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David P Loy

Ph.D., CTRS/LRT, Department
of Recreation Sciences, East
Carolina University, Greenville,
USA

The influence of grapefruit and frankincense aroma on aggressive and negative behaviors in adolescents with emotional/behavioral disturbance: An applied behavior analysis study

David P Loy

Abstract

In this study, adolescents with confirmed diagnoses of emotional/behavior disturbance (E/BD) were included in each session. An applied behavior analysis study using a withdrawal (ABAB) single subject design was conducted to determine the occurrence of negative social interactions during 15-second intervals using instantaneous time sampling observations. Two observers (primary and secondary) determined the number of negative social interactions during baseline and intervention conditions. Data trend stability and level change of the two conditions were used to determine if an essential oil blend of grapefruit (*Citrus paradisi*) and frankincense (*Boswellia carterii*) was effective in reducing the number of negative social interactions among adolescents with E/BD during free play sessions. Two conditions were repeated to investigate replication of effect. Results suggested fewer negative social interactions were present in the essential oil phases than during the baseline control phases without the presence of aroma. Decreasing trends and some replication of effect were also noted during essential oil intervention sessions.

Keywords: Aromatherapy, grapefruit, frankincense, emotional behavioral disorders, social skills

1. Introduction

The Individuals with Disabilities Act (IDEA) defines emotional/behavioral disturbance (E/BD) as, a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a child or adolescent's educational performance: a) an inability to learn that cannot be explained by intellectual, sensory, or health factors; b) an inability to build or maintain satisfactory interpersonal relationships with peers and teachers; c) inappropriate types of behavior or feelings under normal circumstances; d) general pervasive mood of unhappiness or depression; and e) a tendency to develop physical symptoms or fears associated with personal or school problems ^[1]. The United States Office of Special Education Programs indicates that 5.45% (or nearly 400,000) of all students with disabilities have E/BD ^[1]. Some of the characteristics and behaviors seen in children or adolescents who have E/BD include: a) hyperactivity (short attention span, impulsiveness); b) aggression or self-injurious behavior (acting out, fighting); c) withdrawal (not interacting socially with others, excessive fear or anxiety); d) immaturity (inappropriate crying, temper tantrums, poor coping skills); and e) learning difficulties (academically performing below grade level) ^[2]. Children with E/BD (including physical, developmental, and emotional) often demonstrate lower levels of socially acceptable behaviors than typical children, making the consequences more devastating ³. While social and behavioral conduct is common among children with E/BD, children are often treated with approaches that concentrate in training for parents on how to handle child or adolescent behavior; family therapy; training in problem solving skills for children or adolescents; and community-based services that focus on the young person within the context of family and community influences ^[3]. There remains an ever-present need to develop and test approaches to treating E/BD even though there has been a significant decline in intervention-based research for students with E/BD in the past decade ^[1]. In addition, many of these traditional approaches are individualized and often impractical in group settings.

Corresponding Author:**David P Loy**

Ph.D., CTRS/LRT, Department
of Recreation Sciences, East
Carolina University, Greenville,
USA

One such way of accomplishing behavioral change in group settings may be through the use of complementary and alternative medicines (CAM) with children with various health conditions ^[1, 2]. Aromatherapy is one such CAM used to create stimulating and/or relaxing environments for children with health conditions ^[3]. Aromatherapy is the use of essential oils from plants (flowers, herbs, or trees) as a complementary health approach ^[3]. If an individual is calm they are more likely to interact, as well as be able to compose themselves in order not to react negatively toward other. Therefore, the purpose of this study was to examine the influence of aroma (an essential oil blend of grapefruit and frankincense) on negative social interactions in children with E/BD.

2. Materials and methods

2.1. Agency

This research project was conducted at an existing therapeutic summer camp for children with E/BD held on a university campus. The program was supervised by a certified and licensed recreational therapist and staffed by recreational therapy undergraduate and graduate students. The therapeutic summer camp worked with children (N=10) in 30 to 60-minute programs such as Stress Management, Communication Skills, Physical Activity, Social Skill Development, and Family Outreach. The therapeutic summer program lasted 10-weeks and occurred five days a week from 9:00 am – 4:00pm. Data collection for this study occurred in a classroom (30' x 42') that included individual desks, group tables, cabinets stocked with age-appropriate games, puzzles, and craft/program supplies.

