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Identifying Grasp and Pinch Patterns in Ceramic Interventions: Video Analysis of Adults Completing Ceramic Activities

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Identifying Grasp and Pinch Patterns in Ceramic Interventions: Video Analysis of Adults Completing Ceramic Activities

Abstract

Background: Occupation-based interventions are effective in hand rehabilitation. The purpose of this study was to identify the grasp and pinch patterns used during specific ceramic activities for rehabilitative interventions.

Method: A convenience sample of 59 videos with 38 subjects were taken of adults without hand dysfunction completing various ceramic activities. Elementary Grasp Actions (EGA's) were analyzed to identify the different grasps and pinch patterns.

Results: The EGA's occurred 279 times across 12 ceramics activities. The EGA's with the highest frequencies include nonprehensile, pinch, and lateral pinch. Nonprehensile was the most frequently used grasp used by the left hand. The EGA's with the most prolonged durations were nonprehensile, special pinch, and oblique. The mean frequency and duration of each grasp and pinch pattern for specific ceramic activities are presented.

Conclusion: Therapists can use the results of this study to help individuals with hand dysfunction through specific ceramic activity interventions.

Keywords

ceramics, hand strength, hand, occupations

Cover Page Footnote

The authors declare that they have no competing financial, professional, or personal interest that might have influenced the performance or presentation of the work described in this manuscript.

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Each year in the United States, hand-related conditions account for more than 8.6 million emergency room visits (Colen et al., 2018). In addition, a variety of neuromuscular and musculoskeletal conditions may result in hand dysfunction, which can lead to limitations in pinch, grip, and dexterity as well as activities of daily living (ADLs) (Bala et al., 2021; Kim, 2016; Stock et al., 2019; Williams et al., 2015; Wong et al., 2022). The ability to grasp and manipulate objects is necessary to accomplish tasks and live a more autonomous life (Vergara et al., 2015).

Occupation-based interventions can be engaging, effective, and readily available to enhance a client's level of functioning in the rehabilitation of hand injuries (Che Daud et al., 2016; Chong et al., 2014; Mateos-Toset et al., 2016). Compared to rote exercises, purposeful and creative activity can promote function and participation, including increased repetitions, decreased pain, and self-reported enjoyment (Hoppe et al., 2008; Melchert-McKearnan et al., 2000; Omar et al., 2011; Rostami et al., 2017). Ceramics is an activity that involves the fabrication of various products from clay through multiple techniques (Butler, 2021; Byju, 2022; Panchal, 2020; Sentence, 2004). Examples of ceramics activities include pinching a vessel, coil building, slab construction, wheel throwing, mold casting, and decorating (Peterson & Peterson, 2004). Creative activities, such as ceramics, provide opportunities to create various products at different levels of complexity and can develop skills to enhance occupational performance (Hansen et al., 2020). When using ceramics activities as an intervention, consideration must be given to the client's interests and rehabilitation goals (Che Daud et al., 2016; Hansen et al., 2020).

Literature Review

Previous research has identified essential grasp and pinch patterns for independence in ADLs (Gracia-Ibáñez et al., 2018). Vergara et al. (2014) analyzed videos of individuals performing different ADLs to identify different types of elementary grasp actions (EGAs) used during activities. According to Vergara et al., an EGA is "any complete action in which the hand performed a particular action using a fairly constant hand posture configuration" (p. 226). The authors modified the Edwards et al. (2002) grasp and pinch classification of detailed taxonomy into nine grasp types commonly used during occupations. These grasps include cylindrical (Cyl), oblique palmar (Obl), hook (Hook), lumbrical (Lum), intermediate power-precision (IntPP), pinch (Pinch), lateral pinch (LatP), special pinch (SpP), and nonprehensile (NonP). Vergara et al. investigated the frequency and duration of grasps used during ADLs and identified which hand was used. The most frequently used grasps in ADLs were listed in the following order: Pinch, Obl, Lum, Cyl, and NonP. Certain grasps were more commonly used in specific ADLs. For example, Pinch is frequently used in food preparation and leisure; Obl is widely used during driving and transport; and Cyl is a common grasp used during shopping, driving, and housekeeping (Vergara et al., 2014). Table 1 provides a summary of the grasps used in this study.

