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Eating performance in relation to intake of solid and liquid food in nursing home residents with dementia: A secondary behavioral analysis of mealtime videos

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ABSTRACT

Background: Persons with dementia commonly experience low food intake leading to negative nutritional and functional outcomes. While multilevel personal and environmental factors that influence intake are implicated, evidence is lacking on the role of characteristics of dynamic eating performance cycles. An eating performance cycle is defined as the process of getting food from the plate or container, transporting it into the mouth, and chewing and swallowing it.
Objective: This study aimed to examine the association between intake and characteristics of eating performance cycles among nursing home residents with dementia.
Methods: A secondary analysis of 111 mealtime video clips from a nursing home communication training study was conducted. The 111 videos involved 25 residents and 29 staff (N = 42 unique staff-resident dyads) in 9 nursing homes. The Cue Utilization and Engagement in Dementia Mealtime video-coding scheme was used to code the characteristics of eating performance cycles, including eating technique (resident-completed, staff-facilitated), type of food (solid, liquid), duration of each eating performance cycle, and intake outcome (intake, no intake). The Generalized Linear Mixed Model was used to examine the interaction effects of eating technique by type of food, eating technique by duration, and type of food by duration on intake outcome.
Results: Totally 1122 eating performance cycles were coded from 111 video clips. The majority of the cycles (85.7%) resulted in intake. There were significant interactions for eating technique by duration, and type of food by duration. As the duration of the eating performance cycle increased, staff-facilitated cycles resulted in greater odds of intake than resident-completed cycles (OR = 17.80 vs. 2.73); and cycles involving liquid food resulted in greater odds of intake than cycles involving solid food (OR = 15.42 vs. 3.15). Though the interaction between eating technique and type of food was not significant, the odds of intake were greater for resident-completed cycles than for staff-facilitated cycles regardless of the type of food being involved in the cycle (OR = 3.60 for liquid food, OR = 10.69 for solid food).
Conclusions: The findings pointed out the importance of supporting resident independence in eating performance, providing liquid food when residents struggle with solid food, and provision of longer and continuous facilitation at mealtimes to improve intake. The findings inform the development and implementation of innovative mealtime assistance and staff training to promote eating performance and intake.

What is already known about the topic?

- Persons with dementia commonly experience low food and liquid intake, leading to negative nutritional and functional outcomes.
- While multilevel personal and environmental factors may influence intake, current research primarily focus on the amount of intake per meal, with little attention given to the impact of the complex, interactive, and dynamic eating process that consists of one or more eating performance cycles.
- An eating performance cycle is defined as the process of getting solid or liquid food from the plate or container, transporting it into the mouth, and swallowing it, and can be characterized by eating technique (resident-completed, staff-facilitated), type of

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food (solid, liquid), duration of each cycle, and intake outcome (intake, no intake).

What this paper adds

- As the duration of the eating performance cycle increased, staff-facilitated cycles resulted in greater odds of intake than resident-completed cycles (OR = 17.80 vs. 2.73).
- As the duration of the eating performance cycle increased, cycles involving liquid food resulted in greater odds of intake than cycles involving solid food (OR = 15.42 vs. 3.15).
- The odds of intake were greater for resident-completed cycles than for staff-facilitated cycles regardless of the type of food being involved in the cycle (OR = 3.60 for liquid food, OR = 10.69 for solid food).

1. Introduction

1.1. Food intake in residents with dementia

The number of people living with dementia worldwide was estimated at 50 million in 2017, and continues to increase every year, with an estimate of 82 million in 2030 and 152 million in 2050 (World Health Organization, 2017). In residential care settings, around 70% of residents have dementia and experience high risk of low food intake (Thies and Bleiler, 2013; Zimmerman et al., 2014). Low solid food intake is defined as the consumption of 75% or less of a meal, and low liquid food intake as less than 8 ounces of liquid per meal (Reed et al., 2005). Around 31–62% of residents with dementia have low solid food intake and 46–63% have low liquid food intake (Reed et al., 2005; Lin et al., 2010). Inadequate food intake leads to increased malnutrition, dehydration, infection, weight loss, lower quality of life, and increased morbidity and mortality among residents with dementia (Hanson et al., 2013; Chang and Roberts, 2011).

1.2. Factors that influence food intake

Multifaceted factors may influence food intake among residents with dementia (Namasivayam-MacDonald et al., 2018; Keller et al., 2017). The Social Ecological Model (Bronfenbrenner, 1992) presents a framework for understanding the role of the multi-level factors that influence food intake through resident, staff, environmental, and institutional levels.

