, G., & Frans, Ö. (2013). Cognitive abilities of street children: Low-SES Bolivian boys with and without experience of living in the street. *Child Neuropsychology*, 19(5), 540–556.
- Dashora, P., Erdem, G., & Slesnick, N. (2011). Better to bend than to break: Coping strategies utilized by substance-abusing homeless youth. *Journal of Health Psychology*, 16(1), 158–168.
- Dennis, M., Francis, D. J., Cirino, P. T., Schachar, R., Barnes, M. A., & Fletcher, J. M. (2009). Why IQ is not a covariate in cognitive studies of neurodevelopmental disorders. *Journal of the International Neuropsychological Society*, 15(3), 331–343.
- DePrince, A. P., Weinzierl, K. M., & Combs, M. D. (2009). Executive function performance and trauma exposure in a community sample of children. *Child Abuse & Neglect*, 33(6), 353–361.
- Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, 64, 135–168.
- Dworsky, A. L., & Piliavin, I. (2000). Homeless spell exits and returns: Substantive and methodological elaborations on recent studies. *Social Service Review*, 74(2), 193–213.
- Edidin, J. P., Ganim, Z., Hunter, S. J., & Karnik, N. S. (2012). The mental and physical health of homeless youth: A literature review. *Child Psychiatry & Human Development*, 43(3), 354–375.
- Engle, R. W., & Kane, M. J. (2004). Executive attention, working memory capacity and two-factor theory of cognitive control. In B. Ross (Ed.), *The psychology of learning and motivation* (pp. 145–199). New York, NY: Elsevier.
- Evans, G. W., & Fuller-Rowell, T. E. (2013). Childhood poverty, chronic stress, and young adult working memory: The protective role of self-regulatory capacity. *Developmental Science*, 16(5), 688–696.
- Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Giannetta, J. M., Brodsky, N. L., ... Hurt, H. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research*, 1110(1), 166–174.
- Fernández-Serrano, M. J., Pérez-García, M., & Verdejo-García, A. (2011). What are the specific vs. generalized effects of drugs of abuse on neuropsychological performance? *Neuroscience & Biobehavioral Reviews*, 35(3), 377–406.
- Field, A. (2009). *Discovering statistics using SPSS* (3rd Ed. ed.). Thousand Oaks, CA: Sage Publications.
- Fox, C. J., Mueller, S. T., Gray, H. M., Raber, J., & Piper, B. J. (2013). Evaluation of a short-form of the Berg card sorting test. *PloS One*, 8(5), e63885.
- Fry, C. E. (2018). *Executive functions, creativity, and mental health in homeless young people: Implications for housing outcome (Doctoral thesis)*. Wales, UK: Cardiff University. Retrieved from <http://orca.cf.ac.uk/111664/>
- Fry, C. E., Langley, K., & Shelton, K. H. (2017). A systematic review of cognitive functioning among young people who have experienced homelessness, foster care, or poverty. *Child Neuropsychology*, 23(8), 907–934.

- Gabrielian, S., Bromley, E., Hellemann, G. S., Kern, R. S., Goldenson, N. I., Danley, M. E., & Young, A. S. (2015). Factors affecting exits from homelessness among persons with serious mental illness and substance use disorders. *The Journal of Clinical Psychiatry*, 76(4), e469–e476.
- Gathercole, S. E., Alloway, T. P., Kirkwood, H. J., Elliott, J. G., Holmes, J., & Hilton, K. A. (2008). Attentional and executive function behaviours in children with poor working memory. *Learning and Individual Differences*, 18(2), 214–223.
- Gilbert, S. J., & Burgess, P. W. (2008). Executive function. *Current Biology*, 18(3), R110–R114.
- Grant, D. A., & Berg, E. (1948). A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. *Journal of Experimental Psychology*, 38(4), 404–411.
- Greene, J. M., Ennett, S. T., & Ringwalt, C. L. (1999). Prevalence and correlates of survival sex among runaway and homeless youth. *American Journal of Public Health*, 89(9), 1406–1409.
- Hackman, D. A., & Farah, M. J. (2009). Socioeconomic status and the developing brain. *Trends in Cognitive Sciences*, 13(2), 65–73.