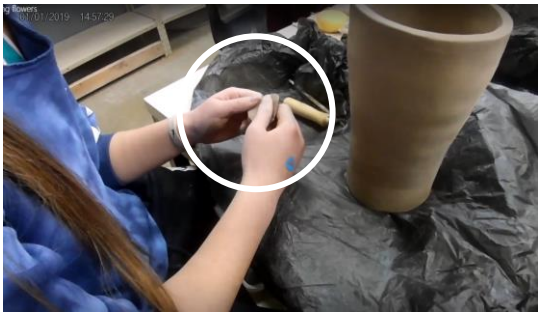
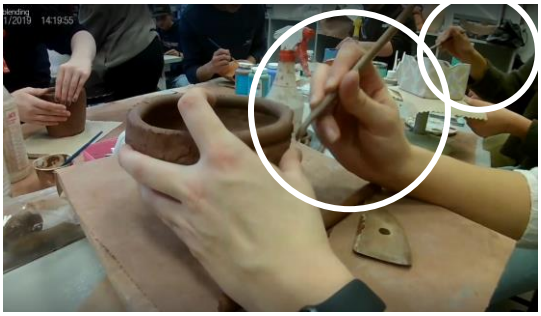
Bullock et al. (2013) highlighted how grasp type, frequency, and duration differ depending on one's occupation. This study found machinists used the grasp types of LatP more than housekeepers. The housekeepers used Cyl (referred to as medium wrap) more than machinists. Another study by Kilbreath et al. (2005) found that subjects more frequently used their hands in bilateral activities than unilateral ones and used their dominant hand more regularly than their non-dominant hand. Gracia-Ibáñez et al. (2018) identified the most essential grasps for independence in ADLs, also referred to as autonomy, from the International Classification of Functioning, which included Pinch, Lum, Cyl, and NonP, further

highlighting the importance of grasp and pinch tasks. This study aimed to identify the types of grasp and pinch patterns used during specific ceramic activities. These identified patterns may direct the kind of ceramic activity that can be used as an intervention in the rehabilitation of specific hand conditions and injuries.

Table 1

Descriptions and Examples of Grasps Used in this Study

Grasp	Description	Example
Cylindrical Grasp (Cyl)	The palm is involved. The thumb is in direct opposition to the fingers (in abduction or neutral).	
Oblique palmar grasp (Obl)	Variation of the Cyl grasp. The palm is involved, but the thumb is adducted.	
Lumbrical grasp (Lum)	Thumb and proximal part of the fingers are involved, but the palm is not involved.	
Intermediate power-precision grasp (InPP)	The palm is somewhat involved, but both the thumb and index stabilize the grasp.	

Grasp	Description	Example
Pinch grasp (Pinch)	Thumb and fingertips (one or more) are used.	
Lateral pinch (LatP)	The lateral part of the fingers (one or more) is used, and usually the thumb as well.	
Special pinch (SpP)	The thumb, the lateral part of some fingers, and the fingertips and fingertips of another/others are involved.	
Non-prehensile grasp (NonP)	Objects are manipulated without grasping them.	

Note. Definitions taken from Vergara, M., Sancho-Bru, J. L., Gracia-Ibáñez, V., & Pérez-González, A. (2014). An introductory study of common grasps used by adults during performance of activities of daily living. *Journal of Hand Therapy*, *27*(3), 225–234. https://doi.org/10.1016/j.jht.2014.04.002
Images obtained from the video recordings.

Method

The methods for this research study are based on the process followed by Vergara et al. (2014) and Gracia-Ibáñez et al. (2018). The university institutional review board approved the study, reference number: 19-320-H.

Partcipants

For this study, a convenience sample of 59 videos with 38 subjects was obtained through two university ceramic art classrooms and an art center for community-dwelling older adults. Inclusion criteria were individuals who were ceramic instructors, students, or artisans. Videos (participants) were excluded if the researchers noted a hand condition (i.e., missing digits) or injury (bandages, etc.). There were no self-reported or observed hand conditions or recent hand injuries. The researchers did not request additional medical history information, as this was irrelevant.

The participants provided both written and verbal informed consent before data collection. Each student participant was asked for consent and videotaped by an author who was not their teacher. The participants were informed that they could leave the study at any time without penalty. The videos included ceramics instructors and students without hand dysfunction completing various ceramic activities. Only the hands of the participants were videotaped, and no identifying information was provided to the researchers.