1.2.1. Resident factors

Residents experience progressive changes in their cognitive and functional ability, behaviors, biological and motor function, taste and smell, oral health, and the ability to tolerate the texture of regular food (Droogsma et al., 2015). Compounded with multiple medications and comorbidities, these changes further lead to changes in dietary habits and appetite, mealtime difficulties (e.g., forgetting to eat, refusal to eat, resistiveness to assistance) (Liu et al., 2014a), fatigue, lack of alertness, impaired ability to plan and perform complex eating activities, and decline in oral related functions (e.g., poor chewing ability, swallowing difficulty, toothless, denture problems, dry mouth, and dental pain) (Poisson et al., 2016; Liu et al., 2018a), which subsequently result in inadequate food intake (Droogsma et al., 2015). Specifically, decline in eating performance (i.e., the functional act of getting food from the plate or container, transporting it into the mouth, and chewing and swallowing it) (Liu et al., 2016; Cipriani et al., 2016; Chang et al., 2017) and pace of intake (i.e., the average length of time it takes to complete an intake attempts) (Liu et al., 2016; Cipriani et al., 2016; Chang et al., 2017) are common among individuals with dementia. These eating performance limitations, coupled with limited mealtime periods in residential care settings, contribute to insufficient food intake (Namasivayam-MacDonald et al., 2018; Keller et al., 2017).

1.2.2. Staff factors

Resident food intake is associated with the adequacy of time staff spend providing mealtime assistance (Namasivayam-MacDonald et al., 2018; Keller et al., 2017; Abbott et al., 2013), the quality of assistance provided, and staff-resident (dyadic) interactions (Abdelhamid et al., 2016; Liu et al., 2014b; Anderson et al., 2016; Paquet et al., 2008). Staff usually provide 90% of direct care to residents with dementia, and have most of the opportunities to engage and motivate residents in eating. High quality care and interactions with residents, including appropriate verbal, visual, and physical prompts and social engagement (Beattie et al., 2004; Ullrich and McCutcheon, 2008), are fundamental to maintain functional independence and increase intake among residents with dementia (Anderson et al., 2016; Liu et al., 2017). However, staff tend to take over residents' eating attempts and provide full assistance to residents regardless of residents' ability and motivation to eat (Morris et al., 1999; Slaughter et al., 2011). Due to inadequate staffing, high time pressure, demanding workloads, and/or awareness of regulations penalizing nursing homes for unintentional weight loss, staff frequently miss opportunities to positively interact with residents and support their independent eating (Slaughter et al., 2011; Liu et al., 2018b). Such care practice may be based on the assumption that more adequate or balanced intake of nutrients can be ensured by providing full assistance instead of allowing residents to eat by themselves. However, there is lack of research evidence to support the benefits of providing full assistance versus encouraging eating independence on improving intake.

1.2.3. Environmental and institutional factors

The quality of the dining environment and other institutional features is also associated with intake, but evidence is inconsistent (Reed et al., 2005; Buckinx et al., 2017). Varied environmental modifications to manipulate meal appearance and quality, physical environment elements, and dining routines fail to demonstrate adequate evidence in improving intake due to low study quality and less rigorous designs (Abbott et al., 2013; Liu et al., 2014b; Bunn et al., 2016; Poscia et al., 2017). While the role of environmental factors on intake warrants further examination, there is emerging evidence to suggest highly specific environmental stimulation, directly tailored and individually delivered to residents based on their needs and preferences, improves resident eating performance (Liu et al., 2017). While food is probably the strongest and most straightforward environmental stimulation for residents at mealtimes, how residents respond to different types of food and how their responses influence the subsequent intake outcome warrant further exploration.

1.3. Importance of characteristics of eating performance cycles on intake

Prior research on factors that influence food intake primarily focuses on the amount of intake from a static perspective, with little attention given to the impact of the complex, interactive, and dynamic eating process that consists of one or more eating performance cycles. An eating performance cycle is defined as the process of getting the solid or liquid food from the plate or container, transporting it into the mouth, and chewing and swallowing it. Characteristics of eating performance cycles include the person who initiated the cycle (resident or staff), the type of

food being involved in the cycle (solid or liquid food), how long the cycle lasts, as well as the intake outcome of the cycle (intake or no intake). Examining how these modifiable personal and environmental factors influence eating performance and are related to subsequent intake outcomes will provide important insights to inform targeted strategies to improve food intake.

To comprehensively examine the role of characteristics of the eating performance cycles on intake, a feasible and reliable tool to identify important elements of the complex eating process is crucial. Existing tools developed from prior research included the Feeding Traceline Technique (FTLT) (Phillips and Van Ort, 1993), the Feeding Cycle Recording (FCR) (Edahiro et al., 2012), and Self-Feeding assessment tool for people with Dementia (SFD) (Edahiro et al., 2012) that conceptualized the complex interactive meal process either as simplified static segments (i.e., acceptance of food, preparation of next bite, and a relaxation period) based on only the caregiver's behavior, or as a composition of multiple feeding cycles only categorized by who initiated each cycle (i.e., self-feeding or staff-feeding). These tools failed to capture complex interpersonal dyadic interactions or any intake outcome, and lacked feasibility (e.g., the ratio of video length to coding time is 1:20 using FTLT) and/or inter-rater reliability.