2.2. Participants

Participants (N=10, age range 8-14 yo, mean = 11.2yo) were enrolled in a summer therapeutic camp program addressing issues related to anger management, stress, and social skills. Participants (6 males, 4 females) were referred by a local mental health agency documenting the participant's history of E/BD and negative patterns of interacting with others in social settings. Each participant met the following inclusion criteria: a) no allergic reaction to aroma oils, b) no seizure or high-blood pressure disorder, and c) voluntarily provided consent to participate in study from guardian. This study was reviewed and approved by a university institutional review board.

2.3. Target Behaviors

This research examined the effect of aroma on the occurrence of negative social interactions that required staff intervention. Negative social interactions in this study included three potential attributes including a) *negative physical behavior* (e.g., punching another with close fist, punching object with close fist, pushing person, throwing object to harm another or break object, kicking another, slapping another with open fist, hitting objects with open fist, "flicking" or finger snapping others), b) *impulsive non-physical aggression* directed at another (e.g., sticking tongue out at others, spitting on another, running out of room to escape/run-away, non-participation in programmed activity, fake punches directed at another, turning lights off/on when unasked as to interrupt others, destruction or vandalization of property, touching or taking others' property), or c) *negative verbal exchange* directed at another (e.g., name calling, antagonizing/taunting,

talking back to program staff, arguing with others, teasing, mocking, whining, racial comments directed at another, and using inappropriate loud voices that require correction from staff). This extensive target behavior definition was based upon interviews and consultation with summer camp staff and observations made prior to data collection (i.e., observer training period). The target behavior definition was revised and revisited until there was a consensus among therapeutic program staff and research staff.

2.4. Essential Oil Intervention

Some essential oils are thought to have a relaxing and sedative effective on others ^[3]. A clinical aromatherapist was consulted about this research project need and the aroma, *Behavior Blend*, was recommended as the intervention. *Behavior Blend* is an essential oil blend composed of frankincense essential oil (*Boswellia carteri*) and grapefruit essential oil (*Citrus paradisi*). Some have suggested that citrus essential oils can be an effective adjunct treatment to improve individuals' mental health and well-being ^[3, 4]. More specifically, frankincense essential oils have been suggested to promote increase in skin blood flow that produces an anxiolytic effect ^[5]. It has also been mentioned that the fragrance of grapefruit has an activation of sympathetic nerve activity that often promotes a calming effect. The target outcome for *Behavior Blend* is relaxation and calming effect and was therefore deemed an appropriate match for the target outcome in this study. The application of the aroma was provided per the aromatherapy consultant and the protocol provided in the user's manual. During the intervention phases of the study, the application was provided via two methods: a) 2 drops of the essential oil were placed on a felt applicator and worn on the left shoulder of each participant (see figure 1), and b) 3 drops of the essential oil were placed on an aromatic diffuser placed centrally in the classroom to disperse aroma molecules in the space.

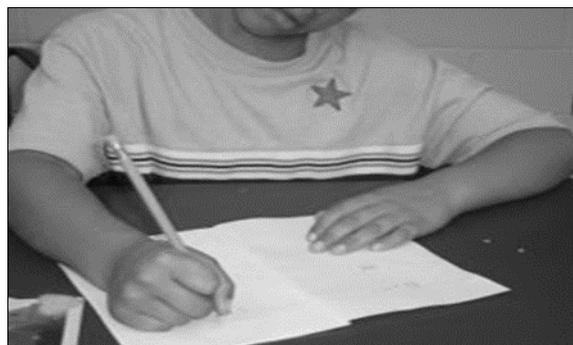


Fig 1: Application of felt applicator "star" on participant left shoulder

The felt star applicator was applied everyday to each participant before the start of the free play period. During the non-intervention conditions, a felt star without essential oil was applied to each participant's left shoulder. In addition, the aromatic diffuser was in the room every day of data collection with applicator pad without essential oil during the non-intervention phases (A₁, A₂) of the research study.