Procedures

Before data analysis, sample scoring was completed as a training exercise to ensure consistency. The training required all of the researchers to watch the same video under the guidance of the primary investigator. The video was stopped and started as needed to determine the accurate times and duration of each identified grasp and pinch. This training improved the consistency among the researchers.

All videos were divided into consecutive EGAs for each hand. Two research teams watched and scored the videos separately and identified the following: type of grasps used, the hand being used (right or left), type of ceramic of activity, and time spent in the EGA. The time of each EGA was recorded to 0.1 s. All of the researchers discussed the data found by each respective team. Data were reviewed and discussed until a scoring consensus was determined. Definitions of the ceramic activities used and the total number of videos analyzed are displayed in Table 2.

Data Analysis

The mean frequency and duration of nine EGAs were analyzed across 12 ceramics activities. Descriptive statistics were used to analyze the data set and report the findings. Data for the left and right hands were recorded separately on a spreadsheet.

Results

A convenience sample of ceramic videos was included in this study ($N = 59$). The length of each video varied, as it was the ceramic activity and its associated EGA that was being observed. Of the 59 videos, 12 unique ceramic activities were identified. None of the videos were discarded. The most frequently noted activities included trimming and smoothing $n = 19$ (32%), decorating $n = 11$ (19%), and throwing $n = 6$ (10%). For each EGA, frequency (i.e., number of occurrences) and duration (i.e., total time) were recorded. The nine grasp and pinch EGA types occurred 279 times across 12 ceramics activities. The EGAs with the highest frequencies (left and right hands combined), including NonP $n = 68$ (24%), Pinch $n = 57$ (22%), and LatP $n = 35$ (12%).

The frequency of EGAs was recorded across the 12 ceramics activities. When creating a coil pot, the most frequent EGAs using the left hand were Lum $n = 4$ and Pinch $n = 4$. Using the right hand for this activity, frequent EGAs included NonP $n = 3$, SpP $n = 3$, and Pinch $n = 3$. For the trimming and smoothing

activity, the EGAs with the highest frequencies using the left hand included NonP *n* = 12, LatP *n* = 11, Pinch *n* = 8, and Cyl *n* = 7. EGAs with the highest frequencies using the right hand during trimming and smoothing included SpP *n* = 10, Pinch *n* = 9, LatP *n* = 7, and NonP *n* = 7. During the decorating activity, the left hand's most frequently used EGAs were NonP *n* = 7, Pinch *n* = 4, and SpP *n* = 2. Using only the right hand for this activity, frequent EGAs included LatP *n* = 6, NonP *n* = 5, and Pinch *n* = 4. During the throwing activity, the most frequently used EGAs using the left hand were NonP *n* = 8, Obl *n* = 7, and Lum *n* = 4. When observing the right hand during the throwing activity, the most frequent EGAs were NonP *n* = 7, Obl *n* = 7, and Pinch *n* = 5. During the glazing activity, the left hand's most frequently used EGAs were NonP *n* = 2, Pinch *n* = 2, and Cyl *n* = 2. For this activity, EGAs with the highest frequencies using the right hand included SpP *n* = 4, Obl *n* = 1, and Cyl *n* = 1. The mean frequencies of EGAs for ceramic activities are displayed in Table 3.