Video data are ideal for capturing characteristics of the interactive eating process, as they allow for more precise measurement and deeper and repeated observation and analysis of a variety of factors that are not achievable with direct on-site observations. New computer-assisted methods for coding these characteristics using mealtime videos are emerging (Gilmore-Bykovskyi, 2015; Liu et al., 2019). Specifically, the Cue Utilization and Engagement in Dementia (CUED) Mealtime video-coding scheme was developed based on the FCR and SFD tools (Edahiro et al., 2012; Liu et al., 2019) to assess characteristics of the interactive eating performance process, as well as verbal and non-verbal mealtime interaction among residents with dementia and nursing home staff, and demonstrated good feasibility and inter-rater reliability using mealtime videos obtained from a case study (Liu et al., 2019). The application of this innovative, feasible and reliable tool to capture the characteristics of eating performance cycles using video-recorded observations of staff-resident mealtime interactions will provide preliminary information to create innovative interventions to support optimal food intake and mealtime experiences.

1.4. Objectives

This study aims to examine the association between intake and the characteristics of eating performance cycles, including eating technique (resident-completed, staff-facilitated), type of food (solid, liquid), and duration of each cycle, among nursing home (NH) residents with dementia. It was hypothesized that intake would be significantly associated with these characteristics of eating performance cycles.

2. Methods

2.1. Design

This study was a secondary analysis of a subset of archived mealtime video recordings that were collected under usual care conditions from a randomized controlled trial of a staff communication intervention between 2011 and 2014 (Williams et al., 2016). The purpose of the parent study was to evaluate the efficacy of a training program to improve nursing staff communication and decrease resistiveness to care among NH residents with dementia. The parent study and this secondary analysis study were approved by the University Institutional Review Boards where the studies were conducted.

2.2. Sample and setting

The parent study enrolled a convenience sample of 127 staff and 83 residents from 13 NHs in Kansas that met specific inclusion criteria. Nursing homes were eligible if they were licensed skilled nursing facilities providing care for residents with dementia and provided an administrative letter of support for participation in the study. Residents were eligible if they had a medical record diagnosis of dementia and long stay status, if they were at times resistive to personal care based on staff report, if they had no known uncorrected hearing loss, and if they had a surrogate decision maker to provide informed consent. Nursing staff were eligible if they were 18 years old or above, English speaking, a permanent employee, and provided direct care for a resident participant at least twice a week over the previous month. In the parent study, observations of morning routine care including bathing, eating, dressing, oral care, transferring, toileting, and other activities of daily living (ADLs) were video recorded to evaluate communication between NH residents and staff (Williams et al., 2016).

In the current study, secondary analysis of recorded observations of eating was performed. Videos were selected if they 1) captured residents' eating and drinking activities, 2) lasted 1 min or longer, and 3) captured one-on-one interactions. Videos were excluded if the resident was 1) being transferred to or from the dining location, 2) present in the dining location but not eating (e.g., waiting for the meal to be served, 3) sitting at the dining table with food being served but not eating or drinking), or 4) only being administered medication. Inclusion of videos lasting at least 1 min ensured adequate time to demonstrate details for coding at least one eating performance cycle while maximizing the sample size for the secondary analysis. A total of 1125 videos from the parent study were screened following the exclusion and inclusion criteria, and 111 videos were eligible for the analysis (Supplementary Data 1). The 111 videos involved 25 residents and 29 staff (42 unique staff-resident dyads) in 9 NHs. The duration of the 111 videos varied from 1 min to 23.8 min (mean = 4.5, SD = 4.0), depending on the length of the dyadic interaction.

2.3. Data collection/coding

2.3.1. Participant characteristics

Staff and resident characteristics were obtained from the parent study. Staff characteristics included age, gender, race, ethnicity, education, job title, number of years worked as a nursing caregiver, and number of years worked in the study site. Resident characteristics included age, gender, race, ethnicity, functional status, comorbidities and dementia stage. Functional status (ADL self-performance and support provided) was extracted from the Minimum Data Set 3.0 (MDS) Section G (functional status). The total score of functional status ranges from 0 to 16s0, with higher score indicating more dependence in self-performance and more support needed. Resident physical comorbidities were evaluated by reviewing the MDS 3.0 and clinical records using the Modified Cumulative Illness Rating Scale (Knoefel and Patrick, 2003). Dementia stage was determined by extracting data on Functional Assessment Staging in Alzheimer's Disease (FAST) from the MDS 3.0 (Sclan and Reisberg, 1992). The FAST score ranges from 1 (normal cognition and functioning) to 7 (severe dementia).

2.3.2. Characteristics of eating performance cycles

The CUED coding scheme was developed to capture the intake process and complex staff-resident mealtime interaction, with codes addressing characteristics of eating performance cycles (Part I, focus of this study), as well as the verbal (Part II) and non-verbal (Part III) interactions among staff and residents (Liu et al., 2019). In

this study, Part I of the CUED coding scheme was used to code characteristics of eating performance cycles by two trained research assistants using Noldus Observer® XT10.5 software (Noldus Information Technology Inc., Leesburg, VA, USA). The coding scheme for characteristics of eating performance cycles along with the operational definitions of these characteristics is shown in Table 1. Events that were coded with starting and ending time points for each video recording included one mealtime and one or more eating performance cycles. Each cycle was characterized to identify the person that completed the cycle (i.e., resident-completed, staff-facilitated), type of food (i.e., solid, liquid), duration of each cycle, and intake outcome (i.e., intake, no intake). An example of the coded data for a video clip in Noldus Observer® is shown in Supplementary Data 2. In this study, the CUED coding scheme demonstrated feasibility (the ratio of video length to coding time is 1: 2.64), indicating that an average of 2.64 h were used to code a one-hour video clip. The tool had good inter-rater reliability across two trained research assistants based on percent agreement (McHugh, 2012) (range = 95.93%–99.17%, all $p < .001$, ± 1 s tolerance) and Cohen's Kappa (McHugh, 2012) (range = .95–.99, all $p < .001$, 95% CI = .91–.99; ± 1 s tolerance).