2.5. Behavioral Observation Technique

This research study provided a group intervention within a

¹Posadzki, Watson, Alotaibi, & Ernst (2013)

²Hunt, K., & Ernst, E. (2011)

³Han, Gibson, Eggett, & Parker (2017)

⁴Perna S, Spadaccini D, Botteri L, et al. (2019)

free play period for children with E/BD. Because the entire classroom could not be observed at one time, an interval sampling method was implemented^[5]. The classroom was divided with floor tape to designate three distinct and equal areas for observation. Based on the frequency of negative social interactions demonstrated during the observer training period, a 15-second time sampling interval was used. The observers scanned each designated observation area for 15 seconds to determine the presence of a negative social interaction occurred as defined within the target behavior definition and demonstrated during observer training period. Once the 15-second time interval elapsed, the observers moved their attention to those participants in the next adjacent observation area. This pattern of rotating observation areas every 15 seconds continued until the 10-minute free play time period ended. Only the occurrence or non-occurrence of a negative social interaction, and *not* the frequency of the behavior, was indicated for each 15-second interval during the 10-minute observational period. The two trained research observers, a primary and a secondary reliability, were both undergraduate recreational therapy students. Both observers sat on an adjacent side so as to have the same viewpoint, but far enough apart to have independent decisions on the occurrence or non-occurrence of the negative social interaction without undue influence from the other observer. To help coordinate each 15-second interval, each observer had a timing device synchronized to the starting time of the observational period, so each observer was viewing the same time period and observation area.

2.6. Observer Training

Prior to the data collection period, the two observers were trained to provide a consensus on the observational procedures and the conceptual definition of the negative social interaction behavior. During these free play periods, observers reviewed and refined the target behavior definition of negative social interaction and observed and scored the number of 15-second intervals until the occurrence, non-occurrence, and point-by-point reliability (i.e., occurrence and non-occurrence agreement) was at least an 80% agreement between the primary observer and the secondary reliability observer^[13]. This pre-data collection observer training period also served to acclimate participants with E/BD to the presence of two non-staff members (i.e., research observers) at the free play period so participants would demonstrate their most naturally occurring behaviors uninfluenced by the two new individuals in the environment during data collection.

2.6. Research Design

A single-subject withdrawal treatment design (i.e., ABAB) was used to measure the number of negative social interactions observed in participants with E/BD during two phases: baseline (i.e., free play with no intervention) and intervention (i.e., free play with presence of the aroma intervention). A withdrawal (or reversal) design is when stable baseline data are continuously taken for specific type of baseline condition response (A₁). In this research, children with E/BD were observed in a 10-minute free play session and the presence of negative social interactions were observed and recorded in 15-second intervals. Then, the intervention phase (B₁) is introduced (i.e., presence of aroma) and negative social interaction observational data is collected. Next, the intervention (i.e., aroma) is withdrawn (A₂) to determine if the

observed behavior (negative social interactions) returns to previous A₁ level. Finally, the aroma intervention is reinstated (B₂) to examine any replication of effect from B₁. The ABAB research design was chosen because behaviors can be specifically analyzed while other extraneous variables are controlled at the greatest extent possible in an applied setting. The design also allows participants to begin the study at different times and has individuals serve as their own controls in the study^[6]. The withdrawal (ABAB) design provides the most powerful demonstration of experimental control because of the repeated introduction and withdrawal of an intervention demonstrates a replication of effect^[14].

2.7. Data Analysis

There are several ways to evaluate the effectiveness of an intervention in research utilizing single-subject designs. In general, data are graphed, and an effect is demonstrated when there is a change in participant's performance when they change from one condition to another; this effect is able to be replicated within and between participants. Four criteria were used to evaluate the participants' behaviors including changes in: (a) level, (b) trend, (c) variability, and/or (d) a combination of these changes^[14]. A *change in level* is exhibited when the participant's data demonstrates an *immediate* change that is either higher or lower on the variable being measured in one condition when compared to the other condition. An immediate change in level in a therapeutic direction provides support of the *strength* of an intervention in changing a behavior^[13]. *Changes in trend* are evident in the data when the direction of the data— whether the occurrence of the targeted behavior increased or decreased—vary from one condition to the other¹³. When data for the dependent variable demonstrates inconsistency during measurements within a condition, this is described as a *change in variability*. Data that are non-variable, or better referred to as “stable,” provide further evidence that the effect of the intervention is consistent^[13]. Split-middle technique analysis was conducted within each data phase to establish slope trends^[14]. For the purpose of this study, the data analysis investigated whether there were changes in the participants' level, trend, and variability of negative social interaction behaviors across the study conditions/phases.

To help interpret results, data collected on negative social interaction behavior patterns during each of the study phases (A₁, B₁, A₂, B₂) were plotted and graphed as data collection occurred. Based on the collected data, the researcher made decisions about when to transition participants to the next condition (e.g., A₁ to B₁; B₁ to A₂, etc.). The occurrence of intervals that included negative social interactions was plotted and graphed using *Sigma plot*TM software for each study conditions. Results were then examined and analyzed.