Table 2

Description of Ceramics Activities and Number of Videos Analyzed

Ceramics Activity	Description	Number of Videos Analyzed
Mold Casting	Using a "plaster form to reproduce any number of accurate copies of the original model in clay" (Peterson & Peterson, 2004). This process includes pressing the clay into the mold, cutting off the excess clay, and removing the clay from the mold.	2
Load/Unload Kiln	The process of placing dried ceramic pieces into a "furnace for firing clay" (Peterson & Peterson, 2004). This includes removing these pieces after firing.	3
Heat Gun	The use of a handheld device that produces a stream of hot air to speed the drying process of a ceramic piece (Cobb, 2021).	1
Cleaning	The use of a file or cloth to finish a ceramic piece after firing by smoothing away rough surfaces or wiping away dust (Osteritter, 2020).	1
Apply Handle	The process of adding a piece of wet clay to an established piece, which is intended to be used as a means to hold or carry the final object. These can be coil-rolled, pinched, or slabbed (Peterson & Peterson, 2004).	3
Coil Pot	The creation of a coil pot involves the construction of "hollow forms by rolling and attaching ropes of soft clay" (Peterson & Peterson, 2004).	5
Trim/Smooth	The process of using your hand or a tool to even the outermost layer of clay or add a foot to a piece (Peterson & Peterson, 2004).	19
Decorate	The process of altering a piece for decorative purposes. This could include "stamping or pressing objects into the clay, scratching or carving clay, and appliqueing clay pieces to other clay pieces" (Peterson & Peterson, 2004).	11
Wedging	The process of "kneading a mass clay in order to remove air bubbles and make the mass homogenous" (Peterson & Peterson, 2004).	1
Slab Prep	The process of "rolling a piece of clay into an even thickness and smoothing using a tool or hand in order to create a flat piece of clay from which shapes can be fabricated" (Peterson & Peterson, 2004).	3
Throwing	The process of "forming pieces on a revolving potter's wheel from solid lumps of clay into hollow forms" (Peterson & Peterson, 2004). This includes placing the clay on the wheel, shaping it, and removing the finished piece from the wheel.	6
Glazing	The process of applying a coating to a kiln-fired ceramic piece by dipping, painting, or pouring. The glaze "provides decoration and color, prevents penetration of liquids or acids, and yields a matt or glossy, easily cleaned, functional surface" (Peterson & Peterson, 2004).	4

Note: Definitions for these ceramic activities are taken from Peterson and Peterson (2004), Cobb (2021), and Osteritter (2020).

The frequency of EGAs was recorded across the 12 ceramics activities. When creating a coil pot, the most frequent EGAs using the left hand were Lum *n* = 4 and Pinch *n* = 4. Using the right hand for this activity, frequent EGAs included NonP *n* = 3, SpP *n* = 3, and Pinch *n* = 3. For the trimming and smoothing activity, the EGAs with the highest frequencies using the left hand included NonP *n* = 12, LatP *n* = 11, Pinch *n* = 8, and Cyl *n* = 7. EGAs with the highest frequencies using the right hand during trimming and

smoothing included SpP $n = 10$, Pinch $n = 9$, LatP $n = 7$, and NonP $n = 7$. During the decorating activity, the left hand's most frequently used EGAs were NonP $n = 7$, Pinch $n = 4$, and SpP $n = 2$. Using only the right hand for this activity, frequent EGAs included LatP $n = 6$, NonP $n = 5$, and Pinch $n = 4$. During the throwing activity, the most frequently used EGAs using the left hand were NonP $n = 8$, Obl $n = 7$, and Lum $n = 4$. When observing the right hand during the throwing activity, the most frequent EGAs were NonP $n = 7$, Obl $n = 7$, and Pinch $n = 5$. During the glazing activity, the left hand's most frequently used EGAs were NonP $n = 2$, Pinch $n = 2$, and Cyl $n = 2$. For this activity, EGAs with the highest frequencies using the right hand included SpP $n = 4$, Obl $n = 1$, and Cyl $n = 1$. The mean frequencies of EGAs for ceramic activities are displayed in Table 3.

Table 3

Mean Frequency of Grasp and Pinch Patterns for Ceramics Activities

Grasp	Hand	Mold Casting	Load/ Unload Kiln	Heat Gun	Cleaning	Apply Handle	Coil Pot	Trim/ Smooth	Decorate	Wedging	Slab Prep	Throwing	Glazing
Cyl	Left	X	2	X	X	1	X	7	1	1	X	1	2
	Right	X	X	X	1	X	X	6	1	1	X	1	1
Obl	Left	X	X	X	X	X	X	2	X	1	1	7	X
	Right	X	X	1	1	X	X	1	X	1	1	7	1
Lum	Left	X	X	X	X	1	4	3	1	X	X	4	X
	Right	X	2	X	1	X	2	4	X	1	1	4	X
IntPP	Left	X	X	X	1	1	X	1	X	X	X	1	X
	Right	1	X	X	X	X	X	4	1	X	X	1	X
Pinch	Left	2	1	X	1	1	4	8	4	X	1	3	2
	Right	1	2	X	X	3	3	9	4	X	3	5	X
LatP	Left	X	X	X	1	X	1	11	2	X	1	2	X
	Right	1	X	X	X	X	1	7	6	X	2	X	X
SpP	Left	X	X	X	X	X	X	2	2	X	X	X	X
	Right	X	X	X	X	2	3	10	3	X	2	2	4
NonP	Left	1	X	1	1	2	3	12	7	1	1	8	2
	Right	1	2	X	1	2	3	7	5	1	X	7	X