2.4. Data analysis

SAS 9.4 (Anon, 2017) was used for statistical analyses. Descriptive statistics were calculated for participant characteristics and characteristics of eating performance cycles. Distributions of continuous variables were examined for normality and homogeneity of variance. The generalized linear mixed model approach (GLMM) was used to examine the association between intake and characteristics of eating performance cycles. Maximum Likelihood Estimation based on Laplace approximation was utilized. Missing data were not imputed in the model. A GLMM model was fit to intake as the dependent variable with characteristics of eating performance cycles as independent variables (i.e., food type, eating technique, cycle duration, and their two-way interaction effects). This approach was chosen because it accounts for clustering effects of eating performance cycles within each mealtime and dyad. Staff gender and years worked as a caregiver, and resident age, gender, and functional status were controlled for in the GLMM model in consideration that 1) these variables are associated with intake based on either prior work (Droogsma et al., 2015), and 2) the use of bivariate statistics that identified correlations between intake and each of these variables using the study sample.

3. Results

3.1. Participant characteristics

Characteristics for resident and staff participants are shown in Table 2. Residents were on average 84.6 years old (ranging from 64 to 96), and were in the severe stage of dementia (FAST scores ranging from 6.6 to 7.4). Residents had moderate levels of comorbidities (scores ranging from 19 to 36) and functional decline (ADL scores ranging from 12 to 39). The majority of residents were female (60%) and non-Hispanic (92%). All residents were white. Staff were on average 34.9 years old (ranging from 19 to 79). Staff worked as a caregiver for 9 years on average (ranging from less than 1 year to 30 years) and at the current study site for 4 years (ranging from less than 1 year to 13 years). The majority of staff were female (83%), non-Hispanic (79%), White (72%), and had college education (72%). The majority of staff were Certified Nursing Assistants (CNAs, 86%) with or without other roles (e.g., activity assistant, medication or rehabilitation aide).

3.2. Characteristics of eating performance cycles

The mealtime duration of the 111 video clips ranged from 0.03 to 23.21 min (mean = 3.68, SD = 3.78). Among the 25 residents involved in the 111 videos, 16 residents (64.0%) both attempted to eat by themselves and were fed by staff. Specifically, 19 residents (76.0%) were fed by staff at least twice, and 22 residents (88.0%) had at least one intake attempt by themselves, indicating that the majority of residents had the potential functional ability to eat by themselves, but were being fed by staff.

A total of 1122 eating performance cycles were coded from the 111 videos. The eating performance cycles lasted on average 4.54 s (SD = 3.33). The majority of the 1122 cycles resulted in intake of liquid or solid food (n = 962, 85.7%), with the rest resulting in no intake (n = 160, 14.3%). The majority of the cycles involved eating solid food (n = 682, 60.8%) and the rest involved drinking liquid (n = 440, 39.2%). Residents were fed by staff in more than half of all the cycles (n = 602, 53.7%), of which 188 cycles (31.2%) involved

Table 1
The CUED Coding Scheme Part I for Characteristics of Eating Performance cycles.

Codes	Description
1. Structure of Mealtime *Mutually exclusive/continuous codes*	Default code at start of coding session is "no mealtime" for both resident and staff.
1.1 Mealtime	Code when the first eating performance cycle begins.
1.2 No mealtime	Code when the last eating performance cycle ends.
1.3 Mealtime duration	From the beginning of the first eating performance cycle to the end of the last eating performance cycle.
2. Structure of eating performance cycles *Mutually exclusive/continuous codes*	Each time the solid/liquid food is moved from the plate/ tray/cup to the mouth is one eating performance cycle. Default code at start of coding session is "no eating" and "no drinking" for both resident and staff. Code when staff or resident uses hands or utensil and begins to lift food from plate/tray to mouth. Return to the default code (no eating, or no drinking) when the food enters the mouth (for a cycle with intake) or when food does not enter the mouth and the attempt ends (for a cycle with no intake).
2.1 Duration of an cycle	From the starting time point when the staff or resident moves food from tray to mouth, to the ending time point when utensils or hands are taken away from the mouth and food enters the mouth (for cycles with intake), or food does not enter the mouth or when intake attempt ends (for cycles with no intake).
2.2 Technique	
2.2.1 Resident-completed	Resident independently moves food from tray to mouth.
2.2.2 Staff-facilitated	Staff assists moving food from tray to mouth using direct hand eating technique.
2.3 Type of food	
2.3.1 Solid food	Movement of solid food from the plate to the mouth.
2.3.2 Liquid	Movement of liquid food from the plate to the mouth.
2.4 Intake outcome	
2.4.1 Intake	Food makes it into the mouth and is consumed.
2.4.2 No intake	Food doesn't make it into the mouth, or is not consumed.