3. Results and Discussion

3.1. Interobservation Reliability (IOR)

To provide better confidence in applied behavior analysis results, interobservation reliability (IOR) agreement is calculated to ensure the primary observer is consistently recording the identified target behavior. IOR agreement refers to the degree to which different raters give consistent estimates of the same behavior and is calculated by dividing the number of agreements between two observers by the total number of observation comparisons and multiplying by 100 to produce an agreement percentage^[14]. IOR is calculated for

⁵Fisher, Groff, & Roane (2011)

⁶Dattilo, Gast, Loy, & Malley (2000)

those sessions including observations that include occurrences, non-occurrences, and point-by-point total (i.e., occurrences and non-occurrences). The acceptable criterion for observer agreement is generally accepted to be a minimum of 80% agreement between a primary observer and a secondary reliability observer [14]. The observer and secondary observer in this study demonstrated acceptable IOR

agreement for occurrence (87%), non-occurrence (98%), and point-by-point total (97%).

3.2. Influence of Aroma on Negative Social Interactions

Figure 2 presents data indicating the influence of aroma on the negative social interactions of adolescents with E/BD.

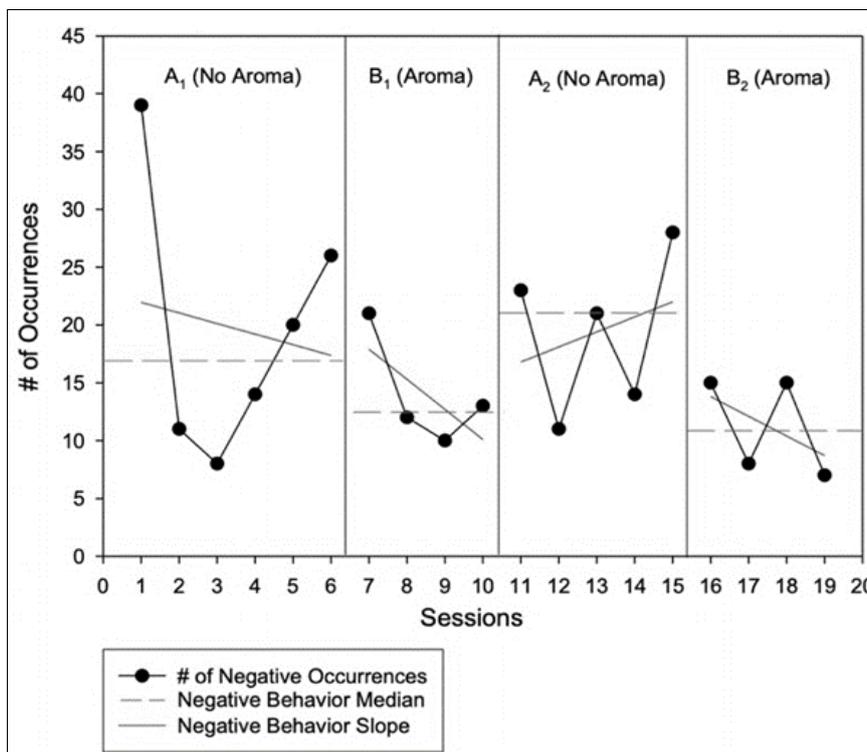


Fig 2: Influence of Aroma on Negative Social Interactions of Adolescents with E/BD

Non-intervention condition (A₁). The first baseline phase (A₁) included a 10-minute observation period without the presence of the *Behavior Blend* essential oil. Observations suggested high initial variability but an increasing trend of negative social interactions near the end of the phase indicated a change to the intervention phase (B₁). The overall slope of the phase indicated a decreasing trend due to day 1 extreme high of 38/40 intervals with a negative social interaction. The A₁ phase median level was 17.

Intervention condition (B₁). The first intervention phase (B₁) demonstrated an immediate decrease during session 7 (reduction of 5 negative social interactions). The immediate change in level suggests some strength in the intervention [13, 14]. Further phase (B₁) performance indicated a decreasing trend slope and reduction in median level (Mdn = 12; reduction of 5 negative social interactions). It should be noted that there was 100% overlap as all B₁ scores were within the range of A₁ phase (8-38). An extremely strong intervention effect would have resulted with limited overlap between the baseline and intervention phases [13].