Note. Scores are reported as the number of occurrences. Left hand and right are reported separately. X = grasp or pinch pattern was not observed in the video.

The duration of EGAs was recorded across 12 ceramics activities. The EGAs with the most prolonged durations using the left hand were Cyl (59.6 s) during the handle-applying activity, IntPP (57.3 s) during the trimming and smoothing activity, and NonP (46.8 s) during the cleaning activity. The EGAs with the most prolonged duration using the right hand included Obl (42.5 s) during the wedging activity and (37.1 s) during the heat gun activity. In addition, SpP (36.2 s) was used during the handle application activity. The mean duration of EGAs for ceramic activities is displayed in Table 4.

Discussion

Existing literature associates favorable outcomes with occupation-based interventions (Che Daud et al., 2016). In addition, previous research has found that occupation-based interventions during hand rehabilitation can significantly enhance function (Che Daud et al., 2016; Chong et al., 2014; Mateos-Toset et al., 2016). Ceramic activities can be used as an occupation-based intervention for clients with hand dysfunction if a client expresses interest in ceramics (Hansen et al., 2020).

Table 4

Mean Duration of Grasp and Pinch Patterns for Ceramics Activities

Grasp	Hand	Mold Casting	Load/ Unload Kiln	Heat Gun	Cleaning	Apply Handle	Coil Pot	Trim/ Smooth	Decorate	Wedging	Slab Prep	Throw-ing	Glazing
Cyl	Left	X	6.2	X	X	59.6	X	8.9	45.8	1.9	X	0.9	14.1
	Right	X	X	X	3.5	X	X	13.6	8.3	0.4	X	1.1	21.1
Obl	Left	X	X	X	X	X	X	1.7	X	42.1	1.4	20.7	X
	Right	X	X	37.1	11.0	X	X	2.4	X	42.5	1.4	17.8	26.1
Lum	Left	X	X	X	X	1.3	25.5	8.5	15.9	X	X	11.3	X
	Right	X	8.2	X	9.7	X	12.5	7.6	X	5.2	3.1	15.2	X
IntPP	Left	X	X	X	5.8	6.9	X	57.3	X	X	X	3.7	X
	Right	12.7	X	X	X	X	X	29.0	27.5	X	X	4.0	X
Pinch	Left	6.3	2.7	X	X	9.1	10.3	7.0	6.2	X	11.2	11.8	10.3
	Right	10.8	1.9	X	7.0	14.7	19.4	13.7	17.8	X	29.2	13.6	X
LatP	Left	X	X	X	2.1	X	2.4	11.3	18.8	X	2.8	1.5	X
	Right	2.6	X	X	X	X	2.4	8.2	15.5	X	7.0	X	X
SpP	Left	X	X	X	X	X	X	3.8	29.4	X	X	X	X
	Right	X	X	X	X	36.2	26.5	24.0	24.0	X	6.5	17.6	27.5
NonP	Left	8.4	X	37.1	46.8	24.3	26.7	20.4	17.2	7.6	1.4	19.1	18.6
	Right	0.3	1.2	X	8.6	10.8	18.5	9.1	10.0	1.9	X	16.9	X

Note. Scores are reported as time in seconds. Left hand and right hands were reported separately. X = grasp or pinch pattern was not observed in the video.