Table 2
Participant Characteristics.

Continuous variables	N	Mean	SD	Range
Staff characteristics				
Age (year)	29	34.86	12.33	19 - 79
Years worked as a caregiver	29	8.95	7.80	0.25 -30
Years worked in current facility	29	3.71	3.68	0.1 - 13
Resident characteristics				
Age (year)	24	84.58	8.00	64 - 96
Dementia Stage (FAST, 1-8)	18	6.84	0.24	6.6 - 7.4
Comorbidities (0-70)	22	26.91	5.47	19 - 36
Functional status (MDS-ADL, 0-60)	23	24.17	5.84	12 - 39
Categorical variables	**N**	**%**		
Staff characteristics				
Gender				
Male	5	17.2		
Female	24	82.8		
Race				
White	21	72.4		
African American	8	27.6		
Ethnicity				
Non-Hispanic	23	79.3		
Hispanic	6	20.7		
Education				
High School	8	27.6		
College	21	72.4		
Job title				
Certified Nursing Assistants	25	86.2		
Registered Nurse	2	6.9		
Licensed Practical Nurse	2	6.9		
Resident characteristics				
Gender				
Male	10	40.0		
Female	15	60.0		
Race				
White	25	100.0		
Ethnicity				
Non-Hispanic	23	92.0		
Hispanic	2	8.0		

Note. The 111 videos involved 42 dyads including 25 residents and 29 staff in 9 nursing homes.

liquid food and 414 cycles (68.8%) involved solid food. Residents fed themselves in less than half of all the cycles (n = 520, 46.3%), of which 252 cycles (48.5%) involved liquid and 268 cycles (51.5%) involved solid food.

3.3. Associations between intake and characteristics of eating performance cycles

The model for intake of liquid or solid food is shown in Table 3. Among the 1122 cycles, there were 76 cycles with missing data such as resident age (5 video clips involving one resident) and 135 cycles with missing data for functional status (12 video clips involving two residents). Ninety nine video clips were used in this analysis, involving 987 cycles (intake n = 840, no intake n = 147) among 27 staff and 23 residents (39 unique dyads). These 99 video clips had complete data for characteristics of eating performance cycles, as well as selected staff and resident characteristics to control for. Durations for each cycle were transformed with the natural log function to create normality distribution.

The model included two significant interactions (duration with technique, and duration with type). The interactions are illustrated by Fig. 1, showing that, while the probability of intake increased with increased cycle duration, the pattern of increase depended on whether the cycle was resident-completed or staff-facilitated, and also on the type of food (liquid or solid). The increase in duration was associated with odds of intake increasing by a factor of 2.73 (95% CI = 1.08–6.91) for resident-completed cycles and by a factor of 17.80 (95% CI = 9.03–35.09) for staff-facilitated cycles. Increase in duration was associated with odds of intake increasing by a factor of 15.42 (95% CI = 6.60–36.10) for liquid and by a factor of 3.15 (95% CI = 1.53–6.50) for solid food.

The interaction between eating technique and food type, illustrated by Fig. 2, was not significant. For both eating techniques (resident-completed and staff-facilitated), the odds of intake did not differ significantly between cycles involving liquid and cycles involving solid food. However, for both liquid and solid food cycles,

Table 3
The Generalized Linear Mixed Model for Intake of Liquid or Solid Food.

Characteristics	b (SE)	t	p	OR	OR 95% CI
Intercept	−3.77 (0.70)	−5.38	<.001		
Staff					
Gender (male vs. female)	0.83 (0.43)	1.95	.05	2.30	1.00 – 5.31
Years worked as a caregiver (years)	0.04 (0.03)	1.50	.13	1.04	0.99 – 1.10
Resident					
Age (years)	−0.004 (0.02)	−0.19	.85	1.00	0.95 – 1.04
Gender (male vs. female)	1.00 (0.37)	2.73	.01	2.73	1.33 – 5.61
Functional status	−0.06 (0.03)	−1.78	.07	0.94	0.88 – 1.01
Characteristics of Eating Performance Cycle					
Food type (liquid vs. solid food)	−3.81 (1.34)	−2.83	.005	0.51	0.25 – 1.04
Eating technique (resident-completed vs. staff-facilitated)	6.72 (1.28)	5.24	<.001	6.20	2.96 – 12.98
Duration of cycle (ln(sec))	3.01 (0.44)	6.80	<.001	8.05	4.41 – 14.70
Technique*type		2.26[a]	.13		
Liquid: resident-completed vs. staff-facilitated	1.28 (0.51)	2.52	.01	3.60	1.33 – 9.72
Solid food: resident vs. staff	2.37 (0.54)	4.41	<.001	10.69	3.72 – 30.70
Resident-completed: liquid vs. solid food	−1.21 (0.62)	−1.94	.05	0.30	0.09 – 1.02
Staff-facilitated: liquid vs. solid food	−0.12 (0.36)	−0.33	.74	0.89	0.44 – 1.80
Duration*technique	−2.71 (0.87)	−3.10	.002		
Duration: resident-completed				2.73	1.08 – 6.91
Duration: staff-facilitated				17.80	9.03 – 35.09
Duration*type	2.29 (0.82)	2.78	.01		
Duration: liquid				15.42	6.60 – 36.10
Duration: solid food				3.15	1.53 – 6.50

Note. Odds ratios (OR) were calculated holding resident age, functional status, and staff years working as a caregiver at the mean values, and video duration at 5 s [ln (5 s) = 1.6094]. Odds ratios for duration were calculated for the increment of 5 s.