- Happaney, K., Zelazo, P. D., & Stuss, D. T. (2004). Development of orbitofrontal function: Current themes and future directions. *Brain and Cognition*, 55(1), 1–10.
- Hodgson, K. J. (2014). *The mental health of young people with experiences of homelessness* (Doctoral thesis). Wales, UK: Cardiff University. Retrieved from <http://orca.cf.ac.uk/59590/>.
- Hodgson, K. J., Shelton, K. H., & van Den Bree, M. B. (2014). Mental health problems in young people with experiences of homelessness and the relationship with health service use: A follow-up study. *Evidence-Based Mental Health*, 17(3), 76–80.
- Hodgson, K. J., Shelton, K. H., & van Den Bree, M. B. (2015). Psychopathology among young homeless people: Longitudinal mental health outcomes for different subgroups. *The British Journal of Clinical Psychology*, 54(3), 307–325.
- Hodgson, K. J., Shelton, K. H., van Den Bree, M. B., & Los, F. J. (2013). Psychopathology in young people experiencing homelessness: A systematic review. *American Journal of Public Health*, 103(6), e24–e37.
- Holmes, J., & Gathercole, S. E. (2014). Taking working memory training from the laboratory into schools. *Educational Psychology*, 34(4), 440–450.
- Holmes, J., Gathercole, S. E., & Dunning, D. L. (2010). Poor working memory: Impact and interventions. *Advances in Child Development and Behavior*, 39, 1–43.
- Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44(11), 2017–2036.
- Johnson, G., Scutella, R., Tseng, Y., & Wood, G. (2015). *Entries and exits from homelessness: A dynamic analysis of the relationship between structural conditions and individual characteristics*. Melbourne, Australia: Australian Housing and Urban Research Institute.
- Jolles, D. D., & Crone, E. A. (2012). Training the developing brain: A neurocognitive perspective. *Frontiers in Human Neuroscience*, 6, 76.
- Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review*, 17(3), 213–233.
- Kessels, R. P. C., van Den Berg, E., Ruis, C., & Brands, A. M. (2008). The backward span of the Corsi block-tapping task and its association with the WAIS-III digit span. *Assessment*, 15(4), 426–434.
- Kessels, R. P. C., Van Zandvoort, M. J., Postma, A., Kappelle, L. J., & De Haan, E. H. (2000). The Corsi block-tapping task: Standardization and normative data. *Applied Neuropsychology*, 7(4), 252–258.
- Kidd, S. A. (2003). Street youth: Coping and interventions. *Child and Adolescent Social Work Journal*, 20(4), 235–261.
- Knoll, L. J., Fuhrmann, D., Sakhardande, A. L., Stamp, F., Speekenbrink, M., & Blakemore, S. J. (2016). A window of opportunity for cognitive training in adolescence. *Psychological Science*, 27(12), 1620–1631.

- Lawson, G. M., & Farah, M. J. (2017). Executive function as a mediator between SES and academic achievement throughout childhood. *International Journal of Behavioral Development*, 41(1), 94–104.
- Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, 83(404), 1198–1202.
- Mackie, P., Thomas, I., & Hodgson, K. (2012). *Impact analysis of existing homelessness legislation in Wales: A report to inform the review of homelessness legislation in Wales*. Cardiff, UK: Welsh Government.
- MacLeod, C. M. (1991). Half a century of research on the stroop effect: An integrative review. *Psychological Bulletin*, 109(2), 163–203.
- Masson, M., Bussi eres, E. L., East-Richard, C., R-Mercier, A., & Cellard, C. (2015). Neuropsychological profile of children, adolescents and adults experiencing maltreatment: A meta-analysis. *The Clinical Neuropsychologist*, 29(5), 573–594.
- Masten, A. S. (2014). *Ordinary magic: Resilience in development*. New York, NY: The Guilford Press.
- Mayock, P., Corr, M. L., & O’Sullivan, E. (2011). Homeless young people, families and change: Family support as a facilitator to exiting homelessness. *Child & Family Social Work*, 16(4), 391–401.
- Medalia, A., & Revheim, N. (2002). *Dealing with cognitive dysfunction associated with psychiatric disabilities: A handbook for families and friends of individuals with psychiatric disorders*. Albany, NY: New York State Office of Mental Health.