This study found NonP was the most frequent grasp used by both the left and right hand. NonP in the left hand was used at least once in all ceramic activities except loading and unloading the kiln. The researchers suggest NonP was frequently used in the left hand because most of the subjects were right-handed. Therefore, the left hand was used to stabilize during the activities. Data analysis shows the NonP grasp was most frequently used with trimming and smoothing, decorating, and throwing. However, the highest mean durations of NonP were during cleaning, heat gun, and making a coil pot. As defined by Vegara et al. (2014), NonP is done when objects are manipulated without grasping them. This EGA requires digit extension. Therefore, if a therapist was working with a client that needed to improve digit extension, they could use ceramic activities that frequently require a NonP grasp, such as trimming and smoothing. Gracia-Ibáñez et al. (2018) found that NonP, together with pinch, is one of the most relevant grasps for functional independence. A therapist may engage a client in a ceramic activity to promote both Pinch and NonP, such as trimming, smoothing, or decorating, to help increase strength and/or motion. In addition, Vegara et al. found that NonP was one of the most used grasps in ADLs; therefore, the development of digit extension may improve occupational performance in ADLs.

This research can be used to direct therapists to specific ceramic activities based on the client's needs and goals. Trimming and smoothing ceramic movements may be used by a therapist to encourage the three types of pinches (LatP, SpP, and Pinch) as well as NonP and Cyl. Decorating ceramic activities may be used by a therapist to promote sustained pinch position strength, NonP, and LatP. Throwing may be used by a therapist to promote varying digital flexion ranges using Cyl, Obl, NonP, Pinch, and intrinsic plus position endurance (Lum).

This research directs therapists to long-duration ceramic activities based on the client's needs and goals. If a client needs to improve Cyl grasp or pinch of multiple digits (SpP) for a longer duration, applying a handle may be selected. To promote a pinch that stabilizes an item in the palm (IntPP) for a longer duration, a trimming and smoothing ceramic activity could be used. To promote digit extension for

a longer duration (NonP), a ceramic cleaning activity or use of a heat gun would be appropriate. Wedging clay and the use of a heat gun are good choices to facilitate an Obl grasp.

Gracia-Ibáñez et al. (2018) found that the most relevant grasps for client autonomy, or independence, are Pinch, Lum, Cyl, and SpP with NonP. A therapist may choose specific ceramic activities that promote these grasps to increase their client's autonomy. In addition, a study done by Vegara et al. (2014) researched the types of grasps most frequently used in ADLs and found pinch was widely used in food preparation. Therefore, if a client with hand dysfunction needs to engage in food preparation, a therapist may choose to use a ceramic activity that promotes pinch, such as trimming and smoothing, for an intervention.

Limitations

Only three of the videos showed the movements of wedging and mold casting. It would be beneficial to have additional data to develop a more comprehensive understanding of the grasps used to complete these activities. The grasps recorded during ceramic activities may not have been representative of the activity as a whole. Each activity was observed for a limited time. Therefore, the participants may have demonstrated additional grasps that were not recorded. In addition, there was no consistent length or varied angles for each video. Because of these limitations, the researchers cannot be certain of the frequency of patterns from start to finish of each ceramic activity. In addition, the small sample size affects the generalizability of results. The participants in this study were ceramics students, ceramics instructors, and artisans that were community-dwelling older adults. Therefore, sampling bias may be a possibility. Future research should consider these limitations. Despite these limitations, understanding the grasp and pinch patterns that occur during specific ceramics activities has clinical significance. This information can assist in choosing appropriate ceramic tasks to address specific conditions.

The authors recognize that engaging in the art of ceramics may not interest all clients and that a client-centered approach is imperative for engagement in meaningful activities. The authors also realize that materials such as clay, brushes, paint, and tools, such as a kiln, are not available to everyone. These problems may limit the accessibility of ceramics activities. However, if a client expresses interest in ceramics, simple designs, inexpensive paints, and materials that do not need to be fired with a kiln should not be overlooked.

Future Research

This study did not measure the gains of using ceramics activities as an intervention. This may include benefits beyond physical improvements. Assessing the value of cognitive, social, and psychological benefits of engaging in ceramics would be beneficial. A similar study by Mahendren et al. (2018) reported cognitive benefits for community-dwelling adults when participating in art activities. Valdes et al. (2019) found enjoyment and social and mental stimulation were common in older adults with memory loss who participated in creative arts. Additional research is needed to explore the benefits of ceramic activities as an intervention for specific hand conditions.

Conclusion

This study identified the specific pinch and grasp patterns used during various ceramics activities. These activities may be a valuable occupational-based intervention tool in rehabilitation for those with deficits and disorders of the hand. Additional research is warranted.

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