[a] F statistic is shown. A total of 987 eating performance cycles, excluding 135 cycles that have missing data on resident age and functional status from a total of 1122 cycles, were used for the model (840 cycles with intake vs. 147 cycles with no intake).

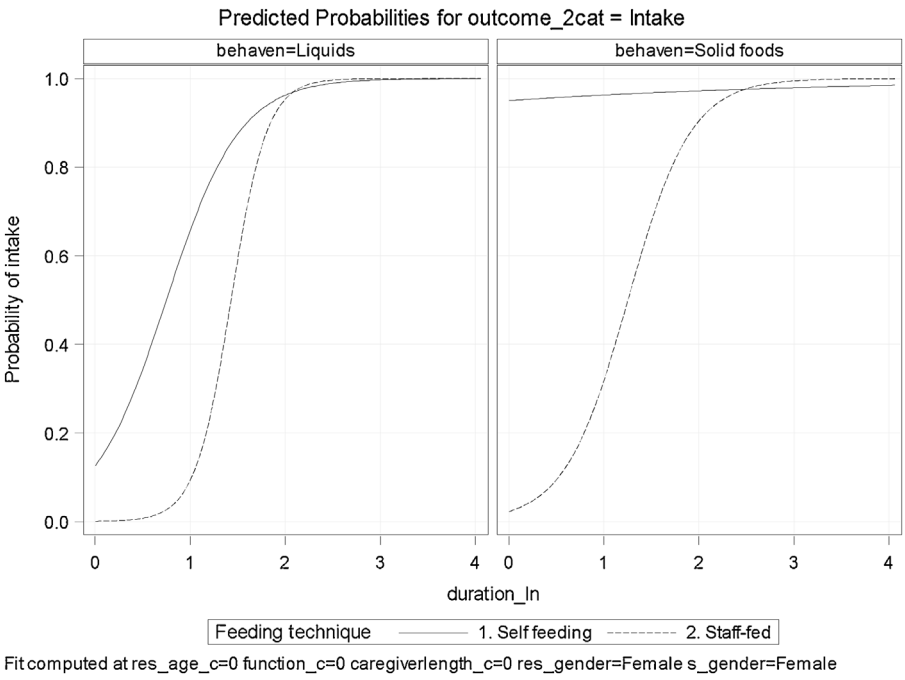

Fig. 1. Estimated probabilities of intake for a range of ln(duration) by food type and eating technique.

the odds of intake were greater for resident-completed cycles than for staff-facilitated cycles (OR = 3.60, 95% CI = 1.33–9.72 for liquid and OR = 10.69, 95% CI = 3.72–30.70 for solid food).

4. Discussion

This study is one of the first that used an innovative and feasible computer-assisted video coding scheme with high inter-rater reliability to evaluate the role of characteristics of eating performance cycles (food type, eating technique and duration) on intake among NH residents with dementia during usual mealtime care. Overall, there were significant interactions between eating technique and duration, and between type of food and duration, indicating the important role of these characteristics on intake. Specifically, resident-completed cycles resulted in greater odds of intake compared to staff-facilitated cycles, and cycles involving liquid resulted in greater odds of intake than cycles involving solid food, especially when the cycle lasted longer. The findings support the hypotheses that food intake is significantly associated with eating performance characteristics.

4.1. Eating techniques

The study found that cycles accomplished by residents resulted in more likelihood of intake than those facilitated by staff