- Medalia, A., Saperstein, A. M., Huang, Y., Lee, S., & Ronan, E. J. (2017). Cognitive skills training for homeless transition-age youth: Feasibility and pilot efficacy of a community based randomized controlled trial. *The Journal of Nervous and Mental Disease*, 205(11), 859–866.
- Milburn, N. G., Rice, E., Rotheram-Borus, M. J., Mallett, S., Rosenthal, D., Batterham, P., ... Duan, N. (2009). Adolescents exiting homelessness over two years: The risk amplification and abatement model. *Journal of Research on Adolescence*, 19(4), 762–785.
- Milburn, N. G., Stein, J. A., Lopez, S. A., Hilberg, A. M., Veprinsky, A., Arnold, E. M., ... Amani, B. (2017). Trauma, family factors and the mental health of homeless adolescents. *Journal of Child & Adolescent Trauma*, Published online ahead of print. doi: [10.1007/s40653-017-0157-9](https://doi.org/10.1007/s40653-017-0157-9).
- Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science*, 21(1), 8–14.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100.
- Molino, A. C. (2007, March 1–2). *Characteristics of help-seeking street youth and non-street youth*. Paper presented at the 2007 National Symposium on Homelessness Research, Washington, DC.
- Morton, M. H., Dworsky, A., & Samuels, G. M. (2017). *Missed opportunities: Youth homelessness in America. National estimates*. Chicago, IL: Chapin Hall at the University of Chicago.
- Mueller, S. T., & Piper, B. J. (2014). The psychology experiment building language (PEBL) and PEBL test battery. *Journal of Neuroscience Methods*, 222, 250–259.
- Nikulina, V., & Widom, C. S. (2013). Child maltreatment and executive functioning in middle adulthood: A prospective examination. *Neuropsychology*, 27(4), 417–427.
- Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental Science*, 10(4), 464–480.
- Nyamathi, A., Hudson, A., Greengold, B., Slagle, A., Marfisee, M., Khalilifard, F., & Leake, B. (2010). Correlates of substance use severity among homeless youth. *Journal of Child and Adolescent Psychiatric Nursing*, 23(4), 214–222.
- Oberauer, K. (2009). Design for a working memory. *Psychology of Learning and Motivation*, 51, 45–100.

- Parks, R. W., Stevens, R. J., & Spence, S. A. (2007). A systematic review of cognition in homeless children and adolescents. *Journal of the Royal Society of Medicine*, 100, 46–50.
- Pechtel, P., & Pizzagalli, D. A. (2011). Effects of early life stress on cognitive and affective function: An integrated review of human literature. *Psychopharmacology*, 214(1), 55–70.
- Pharo, H., Sim, C., Graham, M., Gross, J., & Hayne, H. (2011). Risky business: Executive function, personality, and reckless behavior during adolescence and emerging adulthood. *Behavioral Neuroscience*, 125(6), 970–978.
- Phillips, L. H., Wynn, V., Gilhooly, K. J., Della Sala, S., & Logie, R. H. (1999). The role of memory in the tower of London task. *Memory*, 7(2), 209–231.
- Piliavin, I., Entner-Wright, B., Mare, R., & Westerfelt, A. (1996). Exits from and returns to homelessness. *Social Service Review*, 70, 33–57.
- Pluck, G., Banda-Cruz, D. R., Andrade-Guimaraes, M. V., & Trueba, A. F. (2017). Socioeconomic deprivation and the development of neuropsychological functions: A study with “street children” in Ecuador. *Child Neuropsychology*, Advance online publication. doi: [10.1080/09297049.2017.1294150](https://doi.org/10.1080/09297049.2017.1294150).
- Psychological Corporation. (1999). *Wechsler Abbreviated Scale of Intelligence (WASI) manual*. San Antonio, TX: Harcourt Assessment.
- Quilgars, D., Johnsen, S., & Pleace, N. (2008). *Youth homelessness in the UK: A decade of progress?* York, UK: Joseph Rowntree Foundation.
- Rafferty, Y., Shinn, M., & Weitzman, B. C. (2004). Academic achievement among formerly homeless adolescents and their continuously housed peers. *Journal of School Psychology*, 42(3), 179–199.