Non-intervention condition (A₂). The strength of the withdrawal (ABAB) design is the opportunity to demonstrate replication of effect. If the intervention provides some influence, one might see a return to non-therapeutic scores in the second baseline (A₂) without the aroma. The A₂ baseline phase indicated an immediate change in level (i.e., an increase in negative social interactions of 10) suggesting the return to non-therapeutic levels without the presence of the aroma. While some variability was noticed in the A₂ baseline, there was an increasing trend and an increased median level (Mdn =

22).

Intervention condition (B₂). The final intervention phase (B₂) was provided to determine if the levels of negative social interactions decreased again suggesting a replication of effect. Once again, there was an immediate change in level toward a therapeutic direction when the aroma was re-introduced in B₂ (reduction of 13 negative social interactions). While some variability was noted in the B₂ phase, there was once again a decreasing trend and reduced median level from A₂ (Mdn = 11; decrease of 11 negative social interactions). While not as extreme as A₁:B₁, there was once again overlap (50%) between A₂:B₂. Once again, a stronger effect would have demonstrated limited data overlap between baseline and intervention phases.¹³

Results of this study indicated fewer negative social interaction levels were observed with the presence of the *Behavior Blend* (frankincense and grapefruit blended essential oil) when compared to the baseline phases without its' presence. In addition, a decreasing trend of negative social interactions was demonstrated during the intervention phases when compared to the baseline phases without the aroma. Some replication of effect using the withdrawal (ABAB) design provided further evidence that there appeared to be some therapeutic change in behavior between the baseline and intervention phases. While these preliminary results provide some evidence, the overlap of data between baseline and intervention data indicate the effect strength of the aroma remains uncertain as a stronger effect would have little to no duplication of data scores.

Results of this study suggest continued support for using

grapefruit and frankincense essential oils as short-term treatments for mood enhancement and behavioral conduct. Essential oils have long been used as remedies on mental health and psychosocial conditions ^[7, 8]. The efficacy pathways of essential oils as potential treatments for mental health and behavior have been long discussed and even debated. There does seem to be some consensus that aroma can alter mood through pharmacological effects as odors are absorbed into the blood system through nasal mucosa impacting neural activity in the cerebral cortex or through the stimulation of the olfactory nerve that is associated with the limbic system that regulates our behavioral and emotional responses ^[9, 10]. However, further evidence-based research is indicated to further these physiological and psychological pathways.

The advancement of using essential oils as a treatment option has gone well-beyond determining the overall effectiveness of essential oils as now more emphasis is being placed on the efficacy of *specific* botanical families. The growing body of literature has created efficacy research focused within botanical families of essential oils. While some have suggested that essential oil blends have complicated efficacy research ^[16], it is important to examine results of this study to existing literature examining grapefruit and frankincense essential oils.

Grapefruit (*Citrus paradise*) is a member of the *Rutaceae* botanical family that also includes other citrus-based botanicals such as bergamot, clementine, kumquat, lemon, mandarin, orange, and tangerine. The main chemical property in citrus-based essential oils is *limonene* which has been suggested to positively affect biochemicals affecting depression, stress, anxiety, and mood ^[11]. Results of *this* study support a body of literature that indicates citrus-based essential oils may have anxiolytic or relaxing effects on individuals and are consistent with others supporting the use of limonene-based essential oils for altering mood.

However, there are limited studies using citrus-based essential oils with children and adolescents with E/BD, disability groups, or even children for that matter. Those including individuals with disabilities have small positive gains to sometimes even contradictory results ^[12, 13]. However, Soni, Bhati, and Oberol did find that orange essential oil (92% limonene) had positive effects on various measures of psychological and physiological measures of mood (i.e., anxiety) in pediatric dental patients ^[14]. This current research study helps fill a critical need in an unexamined research gap and therefore explore the potential of essential oils in pediatric populations and even more among those children and adolescents with disabilities.

Results of this current study are consistent with research in citrus-based essential oils and mood enhancement with some adult populations with psychological and physiological pathways. Specific to grapefruit, some have suggested that grapefruit essential oil may have overall relaxation effects through muscle thermogenesis ^[15]. While the amount of

inhaled *Citrus paradise* toxins were unmeasured in this current study, a dose response was therefore unknown and determining if levels were sufficient to elicit such a relaxed motor response was impossible to determine. It certainly provides further need for the specific efficacy mechanisms for the grapefruit essential oil.