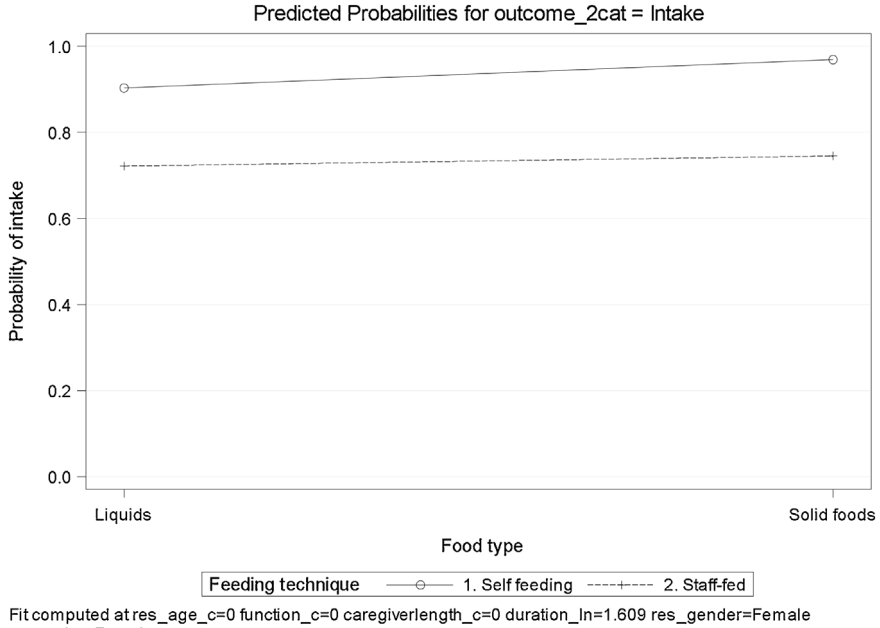

Fig. 2. Estimated probabilities of intake by food type and eating technique.

regardless of whether cycles involved liquid and solid food. The finding was consistent with our prior qualitative work that demonstrated the importance of engaging residents instead of providing full assistance in mealtime activities (Liu et al., 2018b). It is possible that when residents initiate eating by themselves, they are more prepared and motivated to get food into the mouth and swallow it. Whereas when residents are being fully assisted by staff, they are less prepared and motivated and less capable to control the pace of the intake process, and thus may be more resistive to an intake attempt resulting in no intake. The findings point out the importance of resident eating performance in improving intake.

This study showed that the majority of resident participants (88%) still tried to initiate eating by themselves, indicating the potential functional ability to pick up the food and transport the food item into the mouth by themselves. Three-quarters of resident participants (76%) were directly fed by staff at least for part of the mealtime, indicating the high prevalence of lack of continuous staff facilitation during mealtime care. Eating is the most basic ADL for older adults, as well as the easiest function to restore after decline or loss (Liu et al., 2015a). Findings indicate the critical need to support resident independence in eating performance through positive engagement and continuous facilitation by staff. Findings also point out the potential impact of staff training programs that teach the components of optimal mealtime assistance, including positive engagement, motivation, and dyadic interaction with residents to optimize resident function and intake outcomes.

4.2. Types of food

The study showed that cycles involving liquid are more likely to result in intake than cycles involving solid food, especially when the cycles lasted longer. The findings were consistent with prior research that described staff reported care strategies, including starting with liquid at beginning of mealtime and offering liquid between bites of solid food, that helped to get mealtime started and proceeded (Liu et al., 2018b). Because dehydration as the direct consequence of low liquid intake leads to more adverse consequences (e.g., acid-base disorders, skin integrity, fatigue, sickness, loss of appetite), offering liquid to sustain adequate hydration among residents is critical. Whereas drinking liquid results in greater likelihood of intake compared to eating solid food, starting with liquid and trying longer attempts to engage residents in drinking liquid may be preferred during mealtime assistance by staff, especially when assisting residents who struggle with eating solid food to ensure adequate liquid intake.

4.3. Duration of cycles

The study showed that longer duration of cycles is associated with greater likelihood of intake. Furthermore, staff-facilitated cycles with longer duration are more likely to result in intake than resident-completed cycles. Though prior reports showed that shorter eating time overall was related to poorer nutrition (Chang and Roberts, 2011), this is the first study that specifically demonstrated that an eating attempt with a shorter duration was associated with less likelihood of intake. When full assistance is provided by staff at mealtime, the length and continuity of such assistance is more likely to result in successful intake. This is especially important for residents who need mealtime assistance in order to get food into their mouth. Whenever staff attempt to assist residents and encourage residents to eat, longer and continuous attempts are recommended to promote nutritional intake.

4.4. Implications for research

The study identified key modifiable determinants of food intake at resident, staff and environmental levels including resident eating performance, type of food, and duration of the eating performance cycle. Specifically, staff is critically positioned to intervene at the personal and environmental levels by providing optimal assistance and continuous facilitation to support resident eating performance. Improved eating performance and staff mealtime assistance with strong social interaction have been shown to be associated with positive pace of food intake (Namasivayam-MacDonald et al., 2018; Keller et al., 2017). Further, when staff provides resident-centered mealtime care, it associates with not only increased intake, but also delayed functional dependence and improved eating ability (Anderson et al., 2016; de Graaf et al., 2006), indicating the importance of resident-centeredness of mealtime care to promote eating performance (Aselage et al., 2015). It is not the presence of more staff in the dining room, but the presence of well trained staff who provide quality mealtime care and interaction that address and mitigate resident challenges in eating (Namasivayam-MacDonald et al., 2018; Keller et al., 2017).

The findings provide directions for future intervention research to improve food intake for residents with dementia. Staff need appropriate knowledge and skills to effectively interact with residents who need mealtime assistance to optimally engage residents in eating, maintain maximal functional independence and improve nutritional intake. However, current staff training programs are inadequate because they primarily focus on the use of feeding skills, rather than engagement, motivation, quality communication, and dyadic interaction (Liu et al., 2014b; Liu et al., 2015b; Chen et al., 2016; Batchelor-Murphy et al., 2017). Innovative staff training programs should focus on motivating staff and teaching staff attitudes, knowledge, and skills to support resident-centered mealtime care that address resident mealtime difficulties and support resident eating performance. The study findings provide directions for the development and testing resident-centered mealtime assistance and staff training programs targeting multifaceted aspects of a successful mealtime experiences by emphasizing the role of resident eating performance, staff facilitation, as well as eating and drinking activities.