- Rice, E., Barman-Adhikari, A., Rhoades, H., Winetrobe, H., Fulginiti, A., Astor, R., ... Kordic, T. (2013). Homelessness experiences, sexual orientation, and sexual risk taking among high school students in Los Angeles. *Journal of Adolescent Health*, 52(6), 773–778.
- Rohde, P., Noell, J., & Ochs, L. (1999). IQ scores among homeless older adolescents: Characteristics of intellectual performance and associations with psychosocial functioning. *Journal of Adolescence*, 22(3), 319–328.
- Saperstein, A. M., Lee, S., Ronan, E. J., Seeman, R. S., & Medalia, A. (2014). Cognitive deficit and mental health in homeless transition-age youth. *Pediatrics*, 134(1), e138–e145.
- Schmeichel, B. J., Volokhov, R. N., & Demaree, H. A. (2008). Working memory capacity and the self-regulation of emotional expression and experience. *Journal of Personality and Social Psychology*, 95(6), 1526–1540.
- Selemon, L. D. (2013). A role for synaptic plasticity in the adolescent development of executive function. *Translational Psychiatry*, 3(3), e238.
- Shipstead, Z., Redick, T. S., & Engle, R. W. (2012). Is working memory training effective? *Psychological Bulletin*, 138(4), 628–654.
- Solliday-McRoy, C., Campbell, T. C., Melchert, T. P., Young, T. J., & Cisler, R. A. (2004). Neuropsychological functioning of homeless men. *Journal of Nervous and Mental Disease*, 192(7), 471–478.
- St Clair-Thompson, H. L. (2011). Executive functions and working memory behaviours in children with a poor working memory. *Learning and Individual Differences*, 21(4), 409–414.
- Strauss, E., Sherman, E. M., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms, and commentary* (3rd ed.). New York, NY: Oxford University Press.
- Tabachnick, B. G., & Fidell, L. S. (2014). *Using multivariate statistics* (6th ed.). Harlow, UK: Pearson Education Ltd.
- Thomas de Benitez, S. (2007). State of the world’s street children: Violence. Retrieved from <http://www.streetchildrenresources.org/resources/state-of-the-worlds-street-children-violence/>
- Tombaugh, T. N., Kozak, J., & Rees, L. (1999). Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Archives of Clinical Neuropsychology*, 14(2), 167–177.

- Toro, P. A., Dworsky, A., & Fowler, P. J. (2007, March 1–2). *Homeless youth in the United States: Recent research findings and intervention approaches*. Paper presented at the 2007 National Symposium on Homelessness Research, Washington, DC.
- Tsemberis, S., Gulcur, L., & Nakae, M. (2004). Housing first, consumer choice, and harm reduction for homeless individuals with a dual diagnosis. *American Journal of Public Health*, 94(4), 651–656.
- United Nations (1948). The Universal declaration of human rights. Retrieved from <http://www.un.org/en/universal-declaration-human-rights/>
- United Nations Children's Fund. (2007). *Child poverty in perspective: An overview of child well-being in rich countries, Innocenti report card 7*. Florence, Italy: UNICEF Innocenti Research Centre.
- Wagner, S., Müller, C., Helmreich, I., Huss, M., & Tadić, A. (2015). A meta-analysis of cognitive functions in children and adolescents with major depressive disorder. *European Child & Adolescent Psychiatry*, 24(1), 5–19.
- Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence*. San Antonio, TX: Psychological Corporation.
- Welsh, M., Gorman Barry, P., Jacobs, A. A., & Beddes, L. A. (2018). Homeless men living in transitional housing: The brainwise program and improvements in executive functions and coping self-efficacy. *SAGE Open*, 8(2), 1–13.
- Wenzel, A. J., & Gunnar, M. R. (2013). Protective role of executive function skills in high-risk environments. In R. E. Tremblay, M. Boivin, R. Peters (Eds.), *Encyclopedia on Early Childhood Development*. Retrieved from <http://www.child-encyclopedia.com/resilience/according-experts/protective-role-executive-function-skills-high-risk-environments>.
- Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*, 6(4), 354–360.
- Zlotnick, C., Robertson, M. J., & Lahiff, M. (1999). Getting off the streets: Economic resources and residential exits from homelessness. *Journal of Community Psychology*, 27(2), 209–224.