The most researched citrus-based essential oil is bergamot, a hybrid of lemon and bitter orange ^[16]. Navarra *et al.* used animal research models that provide evidence of bergamot producing anxiolytic effects and promoting a corticosterone response to stress and anxiety ^[24]. With humans, research has suggested that the citrus-based Bergamot aroma had positive effects on physiological and psychological indicators of positive mood enhancement in healthy adults ^[17, 18]. Blends of citrus-based essential oils with lavender have also been found to enhance mood ^[19], but the complexity of blending citrus oils with *the* most highly researched essential oil (i.e., lavender) complicates understanding the efficacy of citrus-based essential oils. Therefore, this current study does provide further efficacy support in isolating essential oil blends that do not include lavender.

This current study used a blend that also included the frankincense essential oil. Frankincense (*Boswellia carterii*) is in the *Burseraceae* botanical family whereas alpha-pinene is the primary constituent. Frankincense has traditionally been used as a calming oil and in incense for the ability to slow down and deepen the breathing making it an excellent aid to meditation and prayer ^[20]. It therefore seems logical to blend frankincense with grapefruit essential oil to promote a relaxed mood.

Research has suggested that frankincense has effects on the emotional and behavioral processes in the central nervous system and can provide anxiolytic and antidepressant effects ^[21].

In an animal research model, Moussaleff *et al.* discovered evidence of these effects through the presence and activation of the transient receptor potential vanilloid (TRPV) in the brain which helps in the regulation of emotion and behavior ^[28]. Other research has indicated that frankincense also increases skin blood flow which is often a physiological indicator (i.e., galvanic skin response) of a more relaxed state ^[22]. The blending of the two essential oils in this study (i.e., grapefruit and frankincense) is further supported in that research has suggested that frankincense may also have some chemical components related to limonene ^[29], the same anxiolytic component found in citrus-based essential oils that facilitate mood-altering pathways.

Finally, most of the growing body of literature on aromatherapy efficacy has concentrated on chemical attributes, animal models, or survey research ^[17, 18]. Many of these studies correctly examine the physiological and sometimes psychological pathways to levels of therapeutic effect. However, very few studies look at the byproducts, or behaviors, of such proven pathways. This study offered a different way to evaluate those human interactions through applied behavior analysis and provided a new way for practitioners to potentially examine the effectiveness of

⁷Lizarraga-Valderrama LR (2020)

⁸Herz (2009)

⁹Johnson (2011)

¹⁰Jellinek (1997)

¹¹Lv *et al.* (2015)

¹²Hawkins, Weatherby, Wrye, &Ujch Ward (2019)

¹³Ndao *et al.* (2012)

¹⁴Soni, Bhatia, & Oberoi (2018)

¹⁵Nagai, Nijima, Horii, Shen, &Tanida (2014)

¹⁶Navarra, Mannucci, Delb`o, &Calapai (2015)

¹⁷Watanabe *et al.* (2015)

¹⁸Ni *et al.* (2013)

¹⁹Lehrner *et al.* (2005)

²⁰Pai, S. (2019)

²¹Moussaleff A, *et al.* (2008)

²²Zhu *et al.* (2017)

essential oils on behavior or social conduct in smaller and applied settings.

4. Conclusions

CAM approaches, and specifically aromatherapy, may have some influence in promoting more appropriate social conduct through a more relaxed or mood-altering state among children and adolescents with E/BD. However, there remains stronger evidence that more traditional applied behavioral analysis techniques including self-regulation, behavior shaping, token reinforcement, and group contingencies remain effective individual treatments to alter, if not change, social behaviors in children and adolescents with E/BD^[23]. These cognitive behavioral approaches are certainly most effective when they facilitate long-lasting behavioral change. However, most of these approaches take significant time. If aromas, specifically grapefruit and frankincense, do indeed facilitate more immediate behavioral changes, practitioners working with children and adolescents with E/BD may consider new approaches for addressing behavior conduct even if short term or temporary.

The growing body of literature supporting the use of essential oils as short-term remedies for mental health and behavioral conduct remains promising. Aromatherapy remains a low-cost, low-side effect, and effective option for those working with challenging populations such as children and adolescents with E/BD. While this research provides some encouraging results within a small case-study experiment, it provides further highlight on the lack of, and subsequent need for, further examination of the effects of essential oils on the mood and social behavior of children and adults with E/BD.

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²³ Chen *et al.* (2020)

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