The study has important implications for future observational research in the area of dementia mealtime care. While the role of characteristics of eating performance cycles in relation to the likelihood of intake is demonstrated, future research is need to examine whether the change in intake is clinically meaningful in terms of resident functional and nutritional outcomes, that may be measured by physical function, weight, grip strength, nutritional status, and further health-related quality of life. In addition, other important aspects of staff-resident mealtime interactions including verbal and non-verbal behaviors, as well as nutritional care that occur outside of the regular mealtime periods, warrant further examination in relation to supporting food intake in residential care settings.

4.5. Implications for practice

This study's findings provide preliminary supports for the evidence-based mealtime care practices identified based on the new International Dysphagia Diet Standardization Initiative for texture modified foods and thickened liquid for persons with dysphagia (i.e., chewing and swallowing difficulties) (Peter and Julie, 2017). People with dementia commonly experience dysphagia, which lead to multiple life threating events (e.g., chocking, chest infection) and other adverse consequences including malnutrition and dehydration (Cipriani et al., 2016). For older

people with dysphagia, the gradients of "liquid" and "solid" textures are integral in mealtime care. Providing thickened liquid and texture modified foods (e.g., pureed, liquidized foods) has been highly recommended in clinical practice to decrease the likelihood of significant consequences, as well as to ensure adequate liquid and nutrients. Findings of this study further support this evidence-based clinical practice by demonstrating the benefits on increased likelihood of successful intake through provision of thickened liquid and texture modified foods versus regular solid foods, which has great potential to inform current evidence-based dementia mealtime care practice.

The study demonstrates the feasibility and inter-rater reliability of the CUED coding scheme to assess characteristics of eating performance cycles. With a straightforward coding structure, this tool can be easily applied by specialists and care staff in clinical practice to assess characteristics of the intake process as resident-staff interaction is involved, including resident and staff initiation of the intake attempts, food type, and patterns of successful and unsuccessful intake. Results from such assessments will facilitate understanding of the resident's level of eating independence preferences for types of food, and the degree of staff assistance that results in resistiveness or cooperation, and successful intake.

4.6. Limitations

The study was mainly limited due to the nature of a secondary data analysis. The mealtime videos used in the analysis were clips of mealtime scenarios with varied durations, instead of recordings of the whole mealtime. Thus it is impossible to describe the patterns of eating performance cycles or food intake from the beginning to the end of a meal. Future research needs to collect videos of the whole mealtime to examine the patterns of eating performance cycles as well as the patterns of intake over mealtime. Also, the selection of videos was limited to one-on-one interactions that involved one staff and one resident, in order to minimize complexity of interaction. The generalizability of the findings was limited due to the use of a convenience sample of nursing staff and residents with dementia who consented to participate the parent study. Future work focusing on the role of multi-person interactions should evaluate one-on-two and two-on-one staff-resident combinations. Further, resident functional ability in eating was not controlled for in the analysis. Future work needs to assess residents' ability to eat using validated measurements and control for this variable. Additionally, different meals (breakfast, lunch, dinner) should be examined for eating performance patterns and food intake. Lastly, while the role of different types of food (i.e., solid, liquid) on intake was examined in the current study, the impact of different food textures (i.e., thin liquid, thickened liquid) was not explored because such data were not collected in the parent study. Further research is needed to refine the CUED coding scheme by including the characteristics of food textures and consistencies, and identify any differences on intake outcomes in relation to food textures. In the refinement of the CUED coding scheme, international standards in relation to food and nutrition should be referred to so as to increase the clinical relevance of the findings across care settings and nations.

5. Conclusion

This study provides fundamental information to support the role of eating performance characteristics on food and liquid intake for older adults with dementia who need help with eating. The study findings point out the importance of supporting resident eating performance, providing liquid when residents struggle with eating solid food, and providing continuous staff facilitation at mealtimes to improve intake for residents with dementia. Residents with dementia often demonstrate compromised eating performance that leads to negative functional and nutritional consequences. Nursing staff are critically positioned to promote resident independence at mealtimes through positive engagement and facilitation, rather than directly feeding residents regardless residents' potential functional ability in eating. This study provides important directions to inform the development of evidence-based mealtime assistance and staff training programs to positively engage residents in meals by supporting independent eating performance – a care approach that assures more intake than the current practice of providing full assistance.

Contributions

WL, KW and MBM contributed to the study conceptualization. MBM developed the coding scheme. WL led video screening and video coding. MBM and KW contributed to technical support for the Noldus Observer XT software. WL and MH contributed to data cleaning and management. WL and EP contributed to data analysis and interpretation of findings. KW is the Principal Investigator (PI) of the parent study. All authors meet the criteria for authorship, and have approved the final article. All those entitled to authorship are listed as authors.

Author statement

The work described has not been published previously, that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder.

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Conflicts of interest

None.

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Appendix A. Supplementary data

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